2/28/83

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)
	)
CONSUMERS POWER COMPANY	) Docket Nos. 50-329 OM & OL
	) 50-330 OM & OL
(Midland Plant, Units 1 and 2)	)

NRC STAFF TESTIMONY OF DR. JAMES E. CARSON
REGARDING SINCLAIR CONTENTION 14

Q1. Please state your name and position.

A1. My name is James E. Carson. I am a meteorologist in the Division of Environmental Impact Studies of Argonne National Laboratory, Argonne, Illinois. A copy of professional qualifications is attached.

Q2. Dr. Carson, please state the purpose of your testimony.

A2. I am to present the NRC Staff response to the fogging and icing portions of Sinclair Contention 14. Dr. Steve Tsai, also from Argonne, will respond to the issue of thermal performance raised in the same contention.

Q3. Did you participate in the preparation of the Final Environmental Statement (FES) related to the operation of Midland Plant?

A3. Yes.

Q4. Would you indicate which sections of the FES you prepared?

A4. I prepared the following sections of the Midland FES:

Section 4.2.6.3 - Gaseous Emissions, Dust
Section 4.3.3.2 - Air Quality
Section 5.4 - Air Quality

I also prepared several Staff responses related to issues of fogging and icing raised in the comment letters in Section 9 of the Midland FES.

Q5. Are you familiar with Sinclair Contention 14 as it relates to fogging and icing conditions at the Midland site?

A5. Yes. Sinclair contention 14 provides:

> The Staff DEIS is deficient in that it continues to base its analysis of the cooling pond's effectiveness in controlling thermal discharges (DEIS at 4-6) and ice and fog generation (DEIS at 5-7) on a study based on cooling pond performance in a substantially different climatic region. Instad, the DEIS should analyze information different climatic region. Instead, the DEIS should analyze information from the Dresden, Illinois nuclear facility (or other data from a comparably sized and situated facility) for both purposes, and present the baseline data from that facility to allow the agency and the public to reach an informed decision on the adverse effects of the cooling pond.

Q6. The Draft Environmental State (DES) and the FES contained analyses of ice and generation. Please describe how these analyses were done.

A6. As stated in Section 5.4.1 of both the DES-OL and FES-OL, although the applicant used two models in its assessment, the Staff's analyses and conclusions relative to steam fogging and icing are based primarily on observations made at the Dresden plant, not by the use of a model. As discussed below and in Dr. Tsai's testimony, the applicant used six years of climatological data in its calculations of both thermal performance of the cooling pond and fogging and icing conditions.

The applicant developed two numerical models to predict the frequency of occurrence and the inland extent of the steam fog and icing from the Midland cooling pond (see Section 5.1.4 and Appendix 5.1C of the ER-OL). The earlier model (by Currier et al., Ref. 2 of the FES-CP) is based on theoretical considerations (heat and mositure transfer from heated water bodies, dispersion calculations) and a review of earlier steam fog studies (described briefly in Section V.A.2 of the FES-CP). The model was calibrated using observations of steam fog at two operating power plants, the 1100-acre (455-ha) cooling pond at the Coffeen Plant, Coffeen, Illinois, and the 1200-acre (485-ha) cooling pond for the Four-Corners Plant at Fruitland, New Mexico. Most (128 out of 146 observations) of the data used in the development of this model by Currier et al. were obtained at the Four-Corners Plant over a two-year period.

Currier et al. developed a criterion for the presence of steam fog over the water surface, the fog index number (FIN). FIN is defined as the ratio $(T_w-T_a)/(e_s-e_a)$, where T_w is water temperature, T_a is air temperature, e_s is saturation vapor pressure of air at T_a, and e_a is the actual atmospheric vapor pressure. The units of FIN are degrees Fahrenheit per millibar.

The applicant used six years of hourly meteorological data from the Tri-City Airport to predict average monthly surface water temperature in the Midland cooling pond (Figure III-4 of the FES CP) and to calculate hourly FIN values. He then used the criteria developed in the model and the hourly FIN values to compute steam fog frequencies.

The second model used by the applicant to predict fogging and icing was the Portman and Weber model developed by two meteorologists form the University of Michigan (Appendix 5.1C of the ER-OL). The model has three basic subsections: first, changes in atmospheric temperature and moisture content caused by the heat and water vapor fluxes from the heated water surface were computed from the air-water temperature difference and ambient humidity; next, the standard atmospheric transport and diffusion equation was used to calculate downwind temperatures, water vapor and liquid water concentrations; finally, cloud physics principles were used to convert liquid water concentrations into visual range.

Portman and Weber used six years (1949-1954) of National Weather Service (NWS) meteorological observations taken every third hour at the Tri-City Airport to compute pond surface temperature, sensible heat loss and evaporation rates, and turbulent transport and mixing. As stated by the authors, this model has not been tested at an operating cooling pond.

In other words, the climatological data used by the applicant in both models were those from a National Weather Service (NWS) observing site at the Tri-City Airport, only 7 miles (11 km) southeast of the cooling pond.

Q7. How did the NRC Staff analyze ice and fog generation for the Midland FES?

A7. As stated in Section 5.4.1 of both the DES-OL and FES-OL, my analyses and conclusions relative to predicted fogging and icing conditions at the Midland cooling pond are not based on the Currier et al., Fortman and Weber, or any other mathematical model. My analyses and conclusions are based in part on personal observations made at the cooling pond at the Dresden Nuclear Plant in northern Illinois, and in part on observations made by others at Dresden (FES-OL), Refs. 1, 3-7 and the study by Vogel and Huff cited below). Since the Dresden cooling pond has an area and heat load comparable to that of the Midland pond and is located in a comparable climatic region, fogging and icing conditions at Dresden should be comparable to those at Midland. The Dresden cooling pond also has an east-west road paralleling the southern edge of the lake (Lorenzo Road in Will County, Pine Bluff Road in Grundy County) which has a location comparable to that of Gordonville Road at the Midland site. The road at Dresden is adjacent to the three coolest segments of the five-segment cooling pond. This comparison should yield more accurate estimates of conditions at Midland than would the use of an untested mathematical simulation. Most of the models currently available (Hicks, FES-OL Refs. 3 and 4; Currier et al., FES-OL Refs. 2) are designed to predict the presence of steam fog over the pond itself, not its inland penetration.

My analyses are also based on observations made by others at other cooling ponds (FES-OL, Refs. 2 and 5; references on page V-5 and V-6 of the FES-CP, J. Vogel and F. Huff, "Atmospheric Effects of Cooling Lakes," Electric Power Research Institute Report EPRI ER-1762, April 1981).

Observations made at operating cooling ponds, including Dresden, indicate that under most weather conditions the steam fog is shallow, wispy, in turbulent motion, and usually does not penetrate inland more than a few tens of feet before evaporating completely or becoming very thin and lifting to become a low stratus cloud deck. However, when the air is very cold, dense steam in very turbulent motion will form over the heated water surface and will be advected inland some distance. Fogging conditions are also more frequent and more intense when both reactors are operating.

Observations at Dresden indicate that during periods of very low temperatures when winds are out of the north, steam fog is advected over Lorenzo/Pine Bluff Road; patches of dense steam will reduce visibilities to near zero for short periods. Since this fogging condition does occur at Dresden, I consider it reasonable to expect similar conditions will also exist at Midland, As discussed below, my analyses and conclusions are supported by observations made at other cooling ponds. However, this qualitative anaylsis will not yield quantitative estimates of how often this condition will exist at Midland.

The recent Vogel and Huff report referenced above is the most complete study of cooling pond fogging and icing available. Extensive measurements of fogging and icing conditions were made from February 1976 to March 1978 at the 2200-acre (890 ha) cooling pond for the 1800 MWe coal-fired Baldwin power plant in southwestern Illinois. The authors also analyzed the December 1971-March 1973 fogging data collected at the Dresden Nuclear Plant (FES-OL, Ref. 1). The Lake Baldwin data include measurements of the downwind extent of fogging and icing.

Vogel and Huff report that steam fog was present over the cooling pond on 40% of all days at Lake Baldwin and 49% at Dresden (these Dresden data were collected prior to start of closed-cycle operation). Dense steam fog (visibility equal to or less than 0.25 miles or 0.4 km) was observed most often in the winter: 60% of all cases at Baldwin and 87% at Dresden. Vogel and Huff have established criteria for predicting dense steam fog initiation: air-water temperature differences of 19°C (34°F) or more and saturation deficits of 0.5 g/kg or less. These criteria indicate that dense steam fog will be common over the water surface at Midland.

Vogel and Huff also measured the downwind extent of steam fog at Lake Baldwin. On only 71 out of the 185 days (38%) with steam fog present at Lake Baldwin did the fog extend more than 2 ft (6 m) from the edge of the pond; on 17 days (9%) it extended more than 650 ft (0.2 km) (Vogel and Huff, Table 2-13). On three days, the fog extended more than 1 mile (1.6 km). Vogel and Huff's observations at Lake Baldwin confirm the results of other investigators that the density of steam fog (and also icing) decreases rapidly as it moves away from the edge of the cooling pond.

Vogel and Huff also studied frequency, intensity, and horizontal extent of icing caused by steam fog at Lake Baldwin. As reported by other investigators, only very low density, friable (easily crumbled) rime ice on elevated surfaces (such as branches, vegetation, wires, poles, etc.) was observed. Rime ice was not observed at air temperatures above 19°F (-7°C). Rime ice accumulations were usually (90%) 1 inch (2.5 cm) or less; on one occasion, a deposit of 3 inches (7.6 cm) was observed. Most icing events were observed within 650 ft (200 m) of the cooling lakes; the maximum distance measured was 0.5 mile (0.8 km).

With the exception of my personal observations at Dresden, the data bases upon which the staff's analyses and conclusions relative to fogging and icing at Midland are based are available to the public and other agencies in the references cited in the FES-CP (Section V.A.2), the ER-OL, the FES-OL, and in the Vogel and Huff 1981 report cited above.

Since the Midland cooling lake will have a higher heat load (more heat discharged per unit of lake area) and is located in a colder region than Lake Baldwin, fogging and icing conditions at Midland will be more intense than those observed at Lake Baldwin and will be comparable to those presently existing at Dresden.

The data from both Dresden and Lake Baldwin indicate that there is the potential for fogging and icing over Gordonville Road of sufficient magnitude to create a traffic hazard. The applicant is committed to monitoring the frequency extent, and opacity of pond-induced steam fog and icing conditions near the cooling pond (ER-OL, Sec. 6.2.3.1.2) and is further committed to take mitigative actions in the event that hazards to traffic result from operation of the cooling pond (ER-OL, Sec. 5.1.4.2; Consumers Power Co. comment letter, April 2, 1982, Appendix A of the FES-OL).

Q8. Are you saying that neither Consumers Power Company nor the Staff used climatic data from another area in your analyses?

A8. Yes, neither the Staff nor Applicant used climatic data from another area in its analysis. See the answers to Q6 and Q7.

Q9. Did you use fogging data collected at the Dresden nuclear power plant in your analyses?

A9. Yes. As stated in Section 5.4.1 of the DES-OL and again in the FES-OL, my analyses and conclusions were based in a large part on observations made by me and by others at the Dresden nuclear plant (Refs. 1, 3-7 of the FES-OL; J. Vogel and F. Huff "Atmospheric Effects of Cooling Lakes," Electric Power Research Institute Report EPRI ER 1762, April 1981). I also utilized steam fog observations made at other cooling ponds, as referenced in the FES-CP (Section V.A.2) and the FES-OL (Section 5.4.1).

PROFESSIONAL QUALIFICATIONS

James E. Carson

Argonne National Laboratory

I am a meteorologist in the Division of Environmental Impact Studies (DEIS) of Argonne National Laboratory (ANL). My primary task is to write the meteorological sections (climatology and dispersion characteristics of the site, impact of severe storms on structures, etc.) for Environmental Statements for nuclear fuel facilities, and those sections of Environmental Statements dealing with the effects of the proposed and alternate cooling systems on the atmosphere. In addition, I serve as a consultant to the DEIS staff and to other ANL Divisions on meteorological problems.

I joined Argonne's Meteorology Group in May 1961 and transferred to DEIS in April 1972. I have a Bachelor of Science degree in chemistry from Kent State University (1943). I did my graduate work in meteorology at the University of Chicago, receiving the Master of Science degree in 1949 and the Ph.D. degree in 1960.

I served as a weather officer and forecaster in the Air Force in the Mediterranean Theater. While in graduate school, I served in various capacities, such as an instructor and as a research assistant. I was an Assistant Professor in the Meteorology Department at Rutgers University from 1951 to 1953, a meteorologist in the Army Quartermaster R&D Center in Natick, Massachusetts from 1953 to 1955 and an Assistant Professor of Physics at Iowa State University in Ames from 1955 to 1961.

While at Argonne National Laboratory, I have been involved in a variety of projects, including soil temperature and heat flux studies, smoke dispersion and plume rise measurements, effects of tornadoes and strong winds on structures containing special nuclear materials, urban dispersion models and the atmospheric effects of thermal discharges from power plants. I have over 50 technical publications, many on the effects of waste heat from cooling towers and cooling lakes on the atmosphere.

I am a member of the following professional societies: American Meteorological Society (Professional Member); Air Pollution Control Association; and Sigma XI. I am a member of APCA's TT-3 (Meteorology) Technical Committee.