3/6/81

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNION ELECTRIC COMPANY	)	Docket No. STN 50-483-OL
	)	
(Callaway Plant, Unit 1)	)	

AFFIDAVIT OF KAY DREY

Kay Drey, first being duly sworn, on her oath states:

1. I have been studying nuclear power for six years. I have been doing research on the planned and accidental release of radioactive materials into the environment from the uranium fuel cycle, with particular emphasis on nuclear power plants, since January, 1977. I am particularly concerned about tritium--its health effects and the fact that an estimated 410 curies would be released from the Callaway Plant into the Missouri River, the source of my drinking water, during routine operation. I am concerned about the planned and unplanned releases of radioactive pollutants into the air my family and I breathe, the water we drink and the food we eat.

I have collected and studied reports of accidents at nuclear plants, particularly those caused by human and procedural errors and by component failure. I have filed a petition to intervene in the proposed chemical decontamination of Dresden Unit One, and have intervened or am intervening in proceedings concerning the issuance of the following permits: a National Pollutant Discharge Elimination System (NPDES) permit by the Missouri Clean Water Commission (MoCWC) for the Combustion Engineering uranium fuel fabrication plant at Hematite, Missouri; an NPDES permit by the

MoCWC for the Callaway Plant; and a Section 404 (Federal Water Pollution Control Act) construction permit by the Army Corps of Engineers for the Callaway Plant. I served as statewide coordinator for the successful initiative campaign that outlawed Construction Work in Progress financing for electric generating facilities in Missouri in November 1976.

Basing my testimony on recent laboratory studies and epidemiological data which provide increasing evidence of the hazards of low-level radiation, I have appeared before the Committee on Federal Research on Biological Effects of Ionizing Radiation, National Research Council, in Washington in September 1980. (Oral and written testimony attached).

I have special knowledge about construction defects at the Callaway plant through communication with a least a dozen present or former Callaway construction workers who would be potential witnesses in the operating license proceeding. I have forwarded allegations to NRC staff people at the Region III office (Glen Ellyn, Illinois) by letter, telephone, and in private and public meetings, and to NRC staff people at the headquarters by letter and telephone, starting in 1977. I possess extensive files concerning alleged construction defects relating to the placing of iron and concrete during approximately the first ten percent of construction, and to certain piping placed in 1979, at Callaway.

2. I am a lifetime resident of the St. Louis Metropolitan area, currently residing in University City, St. Louis County, Missouri, approximately 75 miles downwind from the Callaway Plant site. My sole supply of drinking water is the Missouri River, which

would be contaminated by radioactive pollutants from the Callaway Plant if it were to become operative.

I and my family have picnicked, hiked and birdwatched along the Missouri River in Callaway County and eastward into St. Charles County several times a year for many years, that is, within a range of approximately 10 to 60 miles of the proposed plant. We have often travelled along Highway 94 to enjoy the fall colors, a display as outstanding as any in the Ozarks. My husband and I have worked to preserve riverways as recreational assets in Missouri for over twenty years, including the Missouri River, and have inspected and supported the Corps of Engineers' efforts toward riverine habitat and floodway restoration of the Missouri River.

3. Severe damage or melting of the reactor core (a Class 9 accident according to "The Safety of Nuclear Power Reactors (Light Water-Cooled) and Related Facilities," Atomic Energy Commission, WASH-1250, July 1973) and the subsequent release of a significant portion of the isotope inventory of the core to the environment were declared to be virtually impossible by the Rasmussen Reactor Safety Study of 1975 (WASH-1400). In January 1979 the Nuclear Regulatory Commission withdrew its endorsement of the Rasmussen study, and two months later our nation's first Class 9 accident began at Three Mile Island.

According to the Office of Nuclear Reactor Regulation of the NRC, "the accident at Three Mile Island exceeded many of the present design bases (of engineered safety features and radiation protection systems) by a wide margin and was evidently a significant precursor of a core-melt accident. . . " (From "TMI-2 Lessons Learned Task Force Final Report," NUREG-0585, October 1979, p. 3-5). The NRC

Special Inquiry Group report, directed by Mitchell Rogovin, concluded that "within 30 to 60 minutes, a substantial portion of the fuel in the core--certainly the center of the top half of the core, and perhaps as much as half of all the fuel--would have melted." ("Three Mile Island: A Report to the Commissioners and to the Public," Volume I, January 1980, p. 20).

While the probability of a Class 9 accident at the Callaway plant may remain low, the consequences could be severe for St. Louis and beyond. A report prepared for the President's Council on Environmental Quality by the Center for Energy and Environmental Studies at Princeton University (by Jan Beyea with Frank von Hippel; December 1980) predicts delayed cancer deaths and thyroid nodules at least as far as 250 miles downwind (Appendix E) and possible human occupation and agricultural land restrictions "out to distances of 1000 miles and for periods of decades after the release" of radioactivity from a hypothetical accident at the Three Mile Island location (p. 13). "The range of genetic defects would be equal, very roughly, to the range of delayed cancer deaths." (p. 12 fn.)

In reevaluating the levels of safety afforded by safety-grade and non-safety systems based upon the Three Mile Island accident, the NRC has recently added four major "unresolved safety issues" to its list of 133 submitted to Congress initially in 1978. One of those issues is the need for hydrogen control in the reactor containment building following a core-melt or core-damage accident. Whereas NRC guidelines prior to Three Mile Island had anticipated that only from 1 to 5% of the zirconium in the fuel rod cladding would react with steam in the reactor vessel, forming zirconium oxide and releasing hydrogen, apparently it is now postulated that that figure may be at least as high as 50%. The NRC and the Advisory Committee on Reactor Safeguards (ACRS) now acknowledge the fact that new hydrogen control measures may be required to prevent the breaching of the reactor vessel and the accelerated melting of the uranium fuel. In addition, controlled filtered venting of the containment building may be required so that "combustible concentrations of hydrogen will not collect in areas where unintended combustion or detonation could cause loss of containment integrity or loss of appropriate mitigating features." (From a position paper of the ACRS Staff dated February 6, 1981, concerning the Degraded Core Rulemaking). Obviously the increase in the venting from the Callaway plant of radioactive noble gases and halogens, along with other gases and particulates--even if under ideal conditions of controlled filtering--would increase the health risks of people living downwind in St. Louis and for hundreds of miles beyond.

Kay Drey
KAY DREY

STATE OF MISSOURI)
)SS
CITY OF ST. LOUIS)

Subscribed and sworn to before me this 6 day of March, 1981.

Ken M Chackes
NOTARY PUBLIC

My Commission expires: KENNETH M. CHACKES
NOTARY PUBLIC STATE OF MISSOURI
ST. LOUIS CO.
MY COMMISSION EXPIRES SEPT. 28 1984

515 West Point Avenue
University City, MO 63130
September 8, 1980

Dr. Russell H. Morgan, Chairman,
and Members
Committee on Federal Research on Biological Effects of
Ionizing Radiation
National Research Council
2101 Constitution Avenue
Washington, D.C. 20418

Gentlemen and Masdames:

I am submitting this letter as a housewife and mother, and as a citizen who has been studying nuclear power for six years. The more I learn about what is known and not known about radiation and nuclear power, the more convinced I become that all facilities that are creating new radioactive materials should be shut down as soon as possible, except those used for medical purposes. I believe that available nuclear engineering, scientific and medical research talent and funds should be directed toward trying to resolve a problem that is perhaps unresolvable: the need to keep those permanently toxic radioactive wastes we already have out of the biosphere permanently. Unless or until answers can be found for the old wastes, I believe no more should be created.

I realize the above paragraph contains concerns that are not new to you. Although I do not have a list of the other members of your committee, I know that Dr. Russell Morgan, for one, has been trying since at least the 1950's to bring caution and objectivity to bear on questions of radiation standards and health research, an effort which unfortunately has been largely unsuccessful. (This was described, for example, in an April 1979 article by Walter Pincus of the Washington Post about a report Dr. Morgan had submitted in October 1958 to the U.S. surgeon general.)

Throughout this letter I shall cite facts and quote from documents which also are not new to you. That is because I believe these materials are relevant to your appointed task. The U.S. Congress has continued to allow long-lived sources of ionizing radiation to be created and dispersed into the environment years after scientists had learned that those sources would remain permanently hazardous. I believe that the rationale for the decisions and indecisions made in the early years of nuclear power generation should be presented to America's citizens before similar irreversible decisions are made for the future.

Or to quote three dicta on nuclear waste disposal presented by Wolman and Gorman of the Atomic Energy Commission's Division of Engineering at Oak Ridge:

> "The problem of the disposal of radioactive wastes is still one of the most important confronting the industry, even though great progress has been made in identifying the issues and in improving the results

ATTACHMENT 1 (written testimony)

maximum internal radiation dose if present in the air or water: 500 millirems a year to a nearby member of the general public, as per Section 105 and Appendix B, Table II — or 5 rems a year to a worker, as per Table I and the National Bureau of Standards' Handbook 69:

> "The maximum permissible average concentrations of radionuclides in air and water are determined from biological data whenever such data are available, or are calculated on the basis of an averaged annual dose of ... 5 rems when the gonads or the whole body is the critical organ." (from "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure," Handbook 69, June 1959, p. 5)

In other words, although the maximum concentrations permitted in air and water for the 270 isotopes now listed in the NRC's 10 CFR 20 Appendix B may differ from one another by the most minute amounts, the differences may not be much more than conjecture. And yet these concentrations form the basis for the NRC's negotiations with its licensees in determining each facility's firm operating limits — how much radioactivity may be released to the environment and how much may be allowed to leak within the plant before a shutdown for repairs is required.

> "In spite of the enormous amount of work which has been done by this subcommittee (of the ICRP and NCRP), the problem of developing maximum permissible concentrations of radionuclides is still rendered difficult because of the relatively limited direct experience with the action of the radiation from radionuclides on human tissues. The contents of this Handbook are based on what is believed to be the best information available and it is to be expected that <u>as our knowledge increases</u> the numerical quantities presented in this report will be in <u>a state of continuous modification</u>." (<u>Ibid</u>., pp. iv-v; emphases added)

To what extent has this continuous modification occurred? To what extent has the requisite research on the health effects of specific isotopes been performed on which to base any modification? Apparently not enough. According to the "Report of the Interagency Task Force on the Health Effects of Ionizing Radiation," June 1979:

> "The largest animal population studied to date is comprised of 250,000 mice, an enormous population to maintain under laboratory conditions. This study has produced useful information on the biological effects of radiation. Nonetheless, even this animal population is not large enough to provide conclusive information on low dose effects. Also, response patterns vary from species to species, leaving uncertain the question how study results should be applied to humans." (pp. 30-31)

2. How many radioisotopes have already been found to be more hazardous than was suspected back in the 1950's when the maximum permissible contaminant levels (now found in Appendix B) were first published? For example:

a. TRITIUM:

Because no economically feasible way exists to remove tritium from the cooling water and steam discharged from a nuclear power plant, NRC licensees are not required to remove it. Important questions, then, include: How much tritium is created per year per 1000-megawatt reactor, and how much of that diffuses through the ceramic pellets and fuel rod cladding into the cooling water and ultimately into the environment? Following correspondence with Oak Ridge National Laboratory, Westinghouse and others, I am convinced that no one really has the answers.

Some of the ways tritium is produced in nuclear reactors are the following: (1) as a tertiary fission product; some diffuses through the cladding into the coolant; (2) when boron absorbs neutrons produced by the fission process; boron is often used in control rods, and boric acid is introduced into the coolant water in pressurized water reactors for the purpose of absorbing neutrons to control the rate of the nuclear reaction; and (3) as a result of neutron capture by deuterium.

I am always surprised, by the way, when I am reminded of how recent our knowledge is about nuclear physics: The discovery of tritium as a fission product was only first reported in 1959, two years after Shippingport, the first commercial nuclear reactor, became operative — and 14 years after the first atomic bomb was exploded in New Mexico.

The estimates of the amount of tritium released routinely from a nuclear facility range greatly.

(1) Commonwealth Edison, for example, reported to the NRC that the total amount released into Lake Michigan during 1977 from Zion's two 1000-megawatt Westinghouse reactors was 724 curies. After being reprimanded in 1977 by the NRC for not reporting its releases of tritium, ComEd changed its estimates for 1974 from 2.3 curies to 274, and for 1975 from 40 curies to 1030. The amount published for 1976 was 747 curies. ("Radioactive Materials Released from Nuclear Power Plants - 1977," published in January 1979 as NUREG-0521).

I do not know whether the tritium released with the continuous flow of cooling water (e.g., cooling tower blowdown) is monitored and reported to the NRC, or whether only that amount that is released in batches from tanks. Or is all the tritium perhaps estimated, including that in the batch releases? As with noble gases, I understand tritium monitoring takes time and sensitive laboratory equipment, a combination I would imagine is not feasible for continuously flowing effluents.

(2) At an International Atomic Energy Agency seminar held in Vienna in 1969, it was estimated by U.S. Bureau of Radiological Health scientists that a 1000-MWe pressurized water reactor would release approximately 7000

curies per year, based on releases from three reactors which at that time were still using stainless-steel-clad rods.

There seems to be some debate about how much and at what rate tritium diffuses through zirconium alloy cladding. In a personal communication from Westinghouse I was told that "fuel rods are clad with zirconium alloy and tritium diffuses through this alloy whether there are defects in the cladding or not." (February 23, 1979) The NCRP report entitled "Tritium in the Environment" says just the opposite: "it appears that tritium is released only through defects in zirconium alloy clad fuels. Defects in zirconium alloy cladding are infrequent...." (Report No. 62, issued in March 1979; p. 11)

I suppose the estimates of the quantity of tritium released to the environment and the amount to which workers are exposed are important only to the extent that tritium is perceived as a health hazard. Here, too, the scientists do not seem to agree.

(1) One health physicist at Oak Ridge, for example, said to me on the telephone: "Tritium is no big deal; all it can do is destroy a DNA molecule." Another here in St. Louis said he would be perfectly happy to drink tritium everyday in his orange juice.

(2) In 1949 the National Bureau of Standards grouped tritium in the middle range of three as being "moderately dangerous." (Handbook 42, "Safe Handling of Radioactive Isotopes"). By 1964, however, perhaps after scientists had begun to realize that tritium was a fission product and thus was slated to be a common byproduct of nuclear power, tritium was relegated to the lowest of four levels of hazard from absorption into the body. (Handbook 92)

(3) Other scientists, however, have serious concerns about tritium. In a list of radiation research projects funded by the National Cancer Institute in 1977, for example, the following description appears of a study at the University of Chicago School of Medicine (D. J. Mewissen, principal investigator):

> "The carcinogenic potency of tritium has been documented in newborn mice following administration of tritiated thymidine at various dose levels. ... No data exist on a possible carcinogenic potency of other tritiated precursors nor of tritiated water. No data are available for the possible long term toxicity of tritiated water. The need for additional data is obvious in view of the release of tritiated water from nuclear power reactors and nuclear fuel reprocessing plants which will be in operation in the future. Our current research showed that tritium from tritiated

> water is partially retained in the organic component of all organs tested in newborn, juvenile, as well as adult mice." (emphases added)

(4) In research at Lawrence Livermore Laboratory, Dobson and Cooper found that "a 50% decrease in the number of germ cells can be expected in a female mouse exposed continuously during development to approximately 2 microcuries of tritium per milliliter of body water." (Radiation Research 58, 91-100, 1974). A report on these findings in the LLL Newsline, October-November 1974, included the following:

> "'Occupational exposure is of much greater concern to me,' Dobson noted, pointing out that even small amounts of tritiated water vapor in the workplace can pack a powerful concentrated dose because it has not yet had the chance to become diluted in the environment. ...
>
> "'But whether or not the human female is as vulnerable to tritium as the mouse,' he said, 'we have a warning here. We have found at least one population of mammalian cells that is extremely sensitive to radiation effects at remarkably low levels of tritium.'"

(5) In the meantime, while the debate continues over its relative biological effectiveness, tritium is routinely and accidentally being released into the environment — such as into Lake Michigan from each of its nine reactors.

It seems ironic that while scientists today at Argonne National Laboratory blame the tritium found in Lake Michigan on fallout from atom bomb tests, back in the 50's and 60's scientists from the same laboratory were busily denying that fallout from atmospheric testing could ever be significant.

So far no one has proven that drinking tritiated water is a good idea. Would it be unreasonable to require that the producers of nuclear electricity and hence of tritium prove it is safe before they are allowed to burden our planet with even more? Some of the tritium being created today will still be around irradiating living people and things at the end of the 21st Century!

b. NOBLE GASES:

Not only are licensees allowed to release tritium in great quantity to the environment, but they may release radioactive noble gases in quantity, as well. The total amount of radioactive gases allowed to be released to the atmosphere from the two-reactor Zion plant in Illinois, for example, is 60,000 microcuries (a little over one-twentieth of a curie) per second — with a maximum per year of 300,000 curies.

In addition, I believe that only since about July 1979 has the NRC attempted to set limits on the concentration of dissolved and entrained noble gases allowed to be released in liquid radwaste effluents during the routine operation of a nuclear facility. According to the NRC's Draft Radiological Effluent Technical Specifications designed to standardize permissible releases and monitoring, 0.0004 microcuries of noble gases per milliliter may be released. (NUREG-0472 and 0473). For a 1000-megawatt pressurized water reactor, which discharges about 5,000 gallons of cooling water per minute to a river or lake, this concentration could mean the release of 1800 curies of noble gases per year in the liquid effluent alone.

I am submitting a copy of a letter I sent to the Nuclear Regulatory Commission on June 16, 1980, regarding the venting of krypton from Three Mile Island. The health hazards of the noble gases as described in my letter are a far cry from the traditional description of radioactive noble gases (aside from radon) as being inert and virtually harmless to human beings. I had help with my letter from professors of physics, biochemistry, cancer biology, radiation safety, and microbiology. Other questions about noble gases which need research, beyond those in my letter, include:

(1) the accuracy of the state-of-the-art technologies designed to monitor noble gases dissolved or entrained in the liquid effluents at nuclear power plants, and noble gases released to the atmosphere;
(2) the health effects of xenon;
(3) the reason(s) why more inert gas is taken up by the adrenal than by any other tissues (referred to by W. P. Kirk in his review of krypton literature and hazards, an EPA publication, Jan. 1972, p. 22);
(4) the extent to which noble gases may dissolve in body fluids or fat, enabling them to become distributed to various parts of the body, ~~not~~ just the lung.

c. TECHNETIUM-99:

"Recent experimental data suggest that the concentration factor for uptake of ^{99}Tc by vegetation from soils may be two to three orders of magnitude higher than the 0.25 value currently being used in radiological assessments. ... Data on the uptake and retention of ^{99}Tc in humans are also necessary to improve the reliability of dose conversion factors for specific organs and variou age groups. ... It is important to note that the predominant chemical forms of ^{99}Tc released to the environment have not been determined." That is the way a paper published in June 1978 by the DOE/Union Carbide Oak Ridge National Laboratory begins, and the rest is no more reassuring. The title of the paper alone says a great deal: "Assessment of ^{99}Tc Releases to the Atmosphere — A Plea for Applied Research." (ORNL/TM-6260)

Technetium-99 has a half-life of 210,000 years and is known to be toxic enough that the CRC Handbook of Chemistry and Physics (1973-1974) advises that it be handled in a glove box. Instead, here in Missouri at our nation's oldest commercial uranium fuel fabrication plant, an unexpected batch of 5000 gallons of technetium-contaminated liquid wastes was filtered through an ion exchange column and then was allowed to be dumped into the two site evaporation ponds. (The ponds were closed to additional dumping in February 1979.) As might have been expected, the discharged technetium migrated to a monitoring well within a matter of months, and no doubt will have visited lots of other wells and aquifers, etc., before it abandons its irradiating ways.

d. CERIUM AND CARBON AND ZIRCONIUM:

There are other radionuclides created in nuclear reactors about which only minimal information seems to have been available at the time the Appendix B limits were calculated. For example, carbon-14, cerium-141, 143 and 144, and an ever-growing list of corrosion products. One of my favorites is zirconium-96 which until a few years ago was thought to be stable but now is credited with having a half-life of $> 3.6 \times 10^{17}$ years. In addition, new facts about some popularly researched materials have been accumulating. For example, it now appears as if plutonium, if ingested in chlorinated drinking water, can be absorbed by the gastrointestinal tract. It is not, as previously thought, just an inhalation hazard to the lungs.

e. "TECHNOLOGICALLY ENHANCED NATURAL RADIATION" - that is, uranium and thorium and other naturally radioactive materials which are mined from deep within the earth, enabling them to enter the biosphere in the form of breathable dust, sludge, radon gas, etc. Enhanced, indeed!:

An isotope with a controversial biological effectiveness and with a half-life far shorter than that of Zr-96 is uranium-238. Its half-life is only 4.5 billion years. Following a spill of uranium yellow cake on a highway here in St. Louis during rush hour one evening in January 1979, I telephoned Dr. John Gofman in California and was told by him that a milligram (a 30/1000th of an ounce) of uranium-238 is sufficient to cause lung cancer. Is it true that the official NRC position remains that uranium is only chemically toxic, not radioactively so? Which assessment is correct?

And why doesn't the public hear more about polonium-210 as a major hazard of uranium mill tailings piles? Can anyone even comprehend what the following fact means?: A gram of plutonium-210 gives off 165 trillion alpha particles per second, or the equivalent of 5000 curies. How much polonium-210 washed into the Río Puerco River with the 1,100 tons of contaminated debris and 100 million gallons of radioactive water when the dam at the Church Rock, New Mexico, uranium mill broke in July 1979? Apparently body scans performed at Los Alamos on Navajo children who had played in the river shortly after the "incident" began indicated that somehow the children had managed not to inhale or swallow any detectable amount of radioactivity. Similar tests performed by Union Carbide at Oak Ridge — on a man who had worked here in St. Louis County for nine weeks in 1970 in a warehouse saturated wall-to-wall and floor-to-ceiling with uranium ore and oxide residue dust, etc., wearing either no mask or just a paper cone — also registered negatively last year. And two St. Louis children who had played in the same warehouse and on the piles of mill tailings, when tested at Oak Ridge last year, were given the same clean bill of health. A question I have asked repeatedly to no avail is: Has any federally-funded radiation lab ever found a member of the general public — or a worker, for that matter — whose body scan indicated that he or she had indeed been exposed to a detectable amount of alpha-emitting radioactivity?

3. If the new 25 millirem radiation standards for the public are reasonable, how can society condone standards that allow a worker to be exposed to 680 times that amount?

The radiation dose guidelines established in 1959 by the Federal Radiation Council had set the maximum dose for a person living near a nuclear facility at 500 millirems, and the legal average dose for the U.S. population at 170 mrems. That is, <u>each NRC-licensed facility</u> was allowed to release an amount of radioactivity to the air and water that could expose a person living nearby to an annual dose of 500 millirems.

As of December 1, 1979, however, the legal standards changed. According to the EPA's new uranium fuel cycle standards — 40 CFR 190 — no member of the general public may be exposed to more than 25 millirems of radiation a year from the planned releases of radioactive wastes from <u>the entire nation's</u> commercial nuclear power industry.

New standards have not yet been promulgated for workers. A worker is still "entitled" to be exposed to 12 rems every year of <u>external</u> (gamma) radiation until he reaches his maximum lifetime occupational external-radiation dose quota (his age, minus 18, times 5 rems) — according to 10 CFR 20.101(b). Over and above that he may breathe or swallow an additional <u>internal</u>-radiation dose of 5 rems' worth of radioactive air and steam — according to 10 CFR Part 20 Section 103 and Appendix B, and NBS Handbook 69 (as per page 3 of this letter).

4. What genetic effects might the population expect if workers continue to be

allowed to be exposed to 17 rems per year?

One of the most incredible documents I have read about the risks and benefits of nuclear power is the International Commission on Radiological Protection's "Report of Committee II on Permissible Dose for Internal Radiation (1959)."

> "Genetic effects manifest themselves in the descendants of exposed individuals. The injury, when it appears, may be of any degree of severity from inconspicuous to lethal. A slight injury will tend to occur in the descendants for many generations, whereas a severe injury will be eliminated rapidly through the early death of the individual carrying the defective gene. Thus the sum total of the effect caused by a defective gene until it is eliminated may be considered to be roughly the same. The main consideration in the control of genetic damage (apart from aspects of individual misfortune) is the burden to society in future generations imposed by an increase in the proportion of individuals with deleterious mutations. From this point of view it is immaterial in the long run whether the defective genes are introduced into the general pool by a few individuals who have received large doses of radiation, or by many individuals in whom smaller doses have produced correspondingly fewer mutations. However, even in this case it is desirable to limit the dose received by an individual." (p. xv)

> "The decision of the ICRP (1956) to set the average external occupational exposure at 5 rems/year (corresponding to 0.1 rem/week) is not applied to internal dose calculations except in the cases of radionuclides that are distributed rather uniformly throughout the body or are concentrated in the gonads. The purpose of limiting the average weekly total body dose (0.1 rem) to one-third of the former maximum weekly dose (0.3 rem) was to lessen the possible incidence of certain types of somatic damage, e.g. radiation induced leukemia and shortening of life span, which are considered to result primarily from total body exposure. Obviously, the reduction in the gonad dose was intended to lower the incidence of deleterious genetic mutations that will give rise to effects appearing in future generations." (p. 4)

5. What birth defects, if any, might a nuclear worker and his or her spouse expect their children to have?

Is there federal research under way, for example, on birth defects suffered by children of the Department of Defense and Atomic Energy Commission personnel who were exposed to radiation during the atmospheric tests of 1945 to 1962? Or suffered by children born in Utah or Nevada during or after the Nevada tests?

At the Citizens' Hearings on Radiation Victims in April 1980 in Washington, D.C., I interviewed at least 35 of the victims — people exposed to atom bomb tests, the daughter of a Hanford research scientist, a Savannah River plant worker, etc. — and asked many of them if their children had been healthy at birth. I heard about children who were born dead (and whose autopsies revealed nothing); chronic, painful skin diseases and strange scarring; a child who was born without an esophagus, and who died 21 months later; another who was born with his stomach partly closed, causing projectile vomiting the first year; many miscarriages; another child who had a fibrous mass (never identified) attached to the base of her spine; a miscarried brightly-colored fetus that looked like a cross between a seahorse and a toad (similar to stories told by Marshall Islanders); a son who at age 32 suddenly began having numbness of his hands and legs, etc.

I came away from the four-day hearings as angered at the silence of the medical profession as I have been at the silence of the federal government. In several cases a veteran or other victim mentioned that although a doctor had told him or her that a particular disease or problem was quite likely to have been caused by exposure to radiation, none of the doctors — not one — was willing to propose this etiology in writing.

6. Are nuclear workers being provided adequate protective clothing?

In response to a letter I had sent to the Naval Sea Systems Command asking about the anticontamination clothing worn by men exposed to cobalt-60 on nuclear submarines, the Director of the Nuclear Technology Division wrote as follows:

> "Normal clothing or plastic materials will shield beta radiation from cobalt 60 which is the predominant nuclide present in radioactive work in Naval nuclear propulsion plants. These materials and cotton coveralls referred to as anticontamination clothing, shield cobalt 60 beta radiation because this very low energy radiation (0.3 million electron volts) does not penetrate the materials. The anticontamination clothing used in this work is similar to that used throughout the nuclear industry. Its effectiveness in shielding cobalt 60 beta radiation is due not to any uniqueness of the clothing, but due to the nature of the low level radiation involved." (July 3, 1980)

When I asked Dr. Karl Z. Morgan whether he agrees with the above, he said that the cobalt-60 beta has a range in material of "many times the thickness of the anticontamination clothing." (July 24, 1980) I would also like to know about the cobalt-60 gamma radiation. If cobalt-60 is the main isotope found in the accumulation of corrosion products (crud) inside primary coolant systems coast-to-coast, and is responsible for creating the prohibitively high radiation fields in which workers must nevertheless perform maintenance tasks, how is it possible that plastic (e.g., nylon) coveralls would be enough to shield a worker? When I first learned from a nuclear power plant pipefitter that his "protective" clothing consisted of a nylon jump-suit, skivvies, his street shoes with cotton booties and rubber boots over that, a cotton cap, and rubber gloves — all taped "air-tightly" with paper tape — I was incredulous. I still am.

7. How accurately are the workers' radiation doses monitored?

a. When a person is surrounded by radiation sources, apparently one little film badge on his chest cannot tell the whole story:

In the Wall Street Journal of September 4, 1980, it was reported that 73 possible cases of overexposure were discovered at the San Onofre nuclear power plant in California. This did not happen because of an accident or because the radiation fields within the plant suddenly became hotter. It's that each of the workers at this 436-megawatt, 12-year-old plant began wearing multiple badges — that is, a film badge on his head as well as at chest level. The men had been working under the steam generator tube pipes through which the highly radioactive primary cooling water flows. The maximum permissible worker dose to the whole body or the head is three rems in any 13 consecutive weeks. When the additional badges were worn, it was discovered that the workers allegedly experienced between 3 and 5 rems, and some as much as seven rems. The concluding paragraph of the article quotes a professor of occupational health and safety as saying the exposure "wouldn't have any biological effect" and "is about the same as having three or four X rays in a hospital.' If accurately quoted, I believe the professor's comments are highly misleading.

b. Nuclear power plants lack effective neutron monitoring:

In a memo distributed within the NRC by Glenn W. Zimmer of the Office of Standards Development, dated January 25, 1978, Mr. Zimmer wrote that "personnel at some commercial power reactors are receiving some neutron exposure which heretofore has been unknown. Apparently these exposures have gone unnoticed because of the inadequacy of the neutron measurement techniques employed, and insufficient knowledge of this field. I understand that neutron exposures of up to a few hundred millirems in a relatively short period of time (a few hours or days) are possible...."

c. They also lack effective beta monitoring:

Although long recognized as highly toxic, apparently ruthenium has been causing unexpected monitoring problems at nuclear facilities. It was discovered at the DOE/Exxon Idaho Operations Office in Idaho Falls that workers were being exposed to ruthenium but that no one had realized it because ruthenium has an unusually high beta-to-gamma ratio (that is, virtually no gamma). A special dosimeter capable of monitoring beta radiation had to be created. It was interesting for me to learn from a French physicist last week that in France, too, they have found ruthenium to be a new problem — in this case at La Hague, the reprocessing plant.

The above compilation of concerns about ionizing radiation represents only a portion of the list I had outlined for you. Because we cannot have nuclear powered electricity without creating and releasing radiation to the environment, and without exposing workers to doses almost certain to shorten their lives and to threaten the health of their descendants, I would urge you to look beyond our nation's energy needs to give full weight to the burdens this exceedingly hazardous technology imposes upon all future generations.

Sincerely,

Kay Drey

Oral Testimony — at a public meeting Sept. 15, 1980, held by the Committee on Federal Research on Biological Effects of Ionizing Radiation, at the National Academy of Sciences in Washington, D.C. — Dr. Russell H. Morgan, Chairman.

My name is Kay Drey. I am here speaking as a housewife and mother, and as a citizen who has spent the past six years studying and fighting against nuclear power. I appreciate the opportunity to speak before you. The purpose of my trip to Washington from St. Louis, Missouri, is to mention some of those areas of ionizing radiation research which I have found either to be the most replete with contradictory scientific data — or the most lacking in scientific data at all.

Because the creation of new sources of ionizing radioactivity on our planet today is primarily caused by uranium fuel cycle facilities operated for the generation of nuclear powered electricity or of nuclear armaments, I shall try to organize my laundry list of research needs in terms of the stages of the uranium fuel cycle.

I shall start with the front end of the fuel cycle — with questions about the health effects of uranium and thorium as they are dug up out of the depths of the earth and brought into the biosphere — into potential contact with people and our human food chain.

1. Regarding alpha radiation: Is uranium yellowcake only chemically toxic, or is it also radiotoxic? Is it correct that one milligram of uranium-238 is enough to cause a lung cancer in humans? If that is an exaggeration, what amount is enough?

2. If it is correct that plutonium ingested within chlorinated water is more readily absorbed by the gastrointestinal tract, making it not just an inhalation hazard to the lungs as previously believed, to what extent may this also be true of uranium and other alpha emitters? This is important to anyone who drinks chlorinated Missouri River water, ~~for example,~~ because of the quantities of uranium mill tailings that have eroded and spilled into the Missouri River and its tributaries since at least the 1950's.

3. How much radioactivity is released to the environment from uranium conversion, enrichment, and fabrication plants? What impact, if any, are evaporation ponds at these sites having on the ground water?

4. Would epidemiologic studies of workers at the Paducah, Kentucky, enrichment plant; the Hematite, Missouri, fuel fabrication plant; the former Mallinckrodt Manhattan Project and uranium plants in St. Louis; and other front-end fuel facilities indicate an increased incidence of multiple myeloma, pancreatic cancer, and lung cancer comparable to the increases indicated by the data on workers at Hanford, Washington? Is it correct, as I heard in testimony by Battelle scientists in Washington in February 1978 that evidence of an increase in multiple myeloma and pancreatic cancer ~~has been~~ found not only by Mancuso and his colleagues, and by Milham, but by the Battelle researchers as well?

5. Can alpha radiation contamination be accurately assessed by means of the type of whole body scans available at Oak Ridge and Los Alamos?

6. Can radiation hazards associated with spilled uranium yellowcake on a highway or with leached uranium mill tailings in a creek or river bed be adequately monitored with a Geiger counter?

7. I understand that Native American women are concerned about the increased incidence of birth defects among children born near uranium mines and mills. In my written testimony I list some of the birth defects I heard about from men who were exposed to radiation from atom bomb tests. In addition to the establishment of cancer tumor registries, and the collection of epidemiologic data on workers exposed to radiation (and, I might add, to other hazardous substances) in the workplace, isn't it also essential to begin accumulating data on children

ATTACHMENT 2 (oral testimony)

→ over

born with serious birth defects, including data about their parents' work histories? Or would this make the nuclear industry and the federal government too vulnerable to compensation claims?

8. Regarding the back end of the uranium fuel cycle: How much radioactivity is being released into the environment as a result of the routine operation of nuclear power plants? What impacts are the gaseous, liquid and particulate effluents having on the water, sediment, and benthic communities of our lakes and rivers, and on fish and water fowl higher up in the food chain? What are the impacts on dairy food, farm produce and meat, and on the air we breathe?

9. Should the NRC not be required to change its 10 CFR Part 20 Appendix B maximum permissible concentrations now that the EPA's new uranium fuel cycle standards are the law? The NRC's concentrations in air and water — which many technicians, state health officials, and so forth erroneously think are the so-called "safe" limits — are based on a permissible release of 500 millirems of radioactive wastes allowed to be released per each NRC-licensed facility. The new EPA standards, 40 CFR 190, however, limit the planned releases to 25 millirems from the entire nation's commercial nuclear industry.

10. How reliable is the whole concept of the millirem or rem in relationship to curies, as translated in the field by the nuclear industry? In the handling of radioactive wastes, to compare the caution exercised by the medical profession with the casualness of the nuclear industry is mind-boggling. The entire Washington University, Barnes and Jewish hospitals' medical center in St. Louis has on hand for use by the research and therapy scientists, physicians and technicians a total of no more than nine curies of radioisotopes in unsealed sources at any one time — and any sealed source found to be leaking as much as fifty nanocuries (that is, 50 billionths of one curie) must be taken out of service for repair at once.

Compare that with the following emissions from the Millstone Unit One reactor near New London, Connecticut in 1975: 3 million curies of radioactive xenon and krypton were released into the air and 63 curies of iodine; 80 curies of tritium, 18 curies of iodine, 199 curies of fission products (including 146 curies of cesium 137 and 134), and 170 millicuries of alpha emitters were released into Long Island Sound. How was that translated into a millirem dose? Northeast Utilities said that a person living at the plant boundary (drinking the water and breathing the air) would have a 16 millirem dose for the year; a person living 1½ miles away would have a dose of six millirems; and a person about 5 miles from the site would have about a 3 millirem dose. If one were to calculate the number of curies allowed to be released within the NRC's 500 millirem permissible dose on the basis of the numbers of curies released from Millstone One in 1975 (that is, those which were translated into 16 millirems for the year) — the amount would be staggering.

The emissions reported for Millstone One in 1975 were not the result of accidents. They were planned releases during the routine operation of the plant. In the event of an "incident" or unplanned release, the emissions could total as much as a 6¼ rem dose or more for a member of the public before a licensee would be required to notify the NRC immediately of the release, according to 10 CFR 20.403(2) — that is, "The release of radioactive material in concentrations which, if averaged over a period of 24 hours, would exceed 5,000 times the limits specified for such materials in Appendix B, Table II."

Is the conservatism of the medical institutions warranted, or not?

I realize that many of the questions I have listed this morning are related to radiation surveillance, rather than to the biological effects of radiation. I feel, however, that it is important to point out the fact that significant quantities of radioactive materials are being released to the environment from nuclear facilities in order to encourage the investigation of the health effects of those releases. Contrary to the pronouncements of the nuclear industry that the releases to the environment from nuclear facilities are insignificant — "less than a 5-millirem annual dose" — I believe that the releases are very significant indeed. To complete my list:

11. What are the potential health hazards associated with some of the radioisotopes released to the environment in great quantity from nuclear facilities?

a. For example, tritium or radioactive hydrogen: Because there is no technologically feasible way to remove tritium from a nuclear plant's effluents, tritium is not required to be removed. Important questions, then, include: In a typical thousand-watt nuclear plant, how much tritium leaks out through the ceramic uranium pellets, through the fuel rod cladding, and into the primary cooling water? How much is then discharged into the air and water? Five thousand gallons of water a minute are to be released from the Callaway plant near St. Louis into the Missouri River, and another 15,000 gallons per minute as steam and vapor into the air. How many curies of tritium will be included? Is this continuous flow monitored by the licensee, and the total number of curies reported to the NRC — or is only that tritium reported which is released in batches from the hold-up tanks? What is the accumulation of tritium in Lake Michigan, for example, where there are already nine operating reactors, and in which the water turn-over occurs only once in a hundred years?

A new question was posed to me this past week by a professor of physics at Washington University in St. Louis — Dan Bolef. Because tritium has a nucleus with a mass three times greater than the ordinary hydrogen present in our body cells, Dr. Bolef wonders if this extra mass could perhaps change the manner in which tritium forms compounds, and the manner in which tritium is transported through the body — that is, the ease with which it could permeate through cell membranes and move through capillaries. He wonders whether, contrary to the popular theory that tritium is dispersed uniformly throughout the human body, as is natural or light hydrogen, it may instead concentrate in certain organisms. Is research currently under way on these questions?

b. And noble gases: In a recent article in the Chicago Tribune by Casey Bukro (April 7), the following description was included of noble gases: "Reactors give off so-called 'noble gases,' which are radioactive but do not react with other matter. If inhaled, they are usually promptly exhaled, say nuclear experts, and are not likely to cause physical damage. One of them, Krypton, could cause skin cancer in high enough doses."

In a letter I had sent to the NRC on June 16, 1980, regarding the venting of krypton from Three Mile Island, I discuss the health hazards of noble gases based on their physical properties (as opposed to their relative chemical inertness), and based on their solid daughter products. A reporter from Science magazine told me a few weeks ago that he had never read anything like that before about noble gases. Neither have I. I submitted a copy of my June 16 letter along with my written testimony to your committee on September 8. Is the material in my letter about noble gases accurate, or not?

12. As a nuclear plant becomes older — even after only five years or less of operation — the piping, valves, reactor vessel, steam generator tubes, and other parts become encrusted with radioactive corrosion products which not only clog up the works (causing leaks and shutdowns and a loss of effective power), but cause serious radiation hazards for the men who work on maintenance, the replacement of parts, and refueling. Because of the high radiation fields at one plant, for example, caused by the buildup of cobalt-60 and other radioactive materials, it took 700 men eight months to repair a reactor vessel outlet pipe connection, a repair which in a coal-fired plant would have taken 25 men about two weeks, according to Bernard Verna, a columnist in Nuclear News (November 1975, p. 52). The gamma dose rate of a piece of crud that measured only 4½ square centimeters and which was removed from Indian Point One near New York City measured one rem an hour! In order to clean out the corrosion products, the nuclear industry is planning to use chelating agents. Is it possible that the combination of the chelating agent solvent with radioactive materials could act synergistically, causing a health hazard for the decontamination workers?

Again, thank you for this opportunity.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNION ELECTRIC COMPANY	)	Docket No. STN 50-483-OL
	)	
(Callaway Plant, Unit 1)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "Amended and Supplemental Joint Petition to Intervene" and "Affidavit of Kay Drey" have been served on the following by deposit in the United States mail, first class, this 6th day of March, 1981.

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