NUCLEAR ENERGY FACTS

Questions and Answers

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President (1980/81) — Harry Lawroski
Chairman, Public Information Committee — Bernice Paige
Executive Director — Octave J. DuTemple
Director, Society Services — James R. Heelan
Manager, Design and Production — S.H. Krapp

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Q&A

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WHAT IS THE AMERICAN NUCLEAR SOCIETY?

The American Nuclear Society is a professional organization devoted to advancing science and engineering related to the atomic nucleus. More than 13,000 scientists and engineers in the Society's membership are active in diverse fields of research, teaching, consultation, administration, and engineering. Since this not-for-profit scientific and educational organization was founded in 1954, a primary purpose has been the dissemination of information about nuclear science and technology. Informing the public concerning the role of nuclear power in assuring adequate energy supply in the U.S. and abroad now is considered a vitally important responsibility of the American Nuclear Society. This effort to increase public understanding of the promise of nuclear energy is carried out mostly through activities of Society members in 55 ANS Local Sections throughout the world including 1,300 ANS members in some 50 other countries around the world.

NUCLEAR ENERGY FACTS QUESTIONS AND ANSWERS

Will we have enough energy?

It's not the only question we ask. Of increasing importance to all of us concerned about energy supply are economic, environmental, and political aspects as well. And, nuclear power—now a vital part of the energy supply for more and more people around the world—is given more public attention as we strive to meet energy needs today and seek energy solutions for generations to come. With the hope of increasing public understanding, some of the most-asked questions about nuclear energy are answered briefly but as factually as possible in this booklet. Professionally qualified members of the American Nuclear Society have prepared this information, published by ANS as a public service.

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Do we really need nuclear power?

Yes. A look at our fossil fuel resources and our increasing dependence on foreign supplies will explain why. Oil and natural gas supplies are running out and becoming increasingly costly. Because of the long time it takes to build a new plant (about 12-14 years) and the even longer time it takes to develop new technologies, we have to start making some hard decisions right now. Unlike oil and gas, our coal supply is relatively abundant, and also unlike oil and gas, the generation of electricity is its major use. With world energy use growing as the populations expand and economies develop only coal and nuclear energy are now available in large supply. Coal has its own problems in terms of air pollution. However, coal will be needed in the future as a substitute for oil and natural gas. There are few uses for the uranium other than for the production of nuclear energy; the quantities necessary are much smaller; and nuclear power plants are cleaner. Thus, nuclear energy is needed to take over an increasing share of electrical production if we are to become less dependent on foreign oil.

Won't conservation of fossil fuel resources and generated electricity make nuclear power unnecessary? Why do we need nuclear?

Conservation is important and must be encouraged. However, conservation alone will not solve the energy problem. We are unlikely to want zero economic growth, if for no other reason because our population growth will not achieve equilibrium until the 21st century, even with continuation of low birth rates. Even moderate population and economic growth will require increased production of energy.

Nuclear is important because the recoverable energy released from the nuclear reaction for the generation of electricity is about 68,400 times greater than the energy recoverable from burning an equivalent weight of coal in a fossil fuel plant. Ton for ton, uranium ore yields over 50 times the energy of coal. The amount of uranium required each year for a nuclear plant is extremely small (about 30 tons) compared with the amounts of fossil fuels required for the same size plant (2.3 million tons of coal, or 10 million barrels of oil, or 64 billion cubic feet of gas). In addition, 97% of the 30 tons of uranium fuel is reusable. It's cheaper than any way you can think of.

How about the costs of power? Isn't nuclear power more expensive than the other sources?

No. Actually it's less expensive. The 1978 average total cost of producing electricity was: Nuclear—1.5 cents per kilowatt hour; Coal—2.3¢/kwh; Oil—4.0¢/kwh. Nuclear power saved nearly $3.6 billion in 1978 over the weighted average cost of all coal or oil-fired generation. This saved the equivalent of more than 130 million tons of coal or nearly 470 million barrels of oil. Costs for building nuclear plants have greatly increased due to regulations and court delays; many of these delays have done nothing to improve reactor safety or reliability. Coal-fired plants are also facing increasing costs due to regulations, so nuclear plants will remain cost effective. Over the long term, nuclear generation of electricity can produce large savings over coal generation because of the difference in fuel costs and transportation expense.

Why should we depend on nuclear power when some critics say the reactors are unreliable and uneconomic?

The reliability of nuclear plants, on the average, is as good as, or better than, coal plants of the same age and size—within 1 or 2 percentage points of each other. This is true both for number of hours the plants are available each month and for the percentage of generating capacity actually achieved. A few nuclear plants, especially some older ones, have had operating problems that delayed their startups or reduced their operating times. Generally, the problems (in both coal-burning and nuclear plants) are with conventional steam equipment and are unrelated to the nuclear reactor.

A lot of people are worried about radiation from nuclear power plants. How much radiation do I get from the generation of nuclear powered electricity?

Very little. As a gauge, a person in the U.S. receives on an average 180 millirem (mrem) per year from all sources. A millirem is a measurement of the effect of radiation on living tissue. Most is natural: from soil, water, rocks, building materials, food. Since 1970 radiation from all commercial nuclear energy averaged 0.01 millirem for each person in the U.S. In the year 2000, assuming nuclear energy becomes a dominant source of electricity, the average citizen will receive an estimated yearly dose of less than 1 mrem from commercial nuclear energy. Those living near nuclear power plants will receive less than 5 mrem per year. (To compute your own radiation dose, use the table on pages 44 and 45.)

If small amounts of long-lived radioactive materials are released to the environment, isn't there a buildup to dangerously significant levels over a long period of time?

No. The radioactive materials come from the environment in the first place. There is no increase in the sum total, merely a redistribution from one place to another, and these radioactive materials undergo a natural process of continual decay. Because radioactive materials undergo decay, extensive use of nuclear power will decrease the total radioactivity on earth for future generations.

Government agencies limit releases from nuclear power plants and the entire fuel cycle. As for the risk or danger, the levels of releases from nuclear plants may shorten the human life as much as 24 seconds. You can place this in perspective by realizing that being 25% overweight decreases the lifespan by 3.6 years, smoking a pack of cigarettes a day can decrease life by 7 years, and living in the city rather than a rural area can decrease it by 5 years.

Why is any release of radioactivity permitted?

It is as impossible to have zero releases from nuclear plants as it is to have zero releases of pollutants from any industrial process. What is done is to assure that any releases are well below the levels of significant environmental or human health effects; these limits are set by national and international groups and are based on vast quantities of data collected for over 50 years. This attention to releases has been observed in the nuclear power industry from its inception. In contrast, most other technologies were fully developed and in use before pollution control was required or achieved. Radioactive materials are routinely released, with no controls, from coal-burning power plants; this radioactivity comes from minerals that are a natural part of the coal.

Has any person in the United States ever been exposed to an overdose of radiation from commercial nuclear power plants?

The public has never been exposed to radiation levels above the annual dose limits established by international standards. Rare cases of researchers and workers being overexposed have occurred, mostly in early days of nuclear science. Workers in commercial nuclear power production are, in fact, protected with extensive precautions to prevent exposure which might adversely affect them even many years later.

What are power plant operators doing about thermal pollution?

Power plant operators must comply with strict federal, state, and local regulations limiting the amount of unused heat (in the form of water, liquid, or vapor) power plants can release into the environment. Most states limit the rise in water temperature at the plant's heated-water discharge to less than 5°F. The Environmental Protection Agency requires either a system using ponds or towers for precooling the water or proof that direct discharges of power plant heat will not damage the ecological balance of the body of water or the plant and animal life dependent on it. Power plant operators must monitor the discharges and bodies of water to demonstrate continually that the cooling systems are functioning properly with no resulting damage to the environment.

How would an earthquake affect a nuclear power plant located near the quake center?

Nuclear power plants are generally located away from earthquake-prone areas and are carefully designed to withstand an earthquake if one should occur. This applies to all parts of the United States and in other countries as well. Each plant must be able to withstand the maximum earthquake motion that could be expected at its site and be able to shut down safely. Unlike fossil plants, which are not designed to the same exacting standards for earthquake resistance, nuclear plants can be expected to continue operating during a moderate earthquake. Nuclear plants near earthquake epicenters in California and Japan have successfully withstood earthquakes of magnitudes as great as 6.5 on the Richter scale.

What kinds of accidents can occur wi nuclear power plants? How likely are they to occur?

First of all, nuclear power plants cannot explode like an atomic bomb because they do not contain the necessary concentration of fissionable material. Reactors are designed and constructed to withstand the kinds of accidents that could occur. Most often mentioned is an accident that could cause loss of the coolant water as the result of a rupture of a large pipe. This has **never** happened in a commercial reactor. Despite the damage to the core and the small releases of radiation at TMI, the defense-in-depth design philosophy prevented any serious damage to the rest of the plant or to the health and safety of the public. According to a comprehensive study of the probabilities of various kinds of nuclear accidents, the "Rasmussen Report," an accident that might kill as many as 10 people could occur about once every 30,000 ye with 100 reactors in operation.

How is the public protected against various potential hazards?

In a nuclear power plant, the potential hazard is the large amount of radioactive products created in the fuel during the fission process that generates the heat to make the electricity. Plants are designed to contain these fission products in the event of an accident. This is done with multiple physical barriers, beginning with the fuel itself and proceeding to metal and concrete barriers around the reactor core and the entire reactor system. Each plant is also surrounded by an area from which the public is excluded.

Many safety systems, including backup systems, are designed to shut down the reactor if the plant begins to operate abnormally. All people who work in the reactor's control room go through rigorous training and must be licensed by the U.S. Nuclear Regulatory Commission (NRC). Operators must follow written instructions precisely to assure safe and dependable nuclear plant performance.

Following TMI, industry established the Institute of Nuclear Power Operation (INPO) to improve further the standards for reactor operator training.

Doesn't the 1979 accident at Three Mile Island prove that nuclear power is too dangerous?

No. The accident at Three Mile Island (TMI) had a traumatic effect on some of the people in the vicinity of the plant because of a fear of a meltdown of the nuclear fuel. Several expert studies, including the Kemeny Report commissioned by President Carter, agree that a meltdown would not happen and that the defense-in-depth safety design worked to protect the public health and safety. They also agree that the effects on the population in the vicinity of Three Mile Island from radioactive releases during the accident, if any, will certainly be nonmeasurable and nondetectable. The accident was serious, but no lives were lost, no one was physically harmed or is likely to suffer future ill effects. The industry and government are diligently searching for and applying "lessons learned" from the accident at TMI to plant and reactor design, operator training, communication, and regulation.

How good is the nuclear power plant safety record?

In over 20 years of nuclear reactor operation by electric utilities in the U.S., no property damage or injury to the public or operating personnel has ever been caused by radiation from these facilities. U.S. naval vessels have a similar accident-free record for an even larger number of nuclear plants. Studies show that public risks of adverse health effects from nuclear plants are less than from power plants using other kinds of fuel. This remains true even after the accident at Three Mile Island, Pennsylvania, in 1979. The greatest injury resulting from that accident was mental anguish caused by fear.

How are nuclear power plants licensed and regulated?

Before any plant can go into service, the utility must obtain many different licenses and operating permits from federal, state, and local agencies. First, a construction permit from the U.S. Nuclear Regulatory Commission is required. Then, after construction is completed, an operating license must be obtained. After the plant goes into service, the NRC carries out on-site inspections to assure that the plant is operated according to its license. Each utility monitors its plants for radioactive discharges and the records are audited by the NRC and the Environmental Protection Agency. Abnormal operations or conditions are reported to these agencies. Independent inspections are also made by insurance companies (see p. 24).

Why is there a "nuclear exclusion" clause in homeowner's property loss insurance?

Most homeowner's policies have clauses excluding coverage for nuclear damage as well as for various natural disasters. Nuclear exclusion clauses exist because such coverage is channeled into nuclear insurance pools. Groups of private insurance companies, together with Federal Idemnity and the nuclear utilities, supply the legally required liability coverage for all nuclear facilities that could cause damage to the public, to a maximum of $560 million. The nuclear utilities pay appropriate premiums for both the private insurance pool coverage and the Federal Indemnity. The private insurers have committed $160 million for damage to the public, plus $30 million of secondary liability coverage, and $300 million of property coverage, thus making a current commitment of $490 million for homeowner's property insurance from the insurance industry.

Isn't the Price-Anderson Act a subsidy to the nuclear industry? Without it, wouldn't the industry cease operation?

No. First, there is nothing new about Federal Indemnity programs. They already include crop insurance, national flood insurance, medicare, and other large-scale programs. Second, the nuclear utilities have and are paying premiums to the Federal Government for the indemnity (the government has never had to pay a claim under the coverage). Since the indemnity portion of the Price-Anderson Act is being phased out as a responsibility of the government and is being assumed by the nuclear utilities, it is apparent that the loss of this indemnity is not causing the industry to cease operations. Three Mile Island demonstrated the need to cover the cost of power purchased to replace the power lost as a result of the accident; industry has now established Nuclear Energy Insurance Limited (NEIL) to help pay for replacement power in future accidents that result in loss of power production.

Why hasn't the waste disposal problem been resolved?

The high-level radioactive waste disposal problem has not been resolved becuase it has neither been politically expedient not physically necessary to do so. Several plans for handling these wastes *have* been worked out. Scientists, through many years of research, have developed alternate ways to contain and store radioactive waste safely. The need for permanent waste disposal exists even if commercial nuclear power is not continued. Wastes from defense programs at Hanford, Washington, Savannah River, South Carolina, and Idaho National Engineering Laboratory, Idaho, already far exceed the quantities that will be produced by the year 2000 from commercial nuclear power plants.

The volume of wastes is readily manageable. If the liquid wastes from fuel reprocessing are "cooled," converted to stable solid form, and permanently stored at a federal repository, all the nuclear waste—including the low-level waste—from the entire U.S. nuclear power industry until the year 2000 would fit into a cube 250 feet on a side. The high-level portion of the radioactive wastes would take up a cube 50 feet on a side within the 250-foot block.

The National Academy of Science and other noted scientific organizations have stated clearly that the technology exists now for safe disposal of radioactive waste. The problem, then, is a political one, centering around federal licensing of facilities, states' rights in siting, and the need of fuel reprocessing to concentrate the wastes. A demonstration of the feasibility of safe waste storage requires action by Congress to mandate immediate construction of such facilities.

Is it right for us to leave a "legacy" of radioactive wastes as a hazard for future generations?

The consequences of alternatives to nuclear power should be pondered in determining if we consider it morally acceptable to establish carefully guarded and monitored respositories for the high-level radioactive wastes. We may burn up all the fossil fuels that *ever existed on earth* in only a few hundred years just to sustain industry, to feed current world populations, and to satisfy the growing demand around the world for an adequate standard of living with hope of improvment. Should we leave our descendants without fossil materials (coal, oil, gas) from which to extract fertilizers, medicines, and plastics because we elected to burn these fossil materials instead of using nuclear power? Is it fair to leave them without adequate energy to provide employment and the chance to choose their own lifestyles? In a democratic society, a public consensus based on informed opinion must answer these questions.

What happens to low-level wastes?

All low-level radioactive wastes are packaged and shipped for land burial to government licensed low-level waste storage sites. Transportation and burial of the wastes are regulated and controlled by two primary federal agencies, the Department of Transportation (DOT) and the Nuclear Regulatory Commission (NRC).

Low-level radioactive wastes from a nuclear plant are composed of resins from water purification filters, lab supplies, and trash. The typical nuclear power plant generates about 30,000 cubic feet per year of low-level wastes, equal to the contents of 4,000 55-gallon drums. (The high-level wastes are composed of the radioactive fission products contained in the used fuel from the nuclear reactor, about 3% of the total fuel.)

A large portion of the country's low-level radioactive wastes comes from hospitals in the form of empty containers from which the radioactive material has been drawn and put into human beings for diagnostic purposes or treatment. Nuclear medicine in the form of radioactive isotopes is used thousands of times daily in U.S. hospitals. The medical low-level wastes are also sent to government licensed low-level waste storage sites for burial.

How difficult would it be to build a nuclear bomb if you could obtain the basic materials?

You'd also need the knowledge, hardware, special materials, and specific abilities. You *cannot make* an explosive device with the enriched uranium that is used as fuel for power reactors. Uranium enrichment is a difficult and costly process that could be carried out only by a nation with large resources and trained people. Plutonium in the spent nuclear fuel removed from reactors must first be separated from other materials. (From a practical point of view, theft of the nuclear fuel is difficult. For example, a crude bomb using 25 pounds of plutonium would require the theft of about 1,500 pounds of radioactive fuel, removed from 12-foot-long reactor fuel elements transported in a shipping container weighing up to 100 tons.) Then, before a nuclear bomb with the plutonium could explode, precise amounts would have to be brought together with just as precise shaping, sequencing, and timing.

Can't the dispersal of radioact. materials be an effective terrorist device?

Perhaps, in theory. Some scenarios say the most likely radioactive material used as a threat would be plutonium. Although plutonium is radiologically toxic when small quantities are inhaled and ingested, its effects do not occur until 25 to 45 years after exposure. In preference to materials that have delayed effects, like plutonium, terrorists could be expected to choose the psychological impact of immediate damage, such as that caused by bombs and fires. Also, terrorists would have great difficulty obtaining plutonium, while equally or more toxic chemical and biological poisons are much more readily available. The International Fuel Cycle Evaluation made in 1978-80 determined that strict control and safeguards are the best way to prevent unauthorized access to nuclear materials.

Doesn't selling nuclear power plant components abroad, where we can't control their use, increase the kind of danger we've been talking about?

Nuclear power plants are being built and sold around the world by France, Germany, Japan, and other nations. The U.S. can no longer control the use of this valuable resource. Government regulations and restrictions of 1978-79 on exports literally removed the U.S. from the world nuclear leadership; this further reduced the U.S. ability to control the spread of nuclear facilities. Since facilities for fuel reprocessing and uranium enrichment present the greatest opportunity for proliferation, some people believe that the U.S. should provide these services for other countries to help deter the transfer of nuclear materials into unstable areas of the world.

How toxic is plutonium? How many people have ingested plutonium and, as a result, died or developed cancer?

Plutonium, although recognized as hazardous, is *not* the "most toxic material known to man," as has been charged. Various organisms, chemicals and biological agents, such as snake venom, are lethal in smaller amounts and work faster than plutonium. However, while plutonium can be hazardous if inhaled or ingested, there are no known deaths attributable to plutonium poisoning. Of 25 persons who worked with plutonium at the Los Alamos Scientific Laboratory during World War II, not one has developed cancer since their exposure.

The nuclear industry says we need breeder reactors. Why?

Only an estimated 30 or 40 years' worth of uranium remains that can be readily and economically extracted from the ground for use in nuclear reactors. If we are not to use up this resource — the way we are using up our fossil fuel resources — we need to make more efficient use of our nuclear fuels. Worldwide, there is a strong agreement on developing the "breeder" reactor. Breeder reactors can turn the vast majority of uranium atoms (which are not fissionable) into fissionable fuel that can be recycled to produce more energy. Because they produce more fuel than they burn, such reactors are said to breed fuel. The breeder could increase the usable amount of uranium by more than 70 times, stretching 40 years' worth of uranium into many centuries worth of fuel. In the U.S.A., non-fissionable uranium sitting in drums at government sites is equivalent to all of the estimated oil resources of the entire world if we utilize it in breeder reactors.

This source alone, worth more than $60 trillion dollars at today's oil prices, could provide our total electrical energy needs for several centuries.

Isn't it especially hazardous to ship nuclear fuel and high level wastes from one nuclear facility to another?

It is no more hazardous to ship nuclear fuel and high-level radioactive wastes than to ship many other materials we routinely transport all over the country, such as chlorine. Three types of hazards are considered in the transportation of nuclear fuel and wastes — radioactivity, ability to form a critical mass, and theft. The first is controlled by preventing the release of highly radioactive materials, even in the most severe accident. To ensure this, shipping casks have been deliberately subjected to collisions between trucks and trains, and trucks and a concrete wall. In all cases, films document that there was not enough damage to the shipping cask to permit release of any radioactive contents. The second is controlled by the use of appropriate shielding and by separating materials. Theft is preventable by a combination of impenetrable shipping materials and security personnel. All shipments are subject to strict federal regulation.

How do the risks from nuclear power compare with other everyday risks?

Nuclear power offers less risk. This sort of comparison was examined in the many safety studies, most notably the Rasmussen Report. Events such as air crashes and explosions have more than 100,000 times the chance of killing 10 people than 100 nuclear plants, the study concluded. It also found that a dam failure has 10,000 times the chance of killing 1,000 people than 100 nuclear plants. Far greater consequences are calculated for natural disasters — earthquakes are 2,000 times more likely to kill 10 people than 100 nuclear plants. Hurricanes are 60,000 times as likely to kill 1,000 people as 100 nuclear plants.

Can't we use solar and fusion power instead of nuclear power?

Solar, fusion, and other power sources — including hydroelectric, wind, and geothermal power — are limited in future expansion by location and natural conditions or the need for a long period for development of the technology. Hydroelectric power in the U.S. is just about fully exploited. Solar power is not expected to be adaptable to large, central station electric power production in this century, if ever. However, any contribution from solar energy would be helpful. Utilities' demands peak during the day even when the sun shines. Additional oil or coal must be burned to assist base-load nuclear power plants.

The fusion reaction, so far created only in the laboratory, has a long way to go before it can be demonstrated on a large or economic scale. Even in certain areas where windpower might be harnessed, relatively small amounts of electricity will be produced. More geothermal power could be developed in a few specific areas of the West where sources occur, but only as a minor contribution to the nation's total electrical needs. In addition, the safety and environmental effects of those alternative energies have not yet been fully assessed.

Aren't we really talking about the quality of life? Who decides if the benefits are worth the risks?

Ideally, in our democratic society the decisions are made by consensus or by majority decision. One aspect of this can be seen by the voting in 1976 in various states on the issue of "safe power," where majorities of the voters decided additional restrictions on nuclear power plants were not desirable. The public in general has not turned against nuclear power since the accident at Three Mile Island. Voters in Maine in 1980 refused to shut down Maine's only operating nuclear plant.

More subtle, societal consensus depends on a "trade-off" involving not only health and safety, but also esthetics, quality of life, and ecological balance. Sometines societal consensus is embodied in law, such as the National Environmental Policy Act, or in court decisions. Or, it can be built into a licensing process, as is the case with nuclear power plant construction and operation, where public input is a vital part of the process.

What is our responsibility?

Some affluent people contend that there is too much technology today; that it is the basis for many of society's ills, and that we must, therefore, put a stop to further development. Exaggerated are the problems caused by technology while forgotten are the truly large societal problems that technology has helped solve. For example, as we condemn Detroit and auto emissions, let us not forget New York early in this century with 150,000 horses in the street and their emissions.

Throughout history, mankind has had two basic choices when confronted with a problem that technology could solve. The first choice has been to ignore the promise of technology and endure the problem—a choice which has invariably led to reduce comfort, well-being, and security. The second choice has been to put technology to work to solve the problem—a choice which has assured increasing prosperity, opportunity, and hope for all mankind.

It is essential that any decision be based on scientific facts and not on dreams. It is the responsibility of the scientific community with expertise on energy technologies to inform the public on the facts. It is your responsibility to become informed and to choose on that basis.

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AVERAGE PERSONAL RADIATION DOSE*

We live in a [illegible]active world — always have. Radiation is all about us as a part of our natural environmen[illegible]s measured in terms of m[illegible]irems (mrems). The annual natural average dose per person is 180 mrems, but it is not uncommon for any of us to receive far more than that in a given year. This is not dangerous. As an example, exposure to 5,000 mrems a year is allowed for those who work with and around radioactive material.

	Common Sources of Radiation	Your Annual Dose (mrems)
WHERE YOU LIVE	**Location:** Cosmic radiation at ***sea level***	26
	For your elevation (in feet) - add this number of mrem	____
	Elevation - mrem: 1000 - 2; 2000 - 5; 3000 - 9; 4000 - 15; 5000 - 21; 6000 - 29; 7000 - 40; 8000 - 53; 9000 - 70	
	Elevation of some U.S. cities (in feet): Atlanta 1050; Chicago 595; Dallas 435; Denver 5280; Las Vegas 2000; Minneapolis 815; Pittsburgh 1200; St. Louis 455; Salt Lake City 4400; Spokane 1890. (Coastal cities are assumed to be zero, or sea level.)	
	Ground: U.S. average	26
	House Construction: For stone, concrete or masonry building, add 7	____
WHAT YOU EAT, DRINK, AND BREATHE	**Food** **Water** **Air** — **U.S. Average**	24
	Weapons test fallout.	4

HOW YOU LIVE	**X-ray and radiopharmaceutical diagnosis** Number of chest x-rays ______ x 10 . . . . Number of lower gastrointestinal tract x-rays ______ x 500 . . . . Number of radiopharmaceutical examinations ______ x 300 . . . . . (Average dose to total population — 92 mrem)	______ ______ ______
	Jet plane travel: For each 2500 miles add 1 mrem	______
	TV viewing: For each hour per day ______ X .15	______
HOW CLOSE YOU LIVE TO A NUCLEAR PLANT	**At site boundary:** average number of hours per day ______ x 0.2. . . . . **One mile away:** average number of hours per day ______ x 0.02 . . . . . . **Five miles away:** average number of hours per day ______ x 0.002 . . . . . . **Over 5 miles away:** . . . . None . . . . Note: Maximum allowable dose determined by "as low as reasonably achievable" (ALARA) criteria established by the U.S. Nuclear Regulatory Commission. Experience shows that your actual dose is substantially less than these limits.	______ ______ ______ ______
	My total annual mrems dose	______

Compare your annual dose to the U.S. annual average of 180 mrems.

One mrem per year is equal to: Increasing your diet by 4%,
Taking a 5-day vacation in the Sierra Nevada mountains.

*Revised from earlier editions based on the "BEIR Report III" — National Academy of Sciences, Committee on Biological Effects of Ionizing Radiation, "The Effects on Population of Exposure to Low-Level Radiation," National Academy c[illegible]nces, Washington, D.C., 1980.

Other Reference Materials Available from ANS

Nuclear Energy and the Environment: Questions and Answers: Book 1, *Radiation*. This is the first of a four book series (Book 2, *Fuel/Waste;* Book 3, *Safety/Risks;* Book 4, *Energy Alternatives)*, updating the original "Q&A" book. *Radiation* is a compilation of up-to-date factual information responding to certain questions about nuclear power, public acceptance and radiation. This more detailed "Q&A" book is expected to have a world wide distribution of over a half-million copies.

Personal Natural Radiation Dose Chart: we are all exposed to radiation, all the time — from the stars, from food, from water; but how much? And from what? This chart, reproduced from pages 44 & 45, enables one to calculate one's personal natural radiation dose. This individual flyer is ideal for wide spread distribution to students and other large groups.

The Communicators: a 120 page booklet containing the names and addresses of energy-related speakers and contacts for the public and the media. It contains a listing of informed scientists, engineers and administrative persons who have volunteered to talk to critics, consumers, commentators, reporters, civic groups and any other organizations that are concerned about the energy needs of our country.

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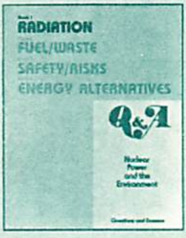

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