

**DIRECT EXAMINATION OF PLAINTIFF'S EXPERT:**

A. ... Orie Loucks ... Madison, Wisconsin .... I'm Professor of Botany and Forestry at the University of Wisconsin. My academic discipline includes both of those areas, but, in addition, the past year and a half I have been working as a systems analyst in environmental problems....

I took an undergraduate bachelor's degree in forestry at the University of Toronto: a master's degree in forestry at the University of Toronto ... in 1955; and I completed the Ph.D. in Botany with a minor in Meteorology at the University of Wisconsin in 1960.

Q. Since that time have you been regularly engaged in ecological research, teaching, and administration?

A. Yes.

Q. And the past year and a half have you been doing specific work in systems ecology”?

A. Yes.

Q. In the course of your regular professional activity have you ever had occasion to work with the Atomic Energy Commission or any of its affiliates”?

A. have served as a consultant on occasion to the AEC.

After preliminary qualification of the witness, testimony was elicited establishing the principles which determined the completeness of a systems model.

Q. So that we understand what we are talking about, what do you mean when you use the phrase “systems ecology”?

A. Systems ecology to me is the investigation of the system that is acting on biological materials in the natural environment, and it has three major components: These are the atmospheric transport system as it influences biological materials; the water transport system, the redistribution of water from the atmosphere to the surface, to the vegetation, and to the groundwater; and thirdly, the biological transport system itself, where we have movement of many materials by grazing and predation activities.

Q. Doctor, would you tell us what you mean by the phrase “transport system”“!

A. By a transport system, I mean the system in the environment that involves a movement, transfer, or exchange of material from one point to another or from one form to another, as in the transformation of carbon dioxide by photosynthesis.

Q. All of these transport systems are functions of time and some of them are functions of distance, aren't they?

A. That's right, and functions of other properties of environmental systems.

Q. Doctor, tritium is a biologically active material, is it not?

A. It can be in certain systems, yes.

Q. Would you please tell us the basic elements of the atmospheric transport system of a biologically active material?

A. The basic elements of this transport system include the circulation of the atmosphere, particularly the circulation of the lower atmosphere, and, in the case of tritium, we are primarily concerned with the water components in the atmosphere. This transport system includes such features as the lateral flow of air, including the flow of water vapor over a landscape where it may encounter areas of high topography which can result in cooling of the air and a resultant condensation of the water vapor, where it enters the water transfer system.

Q. All right, Doctor, would you summarize briefly the elements of the water transport system as they influence a biologically active material such as tritium.

A. The water transport system is much more fully understood than the atmospheric transport system, and we do have a computer simulation capability for predicting the movement of water through the land system from the moment that precipitation strikes the surface. The water is then redistributed to a number of variables within the model. I am describing the Stanford watershed model developed at Stanford University over the past ten years. [With] this model and its simulation capability, one is able to determine how much of the water from any precipitation input will be immediately evaporated; how much will become surface flow and move toward a stream and down a channel; how much will infiltrate into the soil and become accessible to plant roots; how much will be absorbed by the plant roots and transpired to the atmosphere; and how much may enter the groundwater to appear, with a considerable time lag, in a stream fed by groundwater. ...

Q. Is there a single published scientific paper that briefly covers some portions of the Stanford model?

**A.** I have a paper here published by a colleague of mine at the University of Wisconsin. **He and I**, together with two others, are part of a systems group investigating the enrichment of waters, lakes, and streams in Wisconsin, and we are utilizing the Sandford watershed model as the basic predictor capable [of] following [the] flow of water through this system.... Dr. Huff's primary research has been the investigation of the use of the Stanford watershed model as a means of predicting the transport of radioactive aerosols down the stream [by means of] materials picked up at the surface of the ground.

The Stanford watershed model predicts what the flow in the stream will be for some hours after the precipitation. and the hydrologic transport model that Dr. Huff has described is used to predict the concentration of radioactive materials that will be in that peak flow of water or that will be present in the water at any point after a storm or over a period of months.

**Q.** For the record, Doctor, would you identify that paper by title or publication.

**A.** The title of this paper is "A Numerical Model of the Hydrologic Transport of Radioactive Aerosols from Precipitation to Water Supplies," by Dale D. Huff and Paul Kruger. and it was published in Geophysical Monographs. No. **n**, [in]... 1957.

The paper was then offered as evidence.

**MR. EARDLEY:** Just a moment, I object! I haven't read the paper yet, but I would object on the general ground that he is offering this paper which deals with a subject with which he has not yet indicated he has any expert knowledge.

**MR. YANNACONE:** I will continue to qualify the witness] your Honor.

**MR. SEARLS:** I want to enter the further objection that it is hearsay as to these defendants Austral Oil and CER

Geonuclear with no right of cross-examination of the two authors of the paper.

Q. Doctor, in the course of your regular professional activities, have you had occasion to investigate the systems characteristics of streams?

A. Yes, sir.

Q. Have you had an occasion to make an independent scientific judgment of the effect and validity of the Stanford Model as to stream flow?

A. Yes, sir.

\_ Q. Have you, in the course of your regular professional activities, had occasion to rely upon and utilize this model as the basis for work that you have published under your own name?

A. Yes, I have.

Q. Has the work that you have published under your own name been evaluated in the usual scientific sense through the process of publication?

A. Yes.

Q. What was the title of your publication?

A. The paper of primary interest here is entitled "Systems Models for Describing Changes in Ecosystems." The authors are Donald G. Watts and myself, Dr. Watts being another colleague in the systems group at the University of Wisconsin. The paper was published in February of 1969 by the Institute for Environmental Studies at the University of Wisconsin.

Q. Doctor, under whose auspices was this paper prepared and published?

A. This paper was supported by the U.S. Public Health Service in part, by the University of Wisconsin Graduate School in part, and] by the Federal Water Pollution Control Administration in part.

Q. Was it accepted by them as a fair return on their financial investment”?

A. Yes.

MR. EARDLEY: Objection. The question calls for a conclusion by the witness about the state of mind of somebody else.

MR. YANNACONE: I will withdraw the question and rephrase it.

Q. Did you get all your grant money? Did the agencies pay for it completely?

A. The agencies supported all of the work here, yes.

Q. And [they] paid all the money they were supposed to?

A. Yes and continued the project to [include] current work that we are doing.

Q. Is the project continuing now”?

A. Yes.

Q. Under the same auspices and support”?

A. Yes.

Q. You have submitted that [paper] as a report to those funding agencies, haven’t you”!

A. Yes.

MR. YANNACONE: I ask the Court to take judicial notice of the fact that it is pretty obvious the agencies were satisfied.

THE COURT: All right.

At this point, the attempt was made to introduce published

papers into the record as evidence, and, after objections and questioning by opposing lawyers, trial counsel for COSCC asked the following questions elaborating the extent of Dr. Loucks personal research and its relevance to radionuclides directed toward demonstrating that systems analysis is an integrative science requiring direct participation by individual scientists of specialized competence in many disciplines.

Q. Now, with respect to that paper and the water transport system we have under consideration, are there elements of the work done in that study that relate to the transport of biologically active materials such as tritium in a system such as the Rulison regional transport system?

A. The continuing objective of the systems studies at Wisconsin is to investigate the transport of nutrients-nitrogen and phosphorus-from various sources on the landscape to lakes and streams. It is the consensus of our group and of other groups across the country that a simulation capability of the carrier material, water, is the best means of achieving good prediction of a transported material, such as nitrogen or phosphorus.

We have also applied this technique to investigation of the transport of DDT. Any other material that enters water can be modeled and simulated by the techniques that Professor Dale Huff published in his paper.

Q. In other words, then, in the course of your regular professional activities at the University of Wisconsin you participate in and collaborate with and conduct discussions on matters of mutual interest with Dr. Huff?

A. Yes, sir.

Q. And in the course of your regular professional activity, have you had occasion to make an independent professional judgment of the reliability and validity of the material contained in the Huff paper you have just described”!

A. I have.

Q. Doctor, is there anything inconsistent between the Huff- Kruger paper and the paper you have prepared with Dr. Watts?

A. No, there is nothing inconsistent. They are directed to two very, very different but somewhat related activities, and they would have to be studied carefully to see the common denominator that runs through it.

Q. Is the material contained in each of those studies relevant to the basis of your opinion and discussion of the water transport system for a biologically active radioactive material, such as tritium, in the Rulison Regional Transport System?

A. Yes, I view it as an immensely relevant foundation to further discussion of the movement of tritium.

MR. YANNACONE: I now ask they be marked in evidence.

Further cross-examination by counsel for the AEC and other defendants sought to demonstrate the incompetence of Dr. Loucks and the immateriality of his testimony because of insufficient investigation of radioactive materials.