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March 20, 1985

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY	)	Docket Nos. 50-440 OL 50-441 OL
	)	
(Perry Nuclear Power Plant, Units 1 and 2)	)	

SUMMARY OF TESTIMONY

BY

Dr. Ernest J. Sternglass

My name is Ernest J. Sternglass. I am Professor Emeritus of Radiological Physics, University of Pittsburgh School of Medicine, Department of Radiology. I joined the University of Pittsburgh in 1967 as Director of the newly established Radiation, Physics and Engineering Laboratory, to carry out research in the area of nuclear and x-ray instrumentation. In addition, I have taught courses in health physics in the Department of Radiation Health of the Graduate School of Public Health of the University of Pittsburgh, as well as courses in radiation instrumentation, x-ray and nuclear technology in the School of Medicine. I have published extensively in these fields and in the area of the effects of radiation on human health. Prior to joining the University of Pittsburgh, I served as Advisory Physicist to the Vice President and Director of the Westinghouse Research Laboratory, which I joined in 1952. In this capacity I developed nuclear

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instrumentation for space and medical applications, including novel methods of imaging nuclear isotopes and x-rays to allow diagnosis at lower radiation doses. I have testified before the joint committee on Atomic Energy of the U.S. Congress on the effects of low-level radiation on the developing infant, and on the need to reduce radiation exposures to workers and the general population at hearings of the Atomic Energy Commission (AEC) and the U.S. Environmental Protection Agency (EPA), as well as at hearings by various state legislatures and other governmental bodies as well as Atomic Safety and Licensing Boards on the question of the effects of radiation. I am a member of the Radiological Society of North America, a Fellow of the American Physical Society, as well as a number of other professional societies. I am currently engaged in research and consulting work in the fields of radiological instrumentation and radiation effects, so that my testimony is based on personal knowledge and experience in the field of radiation health effects, radiation protection and instrumentation.

Contention I. - Emergency Action Levels

1. With regard to the question whether the existing emergency plans provide reasonable assurance that adequate protection measures can and will be taken as originally admitted by the Atomic Safety and Licensing Board, the final, more specific contention admitted by the Board on January 10, 1985 says:

> "Emergency action level (EAL) indicators are incomplete in applicant's emergency plan."

According to the Applicant's Motion for Summary Disposition dated January 30, 1945, applicant admitted that some (13) individual EAL's were missing because "the detailed technical data needed to determine the missing values was not available when Revision 3 was issued." Apparently, these missing values have been determined only within the past few weeks, which does not permit an adequate technical evaluation of the values as to the nature of the assumption made with regard to the equipment status and the specific instruments used under the various emergency situations, either by the NRC staff or the intervenor's technical advisors.

Not only has there not been sufficient time for a meaningful examination of applicant's assumptions on which the EAL's are based, but the applicant has not provided a sufficiently detailed technical basis for the evaluation of these crucial numbers on which vital decisions must be based as to what emergency and protective action needs to be taken, especially when precise information on doses and dose-rates to the population may not yet be available from outside monitors.

As the Commission's regulation 10 C.F.R. Part 50 cited by the applicant (p. 4) note that emergency action levels must be based not only on on-site and off-site radiation monitoring information, but "also on readings from a number of sensors that indicate potential emergency, such as the pressure in the containment." Clearly, the off-site dose-rate will be determined by the status of the filtration system, the status of various containment isolation valves, the functioning of spray systems,

etc. Without knowing what assumptions were made with regard to in-plant conditions or equipment status, it is clearly impossible "to evaluate the release of radioactive materials" and to adequately "assess their impact." (p. 5 of Applicant's January 30, 1985 motion).

The need for a full and complete examination of the technical basis for the EAL's by the staff and the intervenors is particularly important in view of the fact that present plans do not call for a fixed system of remotely controlled and remotely readable system of radiation monitors in place at the time of a major accident, as will be more fully discussed in connection with Contention M. In the absence of immediate, real-time information from a remotely operated ring of radiation monitors to give an accurate real-time and complete picture of the magnitude of the off-site dose-rates, all rapid decisions affecting the health and safety of the population must be made on the basis of uncertain information on the status of valves, pipes, filters, etc., that are intended to confine the radioactive gases within the plant, and a few mobile monitors that may or may not be able to see the plume and measure its intensity quickly, for instance, if the plume should initially be directed towards nearby Lake Erie.

2. The existing regulations require that tables and monograms be furnished by the applicant that deal with a range of possible EAL's for different situations during an emergency, and such material has not been provided to the intervenor's technical advisors. In this sense also, the existing information

needed to allow an independent examination of the applicant's figures is also incomplete.

3. There is still another sense in which the applicant's information on Emergency Action Level indicators is incomplete, thus failing to provide for adequate protective measures to be taken in the event of an emergency. This has to do with the claim made by the applicant in Footnote (3) of Table 6-2 (p. 6-17) of the Plant Site Emergency Plan (Rev. 3.) that the "newborn infant, includes fetus (pregnant woman) as critical segment of population for Iodine-131."

This statement implies without any scientific justification that the fetus is no more sensitive to the effects of radioactive iodine than the infant between age 0 and 1, so that the EAL indicators for various levels of protective action can be set at the same level for the fetus as for the young infant.

However, many scientific studies in the literature clearly indicate that this is not the case. In fact, recent government regulations for the permissible exposure of radiation workers call for a ten-fold lower radiation dose to pregnant women than to other workers because of the overwhelming scientific data showing the fetus to be much more sensitive to a given amount of radiation than either the young infant, the child or the adult. Furthermore, many studies have shown that the fetus is much more sensitive in the early stages of development than in the last stage close to delivery, by as much as a factor of 10 times. In addition, there is evidence from direct measurements of the concentration of iodine-131 in fetal thyroids during periods of heavy fallout from bomb-testing by Beierwaltes et al and other

investigators that the radiation dose to the fetal thyroid is as much as 100 times larger than to adults, like the mother, inhaling the air or ingesting milk and food during the same period.

As a result, the health effects on the fetus with regard to such problems as cancer, thyroid nodules, hypothyroidism, retardation in physical growth and mental development are some 1000 to 10,000 times more serious for the fetus than for the adult, and some 10-100 times greater than for the young child in the first year of life.

This is supported by the sharp rise in hypothyroidism among newborns in the area around 3 Mile Island discovered by Dr. Gordon Macleod, former Head of the Health Department of the State of Pensylvania, as well as extensive studies of the children accidentally exposed to iodine-131 in the Marshall Islands. More recently, detailed studies of the effects of iodine-131 on the mental development of the fetus as detected in state-by-state tests of later intellectual performance have further substantiated the great sensitivity of the fetal thyroid to changes in hormone production.

Thus, the present Emergency Action Levels are incomplete and in their present form inadequately justified by both scientific considerations and technical data so that in their present form as supplied by the applicant, they cannot achieve the stated goals set out by the NRC regulations, namely, to properly "assess the impact of the release of radioactive materials."

II. Contention M - Adequacy of Monitoring System

1. As pointed out in intervenor's Statement of Material Facts, 10 CFR 50. 47(6)(9) requires an emergency plan to ensure adequate methods and equipment for assessing and monitoring actual or potential offsite consequences of a radiological emergency. Here, the emphasis must clearly be placed on the word "adequate," and the issue is whether the proposed use of only mobile radiation instruments and some two dozen thermo-luminescent detectors each, by the applicant, by the State of Ohio and by the NRC can in fact be judged to provide "adequate" information on the dose-rate to the population in the event of a major accidental release of radioactivity.

In the case of a rapidly developing emergency such as occurred at Three Mile Island, immediate and complete information must be available to public officials on the intensity of the radio-activity and the direction in which the radioactive gases are moving in order that protective actions such as sheltering and/or evacuation can be ordered. Clearly, time is of the essence, and any delays in the arrival of mobile equipment or finding the radioactive gas plume is critical. Experience at Three Mile Island, as shown in a detailed report by Dr. Jan Beyea for the Public Health Fund, dated August 15, 1984, entitled "A Review of Dose Assessment at Three Mile Island," showed that mobile equip-ment such as car-mounted or helicopter mounted instruments failed to provide adequate dose information on the shifting winds. For instance, on p. 13 (Table 3), he lists the reasons for the failure to obtain adequate information on the population dose

for the case of the Department of Energy:

> "Helicopters missed releases in the first few days; may have missed center of plume on other occasions."

Thus, actual experience has shown, as Dr. Beyea's report makes clear, that the serious problems of determining the dose to the population arose,

> "because of the inadequacy of monitoring equipment in place at the time of the accident." (Emphasis added). (Appendix A, Par. A1.0)

Mobile detectors mounted on land vehicles are severely handicapped by accessability to certain areas where the plume may be closest to the surface, for instance on the other side of rivers, railroad tracks, or in woods, etc. Furthermore, they cannot make measurements over the water, which was the case in Three Mile Island, and would be even more of a problem in the case of the Perry Plant located near Lake Erie. Thus, a plume may initially move over the water and then change its direction so as to reach a heavily populated areas, such as Cleveland, without any way to measure the intensity of the radiation or to judge the necessity for sheltering and evaluationg the population.

As is clear not only from Dr. Beyea's report but also from articles by many AEC experts such as C.A. Pelletier writing in "Environmental Surveillance in the Vicinity of Nuclear Facilities" (Edited by W.C. Reinig, C.C. Thomas Publishing Co., 1970), only a ring of many air samplers and other fixed electronic detectors can adequately characterize the nature, intensity and direction of radioactive gas released from a nuclear facility in a timely fashion.

The use of a small number of the thermoluminescent dosemeters (TLD's) was found by Dr. Beyea to have been totally inadequate for determining the dose, due to the large "holes" between the locations of these detectors. In addition, these chips of luminescent material must be retrieved and measured in a central location before radiation levels can be determined. They do not give an instantaneous reading that could be sent to remote locations by radio-telemetry.

Without a system of electronic detectors located around the plant at various distances capable of providing an instantly available picture of the shape of the plume, its intensity and its motion, public officials were extremely handicapped in making proper decisions at Three Mile Island, and the same would be the case for an accident at the Perry Plant.

The cost of such a system would be minimal compared to the billions of dollars spent on the plant itself, and minimal compared to the costs associated with the lives lost or health damaged as a result of inadequate information. Even a network of some 100 instruments could be installed at one ten-thousandth of the cost of the plant and its safety systems, thus adding a negligible amount to the cost of the electric power generated.

Considerations of cost-effectiveness such as advanced by the Applicant should not be applied when the total costs are so small, and the likelihood of a major release is so uncertain. Only a desire not to have local officials, the media and the public at large have access to information that might reveal smaller releases during routine operations or lesser accidents

can be the reason for a refusal to learn from the Three Mile Island accident, and to install a monitoring system based on the latest available technology.

2. The need for an adequate, fixed, and remotely operated monitoring system that can detect and characterize the radioactivity released under all conditions, including the most severe releases, is further brought out by the following considerations.

At Three Mile Island, the stack monitors went off-scale and thus could not give a measurement of the actual activity released into the atmosphere, as discussed by Beyea. If there had been a ring of electronic detectors and/or air samplers installed at various distances, it would have been possible to judge the potential hazard to the infant in the womb of mothers much more accurately, and much sooner. As it turned out, the decision to evacuate pregnant women and young children was not made until a few days of large releases had elapsed so that the warning to leave the area came too late: much of the damage had already been done to the thyroids of the fetuses when the mothers inhaled the radioactive iodine. In fact, as Beyea points out it now appears that the high levels of iodine-131 discovered in the local milk could only be explained if inhalation of the iodine rather than ingestion was the principal pathway into the milk.

Thus, timely response when gases are in the air rather than after they have settled on the vegetation is needed to avoid a repetition of this unnecessary tragedy, and only a system of continuously operating monitors at various distances leaving

few gaps can accomplish this adequately. Millions of dollars have been paid in damages to families whose children developed mongolism and other conditions known to be associated with radiation damage to the fetus, making it clear that saving money on electronic detectors costing a few hundred dollars each was not really "cost effective."

3. The need for independent, off-site monitoring using fixed electronic detectors that are in continuous operation is further brought out by the fact that according to the published indictment of the utility that operated Three Mile Island and admitted to by the company, releases into the secondary steam loop from the radioactive primary loop took place for a period of time before the accident in March 1979. Radioactive gases emitted with the venting of steam from the secondary loop were not monitored, and since there were no fixed off-site monitors in place that could have warned health officials, the releases of radioactivity went undetected.

These were abnormal, unreported releases that endangered the health of the public, and especially that of the newborn, whose lung must be fully developed at the moment of birth or else the baby is at high risk of death due to respiratory failure. The effects show up as large spikes in the monthly infant mortality rates for areas to which the radioactive gases drifted, such as Upstate New York to the north and Maryland to the south along the Susquehana River. These spikes of as much as double or triple the normal rate of infant mortality occurred only after the TMI plant went into operation, and they disappeared when the plant was shut down after the accident. No other cause of

sudden brief increases of infant mortality followed by sharp declines is known. However, they are consistent in the earlier findings of close correlations between rises and declines of infant mortality near the Dresden Nuclear Plant southwest of Chicago. They are also consistent with similar rises of infant mortality and the percent of children born with low birth weight downwind of the Nevada test site in Utah, Idaho and Montana, for which no other explanation exists. And they are also similar to the recent upward changes in infant mortality in such states as Georgia next to the large Savannah River reactors and in the state of Washington, where large releases from the Hanford nuclear facility are known to have taken place in January 1984.

In all these accidental releases, an independent, fixed monitoring system could have given ample warning, avoiding needless death, disease and birth defects for hundreds of babies, either by evacuating pregnant women, or warning them to switch to powdered milk on a temporary basis.

Thus, it is clear that a continously operating, fixed monitoring system is not only necessary for the case of large accidents such as occurred at TMI, but also for small accidents that are much more frequent and particularly serious for the developing baby in the mother's womb, or the older, more susceptible members of the population that already suffer from immune resistance and chronic diseases not encountered for the healthy adult for whom small, brief radiation exposures present little risk.

III. Contention P - Adequacy of Hospital Facilities

1. Large nuclear accidents present a particularly difficult problem for hospitals, not only because of possible external and internal contamination of the individuals. In such events, hundreds to thousands of individuals could receive whole-body doses in the range of 100 to 1000 rads according to various studies carried out by the AFC at Brookhaven during the 1950's and 1960's, as well as by later studies at MIT and the American Physical Society.

In such cases, survival depends critically on the availability of specially designed rooms capable of providing a completely sterile environment, since one of the most serious medical complications of such exposures is the greatly lowered immune resistance that opens the individual to infections.

Such highly specialized facilities exist only in a few large hospitals, such as in Pittsburgh, where they have been used successfully to save the lives of workers accidentally exposed to high levels of radiation.

However, in the event of a major accident at the Perry Plant, hundreds to thousands of such specialized facilities would be needed, and these are clearly not presently available nor contemplated for this area by the Emergency Plan.

2. Although it is true that most individuals who are exposed to radioactive materials by inhalation and ingestion are not likely to have traumatic injuries such as from blasts or burns, highly specialized facilities are nevertheless needed to determine the full nature of their body burdens, and to

take therapeutic steps to reduce these burdens by various techniques such as chelation.

Whole-body counting facilities, together with the trained personnel to carry out these diagnostic and therapeutic procedures are not widely available, and an accident involving hundreds to thousands of individuals could not be handled by the existing facilities in Pittsburgh, Cincinnati, or Cleveland, let alone the smaller hospitals in the local areas, yet timely diagnosis and treatment is essential to achieve optimum survival. Clearly, the local hospitals are not capable of caring for such patients adequately, and no provisions have been made in the Emergency Plan for such care to be provided in a timely fashion.

3. When individuals are exposed to high levels of ambient radioactivity in the air, inhalation can lead to acute respiratory distress and edema of the lung, requiring care on an emergency basis. This is particularly true for individuals already ill with respiratory diseases, emphysema, asthma, pneumonia, congestive heart diseases and strokes. As in a severe air-pollution epidemic, there can be a large increase in demand for hospital services due to the aggravation of such conditions within a matter of hours or days, overloading the resources of existing critical care units. This would of course be vastly complicated by the presence of radioactive contamination on the clothing, skin and hair of the affected individuals. Thus, it does not appear that adequate facilities and trained individuals exist to handle massive numbers of critically ill individuals suffering from severe respiratory irritation and lung congestion, similar

to the symptoms produced in the Bhopal accident, especially when these individuals also need specialized diagnosis for radioactive body burdens and treatment to reduce the doses received by internal organs.

4. Still another problem facing the local hospitals would be a sudden large increase in the number of babies born that are severely premature or underweight. Both the experience in the case of the Marshall Island population and individuals exposed to large increases in radioactivity following massive nuclear bomb tests showed a sudden, large increase in early miscarriages, still births and premature births of very small babies. Such infants can only be kept alive in special premature infant facilities, and there are not enough of these in the area to handle a many-fold increase in such babies. These infants also have a much larger incidence of serious congenital defects requiring surgery for survival, again overloading the available facilities and staff.

Considering all these aspects of major radiation accidents involving thousands of individuals who are also contaminated to various degrees internally and externally, it does not appear that existing hospital facilities and personnel are adequate to handle a major accident at the Perry Nuclear Plant.

IV. Contention Z - Protection of Bus Driver

1. One of the concerns expressed by the intervenors is the question of the protection of bus-drivers needed to evacuate children and adults from areas where significant radioactivity may exist in the air.

The problem is particularly serious when shifting winds change the conditions, and when there is no fixed monitoring network in operation that would allow a central dispatcher to warn and direct drivers to avoid the areas of highest radioactivity in the air or on the ground.

Additionally, the drivers will have to make repeated trips into contaminated areas to rescue exposed individuals, or to evacuate them before the radiation levels have reached lethal levels.

Equipping the drivers with electronic monitors is not a solution to the problem for a number of reasons. First, such monitors do not tell them in which direction to dirve to reduce the exposure rate. Secondly, these instruments are generally only sensitive to ground radiation not to inhaled alpha and beta radiation that is of greatest concern in such a situation.

Although gasmasks that filter the ambient air can be of help with regard to particulates, they are inefficient or totally ineffective against radioactive gases and vapors. Only completely self-contained respirators with their own oxygen supply can give protection in the presence of high concentrations of radioactivity in the air after a nuclear accident. Failure to provide for such protection would make the drivers unwilling to incur the risks involved in repeated trips into possibly highly contaminated areas. The present emergency plans are therefore inadequate to protect the population in the event of a major accident.

2. Another aspect of this problem not addressed by the present emergency plan is that many of the drivers are likely to be women of child-bearing age, perhaps as many as 10 to 30% of all drivers.

Since the developing fetus is as much as 1000 to 10,000 times more likely to show serious effects than the mother at a given air concentration of radioactive iodines of all types, women drivers who may be pregnant will not want to take the same risks as men, nor could they be asked to do so by health officials. The availability of respirators would help to alleviate this problem, or else the existing evacuation plans would have to be revised to exclude women bus drivers since it is impossible to know for certain which of the women will be pregnant at a given time.

Ernest J. Sternglass, Ph.D.

State of Indiana)
)SS
County of Monroe)

Subscribed and sworn to before
me this 20th day of March, 1985.

Dawn P. Jimeson, Notary Public for
Monroe County, State of Indiana

My commission expires June 24, 1988

Biographical Sketch

Dr. Ernest J. Sternglass is Professor of Radiation Physics and Director of Radiological Physics in the Department of Radiology, School of Medicine, University of Pittsburgh. Until 1967, Dr. Sternglass was Advisory Physicist reporting to the Vice-President and Director of Westinghouse Research Laboratories, where he did research in the area of nuclear physics, nuclear instrumentation and electronic imaging devices applied to nuclear power generation, medicine and space sciences. He joined Westinghouse in 1952, directly after receiving his Ph.D. from Cornell University in Engineering Physics.

Professional Societies

Fellow, American Physical Society; Member, American Astronomical Society, Health Physics Society, Association of Physicists in Medicine, American Association for the Advancement of Science; Past Chairman, Federation of American Scientists, Pittsburgh Chapter, Committee on Diagnostic Radiology of the Association of Physicists in Medicine; Associate Member, Radiological Society of North America; Sigma Xi, Eta Kappa Nu

Publications

Over seventy papers in the areas of the interaction of radiation with matter, nuclear and elementary particle physics, nuclear instrumentation, electronic imaging devices for dose radiation in radiology and nuclear medicine, radiation effects on the developing human embryo and infant, a book summarizing radiation effects in man entitled: "Low Level Radiation" was published by Ballantine in 1972, and by Earth Island Ltd. in London, England in 1973.

Current Research Activities

Development of techniques of electronic radiography for dose reduction in diagnostic x-ray procedures. Statistical studies of the effects of low-level radiation in man, in particular infant mortality, cancer and heart disease.

SECTION II – PRIVILEGED COMMUNICATION

BIOGRAPHICAL SKETCH

(Give the following information for all professional personnel listed on page 3, beginning with the Principal Investigator. Use continuation pages and follow the same general format for each person.)

NAME	TITLE	BIRTHDATE (Mo., Day, Yr.)
Sternglass, Ernest J.	Prof. of Radiological Physics	9/24/23
PLACE OF BIRTH (City, State, Country)	**PRESENT NATIONALITY (If non-U.S. citizen, indicate kind of visa and expiration date)**	**SEX**
Berlin, Germany	U.S.	☒ Male ☐ Female

EDUCATION *(Begin with baccalaureate training and include postdoctoral)*

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
Cornell University, Ithaca, N.Y.	B.E.E.	1944	El. Engineering
Cornell University, Ithaca, N.Y.	M.S.	1950	Eng. Physics
Cornell University, Ithaca, N.Y.	Ph.D.	1953	Eng. Physics

HONORS

Eta Kappa Nu (El. Eng. Hon. Soc.) Sigma XI: McMullen Fellow 1949-51; Westinghouse Research Fellow, Institute for Theor. Physics, Univ. of Paris (1957-58); Fellow of the American Physical Society; Sigma Pi Sigma (Physics Hon. Soc.)

MAJOR RESEARCH INTEREST	ROLE IN PROPOSED PROJECT
Physics in Medicine & Biology	Radiological Physics - Consultant

RESEARCH SUPPORT *(See instructions)*

RESEARCH AND/OR PROFESSIONAL EXPERIENCE *(Starting with present position, list training and experience relevant to area of project. List all or most representative publications. Do not exceed 3 pages for each individual.)*

Professor of Radiology and Consultant, Imaging Division, Department of Radiology, University of Pittsburgh, Pittsburgh, PA, 1974-present

Professor of Radiology and Director of Radiological Physics and Engineering, University of Pittsburgh, Pittsburgh, PA, 1967-1974

Advisory Physicist and Consultant to Director, Westinghouse Research Laboratories, Pittsburgh, PA, 1960-1967

Visiting Professor, Institute for Theoretical Physics, Stanford University, Palo Alto, CA, 1966-1967

Fellow Scientist, Electronics and Nuclear Physics Department, Westinghouse Research Laboratories, 1958-1960

Westinghouse Research Fellow, Institute for Theoretical Physics, University of Paris, 1957-1958

Research Scientist, Electronics and Nuclear Physics Department, Westinghouse Research Laboratories, 1952-1958

Graduate Study (Physics) Cornell University, 1949-1952

Research Engineer, Electricity and Magnetism Department, U.S. Naval Ordnance Laboratories, White Oak, MD, 1945-1946

U.S. Navy (Radar and Electronics) 1945-1946

Patents: Eleven Patents issued in area of Electron Tubes, Image Intensifiers, Photo-Multipliers and Television Cameras

Professional Societies: Am. Physical Soc., Am. Assoc. of Physicists in Med.; Radiol. Soc. of N. Am.

E. J. Sternglass

Publications

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