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)	)	

RESPONSE TO APPLICANT'S INTERROGATORIES AND REQUESTS FOR DOCUMENT PRODUCTION (SET. NO. 2) TO JOINT INTERVENORS ON THEIR CONTENTION NO. 2

Joint Intervenors submit the following Response to Applicant's Interrogatories and Requests for Document Production (Set No. 2) to Joint Intervenors on their Contention No. 2. All documents identified, unless otherwise indicated, are in the possession and/or control of Kenneth M. Chackes, Attorney for Joint Intervenors and will be made available for inspection and/or copying upon reasonable request. Joint Intervenors are unable to answer completely many of the questions pertaining to Contention No. 2 because of the unavailability of the technical specifications, and the FES and SER.

2A-1. The following is a list of inadequacies of currently available systems for monitoring the radionuclide levels in liquid effluent streams at commercial nuclear power generating facilities:

(1) There is a need for monitoring equipment sensitive enough to detect the low release rates permitted by regulatory organizations from relatively local sources of radionuclide emission. (NCRP Report No. 50, Environmental Radiation Measurements, p. 193. See also Joint Intervenors' Response to Interrogatory A-1(1) at p. 5).

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In the case where population dose measurement is needed following a release of radionuclides, instruments of the required sensitivity are not available as

the extensive monitoring capabilities required are so expensive that the EPA has recommended substituting the use of calculational techniques for assessing the resulting population dose (EPA, A Computer Code (RVRDOS) To Calculate Population Doses from Radioactive Liquid Effluents and an Application to Nuclear Power Reactors in the Mississippi River Basin, Technical Note ORP/EAD-76-4, October 1976, p. 3). EPA's suggestion both admits and presumes that in-plant liquid effluent monitoring systems will not be able to adequately detect and respond to various forms of unplanned radionuclide releases resulting from nuclear plant operation.

(2) Current monitoring technology has been found to allow the release of radionuclides, as measured at liquid effluent release points, that either decay rapidly (into stable or radioactive daughters) or that are not able to be readily detected by the preferred method of gamma-ray spectrometry (EPA, Radiological Surveillance Study at the Haddam Neck PWR Power Station, EPA-520/3-74-007, Cincinnati, December 1974, p. 1. See also Joint Intervenors' Response to Interrogatory A-1(1) at p. 5).

(3) It is possible to miss critical radionuclides if detection systems monitor only the obvious effluents and the easily measured radionuclides, or are not able to adjust to changes in the operating cycle of the plant (EPA, Radiological Surveillence Study at the Haddem Neck PWR Nuclear Power Station, EPA-520/3-74-007, December 1974, p. 118. See also Joint Intervenors' Response to In[illegible] 1(1) at p. 6).

(4) Radionuclides which have no gamma rays and relatively weak beta radiation (e.g. Fe-55, Ni-63, etc.) are not easily detected by current monitoring technology. As such, it may be necessary to calculate the releases of such radionuclides, rather than depend on available monitoring systems for their detection and measurement. (NRC Regulatory Guide 1.21, pp. 1.21-4 and 1.21-5. See also Joint Intervenors' Response to Interrogatory A-1(1) at p. 6).

(5) Although rather sophisticated versions of radionuclide monitoring and warning systems are not under consideration, the systems in currently operating plants are relatively primitive and may not be adequate to provide sufficient warning (with sufficient detail on release size) for implementation of the most effective measures for protecting surrounding populations. (Nero, A.V. and Wong, Y.C., "Radiological Health and Related Standards for Nuclear Power Plants," Lawrence Berkeley Laboratory, LBL-5285, January 1977, p. 61).

(6) There is substantial evidence that currently available monitoring systems are subject to failure from mechanical problems and human error. Documented cases are easily found in the Nuclear Regulatory Commission's bi-weekly printout "reportable occurrences" and in a special printout of Licensee Event Reports covering plant operations from 1969 to early 1981 entitled, "LER Output on Pressurized Water Reactor Events Involving Released Activity from 1969 to the Present." The former is sent to depository libraries and the LER output is available from the NRC's Office for Analysis and Evaluation of Operational Data in Washington, D.C.

Component failure is one of the two main causes of accidents at nuclear power plants. Monitoring systems malfunction because of inadequate maintenance, aging of parts, electronic failure and even natural phenomena.

In January, 1977, at the Cooper plant in Nebraska, the monitor located 7500 feet downstream was damaged by ice on the river and could not be repaired until the weather improved.

On April 12, 1979, at Crystal River 3, the liquid radiation release monitor went into high alarm. Several valves failed to close because of sticking contacts within the radiation monitor by-pass switch. The contacts had to be cleaned and lubricated.

Corrosion products at a throttle valve plugged the sample line to the radiation detector at Turkey Point 4 on August 12, 1974. The monitor system failed to alarm when needed during a leak.

On March 11, 1976 at the Millstone plant in Connecticut, there was a monitor failure. High voltage and discriminator control drift were caused by aging parts.

At Fort Calhoun 1 on March 7, 1975, the liquid effluent control monitor failed due to a shorted reset switch. As a result, a radioactive discharge eighteen times the allowable limit in 10 CFR 20, Appendix B, Table 2 was made into the Missouri River.

There are instances in the LER printout in which monitors are simply inoperable and no cause is provided (or known). Ten times the maximum permissible concentration for tritium was discharged into a sewer at Donald C. Cook 1 on August 19, 1976 because neither of the G.E. gamma spectrum analysis units was operating. A similar incident occurred at Zion 1 on September 22, 1977 when a radioactive discharge was made into Lake Michigan.

Human error accounts for monitoring failures in a variety of ways. Sometimes samples are not counted for a sufficient length of time by technicians. This happened at Joseph M. Farley 1 on October 21, 1977 as a discharge was being made into the Chattahoochee River.

More often in LER, releases are made without sampling at all, as at Zion 1 on August 2, 1980. Staff is usually "reprimanded" or "reinstructed" when this occurs.

On March 26, 1976 at the Quad Cities plant in Illinois, the radiation protection technician miscalculated the discharge rate by a factor of 10 and the shift engineer failed to catch the mistake when using his graphical verification.

Some reports show that personnel do not always respond correctly when monitoring systems indicate a problem. On August 15, 1973 at the Palisades 1 plant, the operator did not stop purging iodine gas when high levels were realized. During a release of radioactive gas, caused by component failure at Crystal River 3 on September 18, 1977, personnel did not respond to a computer alarm. The release was unmonitored and lasted for 2 hours and 50 minutes.

Plant personnel remove monitors from service or neglect to reset them. At Oconee 1 on May 13, 1974, the operator failed to follow procedures and did not return the waste gas monitor and the stack monitor back to operation after calibration. On February 7, 1971 at H.B. Robinson 2, 300 gallons of radioactive liquid waste were released from a tank after the technician inadvertently removed the monitor from service in order to clean the chamber.

The monitoring systems are susceptible to component failure and human error. There may be no redundant systems and that the data provided in incidents involving monitoring problems could be only estimates. The most chilling example is on p. 111 of the LER Output. On March 28, 1979 at Three Mile Island 2, the amount of radioactivity released in an accident is inexplicably described as "greater than 100,000 curies total."

2A-2. A 100 year drought is evaluated by a statistical study of Weather Bureau Records. As withdrawals and diversions become more important, extensive dry weather conditions can become more important in determining low flow conditions. Most low flow conditions have occurred in the historical record as a result of ice jams. The past is not necessarily a good guide to the future. It is the purpose of the stream dilution models to predict the future. Therefore, the possbilities of large withdrawals coinciding with a 100 year drought should be taken into consideration.

2A-3. No. It is possible to estimate but not to absolutely, accurately predict the amount of dilution afforded by the Missouri River. To base the estimation on only

average conditions does not take into account the fact that the river is not a static system and is frequently not at average conditions. A range of values should be reported to cover the best and worst circumstances.

2A-4. Both the UE Environmental Report - 1974 and the UE Environmental Report, Operating License Stage show that an extensive population study of the "fish standing crop biomass" was made, EROLS Vol. I Section 2.2.2.7 Fish, pp. 2.2-18 - 37. However, in the section: "Pathways for Exposure to Biota Other Than Man," Section 5.2.1.1 and Figure 5.2-1, EROLS Vol. II, fish are shown to be subject to radio-contamination only by "immersion" and "ingestion" while suspended in mid-stream. No mention is made of bottom-feeding fish being exposed to "radioisotopes deposited in sediments at the bottom of the river," though the existence of the radioisotopes in sediments is acknowledged (Section 5.2.1.1).

By comparison, at the Savannah River Plant (SRP) two preoperational surveys and a monitoring program include "specific radionuclide analyses of selected organisms" chosen for the following attributes:

"1. It efficiently concentrates radionuclides in the environment and, therefore, is used as a sensitive monitor of environmental radionuclides.

"2. It is a food item of man and, therefore, is useful in evaluating the dose received by the off-plant population" ("Biological Indicators of Environmental Radioactivity" by R. S. Harvey, pp. 136-139 in Environmental Surveillence in the Vicinity of Nuclear Facilities, Reinig, W. C., editor. Springfield: Charles C. Thomas, publisher. 1970). Organisms accumulate radionuclides by absorption, adsorption, and ingestion. Those organisms studied at SRP include fresh water clams which live in sediments and both bottom-feeding catfish and bluegill sunfish, a surface and bottom-feeding omnivore.

Another study, "A Statistical Study of the Habits of Fishermen Utilizing the Columbia River below Hanford" (pp. 302-308 in Environmental Surveillance), covered 21 fishing sites for an entire year in 4-hour time intervals, and the fish-eating habits

of the fishermen, to obtain the "incremental radiation dose attributable to this pathway which includes both the internal radiation received from consumption of the fish and the small amount of external radiation received while fishing."

Though there is some commercial fishing on the Missouri in addition to recreational fishing, and both catfish and bluegill sunfish are present in the river and surrounding waters, there is no indication of published studies, estimates, or projections on the amount of fish eaten and the effects of sediment contamination on fish, fishermen, and fish-eaters along the Missouri River and other waterways mentioned in EROLS.

In "Evaluation of Human Radiation Exposure" (pp. 240-260 in Radioactivity in the Marine Environment, prepared by the Panel on Radioactivity in the Marine Environment of the Committee on Oceanography, National Research Council, National Academy of Sciences, 1971) Foster, R.F., et al., emphasize that "the levels of contamination in the edible portions of marine plants and animals may be many times higher than in the water because of biological reconcentration processes. The levels that are acceptable for any specific situation depend upon the rates of consumption of locally derived foods, and these rates vary widely. Statistics for countries as a whole are usually of little relevance with respect to specific regions, and only surveys of local consumption can provide the data necessary to determine permissible concentrations in particular dietary items (p. 241)."

"Some radioactive debris enters the water as particulates, and some radionuclides in solution are easily adsorbed to the surface of particles. The result is radioactive contamination of sand and sediments (p. 143)." Plant life and small arthropods eaten by bottom-feeding fish pick up and concentrate the radionuclides, which are then concentrated further in the fish.

Finally, as another pathway to man related to bottom-feeding fish and sediment contamination, "fishing gear — and particularly commercial fishing gear — may

become contaminated directly by adsorption of radioactive materials from the water or indirectly from radioactive particulates on the [river] bed or in silty water (p. 143)."

While pre-operational studies of the environment may have been done, in "Objectives of Environmental Surveillance" (Environmental Surveillance in the Vicinity of Nuclear Facilities, pp. 21-25) the panel agrees that "we need to repeat this type of study about every five years. Peoples' (sic) habits change and the environment itself changes; you may find that a community which is eating oysters at a certain rate one year will be eating them at a quite different rate in the future."

Moreover, "we do not yet know all the possible routes by which all the materials can reach man in an environment. We are not invariably and infallibly able to pick the correct route (p. 22)." No one model is enough, and no model complete enough has yet been constructed.

In a study of the accumulation of radionuclides in the sediment of the Hudson River estuary, the authors have shown that "accumulation rates of sediment in the harbor approach 5-10 cm/yr over large areas, which is more than an order of magnitude greater than the long term average for the entire Hudson." Simpson, H.J., Olson, C.R., Tribr, R.M. and Williams, S.C. (1976) Man-made Radionuclides and Sedimentation in the Hudson Estuary. Science 194, 179-183. The area of the Hudson in question was the New York Harbor and the radionuclide source was from global fallout and "low-level" releases of a local nuclear reactor. This study showed that accumulation in the sediment of radionuclides occurred at a high level which indicates that particular areas of river ecosystems are more susceptible to accumulation of radionuclides than other areas. Therefore, the area at or near the outflow might be more susceptible to accumulation of radionuclides than other areas of the river in general.

The effects of accumulation of toxic compounds, such as mercury, on bottom-feeders in river ecosystems are well known. In a report in Science in 1977 the rapid uptake of methyl mercury by bottom-dwelling plants and bottom-feeding

aquatic animals ws documented. Further, it was emphasized that sediment dwelling microorganisms tended to concentrate the toxic compounds. Therefore, bottom-dwellers tend to incorporate high levels of bottom waste matter. Carter, L.J. (1977), Chemical Plants Leave Unexpected Legacy for Two Virginia Rivers. Science 198: 1015-1020.

Although few direct data have been collected on the levels of radionuclides in bottom-feeders and in fish in general it seems likely that where there is an accumulation of radionuclides in river sediment, there is a further concentration of radionuclides by microorganisms and a rapid uptake of radionuclides by organisms in direct contact with the river sediment. Pentreath, R.J. and Lovett, M.B., (1976), Occurrence of Plutonium and Americium in Plaice from North-Eastern Irish Sea. Nature 262; 814-816. Cherry, R. D., and Shannon, L.V. (1974); Atomic Energy Rev. 12; 3-45.

2A-5. See 2A-4, above.

2A-6. Models in biology or in any scientific discipline indeed are useful as predictors of parameters set forth by the modeler. However, several qualifications must be included in this summary definition of the usefulness of models in science.

R.B. Braitwaite states that "for using models we must never forget that we are engaging in as if thinking . . . to forget the limitations [of models] is to misuse the valuable aid to thought provided by the model." (p. 52). This statement encompasses the philosophy behind modeling in ecology. The model exists as a predictor and as a hypothesis to be tested by direct experimental evidence. If a model is not used as a guide or base for experimentation then, according to Braitwaite, it is being misused, and the invaluable experimental stimulation provided by the model is lost. Braitwaite, R.B. (1973); "The Nature of Theoretical Concepts and the Role of Models in Advanced Science" in Theories and Observation in Science, ed. by R.E. Grandy.

E.C. Pielou, in one of the more recent reviews of biological modeling, defines a model in the following way:

> Modeling consists in constructing, mentally, a plausible symbolic representation of an ecosystem, in the form of mathematical equations. One then tests whether the behavior of the ecosystem conforms with that of the model. (p. 17, emphasis added).

She believes that most ecological models today are "constructed, refined, elaborated, tinkered with, and displayed with little or no effort to link them with the real world." (p. 17). Hence her appeal is to ecologists to perform experimental tests of the models they formulate. She states that "models have many uses, but as means to various ends, [illegible] ends themselves." (p. 18). And it is with a tinge of irony, because she has spent most of her professionnal career as a mathematical model builder in ecology, that she makes the following statement: "Modeling is only a part, and a subordinate part, of ecological research." (p. [illegible]). Pielou, E.C. (1981); "The Usefullness of Ecological Models: A Stock Taking." The Quarterly Review of Biology 56: 17-31. See also 2A-4, above.

2A-7. The basis for that contention is found in Joint Intervenors' original response, in paragraphs (a) through ([illegible]), pages 10 through 17.

2A-8. The "other factors" are Joint Intervenors' entire case on Contention 2. See responses to both 1st and 2nd sets of interrogatories on Contention 2.

2A-9. "Six State High Plains Ogallala Aquifer Regional Resources Study," Public Law 94-587, Section 193. Presented by the High Plains Study Council and its associates at Congressional briefings in Washington on February 25, 1981.

2A-10. See 2A-1, above.

2A-11. Yes.

2D-1. The inadequacies of gaussian models, especially for predictions of dispersion have been discussed frequently in recent years. Below is a sampling of references dealing with this subject.

(1) Lectures on Air Pollution and Environmental Impact Analysis, published by the American Meteorological Society, Boston (1975).

(2) R. G. Lamb, "Air Pollution as a Problem in Statistics," in Preprints of the Invited Papers to Environmetrics '81, sponsored by the Society of Industrial and Applied Mathematics, New Canaan, CN (April, 1981).

(3) A. Venkatram, "The Expected Deviation of Observed Concentrations from Predicted Ensemble Means," Atmospheric Environment 13, 1547-1549 (1979).

(4) S. R. Hanna, "Accuracy of Dispersion Models," (A position paper of the AMS 1977 Committee on Atmospheric Transport and Diffusion). Bulletin of The American Meteorological Society 59, 1025 (1978).

(5) D. Bruce Turner, "Atmospheric Dispersion Modeling - A Critical Review," Journal of the Air Pollution Control Association 29, 502 (1979).

(6) Discussion Papers in response to the above article. JAPCA, 29, 923 (1979).

(7) A. H. Weber, "Case Studies of Horizontal Spread of ^{85}Kr at 100km Downwind," Second Joint Conference on Applications of Air Pollution Meteorology, (March, 1980) published by the American Meteorological Society.

(8) Several papers in Fourth Symposium on Turbulence, Diffusion and Air Pollution - January, 1979, published by AMS.

(9) Several papers in Fifth Symposium on Turbulence, Diffusion and Air Pollution - March 1981, published by AMS.

2G-1. Joint Intervenors hereby strike the following sentence from their answer to Interrogatory G-1(2)(a): "The presence of radioisotopes accelerates the corrosion rate of metallic materials." The striking of this sentence does not alter the importance of the interaction of radiation with corrosion products which results in a considerable contribution to the burden of radioactive isotopes in the cooling water. There is no disagreement among solid state physicists who are familiar with the field of radiation effects on metals that the presence of radioactivity results in defects in metals as well

as in the increased likelihood of fatigue in metals, and that massive irradiation of certain metals could result in damage which could very well result in fractures, leading to releases of radioactivity to the environment. With prolonged exposure to radiation the likelihood of such fractures occurring increases significantly. Documentation includes: (1)Dienes, G. J. and Vinyard, G. H., Radiation Effects in Solids. New York: Interscience. (1957). (2) International Atomic Energy Agency, Radiation Damage in Reactor Materials Vol. I, (Proc. Symp. Vienna 1969). Vienna (1969). (3) Peterson, N. L. and Harkness, S. D., editors, Radiation Damage in Metals. (Proc. Symp. 1975). American Society for Metals, Metals Park, Ohio. (1976). (4) Thompson, M. W., Defects and Radiation Damage in Metals. Cambridge: University Press, (1969).

Kenneth M. Chackes, attorney for Joint Intervenors Coalition for the Environment, St. Louis Region; Missourians for Safe Energy; and Crawdad Alliance, and authorized as their agent for the purpose of answering the above interrogatories, hereby states to the best of his knowledge, information and belief that the responses provided above are true and contain such information as is presently available to Joint Intervenors.

Kenneth M. Chackes
Kenneth M.Chackes

Subscribed and sworn to before me this 17th day of September, 1981.

Bertram Cooper
Notary Public

My Commission Expires: 10/16/82

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NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
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UNION ELECTRIC COMPANY	)	Docket No. STN 50-483-OL
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CERTIFICATE OF SERVICE

I hereby certify that copies of the Response to Applicant's Interrogatories and Request for Document Production (Set. No. 2) to Joint Intervenors on Their Contention No. 2 have been served on the following by deposit in the United States mail this 17th day of September, 1981.

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