SS: STATE OF MICHIGAN
COUNTY OF WASHTENAW

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF DONALD H. EVANS

Donald H. Evans, being duly sworn, deposes and says that he is the coauthor of the "Testimony of Donald H. Evans and David A. Sommers concerning the Cooling Pond Performance Studies," and that such a testimony is true and correct to the best of his knowledge and belief.

Donald H Evans
Donald H. Evans

Sworn and Subscribed Before Me this 10 Day of February, 1983

Beverly A Beas
Notary Public
Washtenaw County, Michigan

My Commission Expires October 26, 1986

BEVERLY A. B[illegible], Notary Public
WASHTENAW COUNTY - MICHIGAN
MY COMMISSION EXPIRES 10-26-86

SS: STATE OF MICHIGAN
COUNTY OF JACKSON

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF DAVID A. SOMMERS

David A. Sommers, being duly sworn, deposes and says that he is the coauthor of the "Testimony of Donald H. Evans and David A. Sommers concerning the Cooling Pond Performance Studies," and that such a testimony is true and correct to the best of his knowledge and belief.

David A Sommers
David A. Sommers

Sworn and Subscribed Before Me this 11th Day of February, 1983

Pamela J. Griffin
Notary Public
Jackson County, Michigan

My Commission Expires September 8, 1984

mi0283-1599a131

TESTIMONY OF

DONALD H. EVANS AND DAVID A. SOMMERS

ON

COOLING POND PERFORMANCE STUDIES

My name is Donald H. Evans. I am an engineering supervisor for Bechtel Associates Professional Corporation in Ann Arbor, Michigan. In this capacity, my responsibilities are for the hydraulic, hydrologic and hydrothermal analyses performed for the Ann Arbor Power Division.

I hold three degrees, these are: Bachelor of Science in Civil Engineering, 1966; Master of Science in Civil Engineering, 1972; Civil Engineer, 1973. A Civil Engineer degree is similar to a PHd except that no dissertation is required; the Civil Engineer degree program provides a broader background in the field of Civil Engineering. The two graduate school degrees were received from the Massachusetts Institute of Technology. I joined Bechtel in 1973. Since that time I have been associated with the hydraulics/hydrology (H/H) group of the Hydro and Community Facilities Division of Bechtel Civil and Minerals, Inc. This group provides consulting services to the Bechtel group of companies in the fields of hydraulics, hydrology and hydrothermal. The field of hydrothermal engineering includes studies of cooling pond performance. As the H/H engineering supervisor, I am familiar with and presently responsible for the Midland cooling pond thermal performance study described in this testimony. My resume is attached.

My name is David A Sommers. I am a Section Head in the Midland Safety and Licensing Department of Consumers Power Company. I hold a Bachelor of Science Degree in Electrical Engineering, 1972, and a Master of Science Degree in Nuclear Engineering, 1973, both from the University of Illinois. I joined Consumers Power Company following four years of service in the nuclear Navy on the technical staff of the Division of Naval Reactors, USAEC/Naval Sea Systems Command, Washington, DC. I have held various positions at Consumers Power Company since I became associated with them in 1977. In my present capacity, my responsibilities are supervising and coordinating the review of environmental licensing and radiological safety issues for the Midland Project Office. This specifically includes supervising the Company review of the DES and providing Project interface with our Environmental Department on the NPDES Permit application. In this capacity, I am familiar with the environmental issues involved in Sinclair OL Contention 14.

REFERENCES

1. "Model Study, Midland Cooling Pond," Ferron, Albert G., Alden Research Laboratories, January 1970.

2. "Cooling Pond Thermal Performance, Summary Report, Midland Plant Units 1 & 2," Prepared for Consumers Power Company by Bechtel, Incorporated, August 1973.

3. "Mathematical Predictive Models for Cooling Ponds and Lakes, Part A: Model Development and Design Considerations," by Gerhard H. Jirka, et al, Technical Report No. 238, Ralph M. Parsons Laboratory for Water Resources and Hydrodynamics, December 1978.

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COOLING POND PERFORMANCE STUDIES

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COOLING POND PERFORMANCE STUDIES

1.0 BACKGROUND

1.1 SCOPE OF TESTIMONY

The purpose of this testimony is to describe the Bechtel thermal performance study which is referenced in the summary tables (4.1, 4.2) on pages 4-6 and 4-7 of the Draft Environmental Statement for the Midland Plant. These same tables are also found on pages 4-24 and 4-25 of the Final Environmental Statement. This testimony will show that the Bechtel thermal performance study and the Midland cooling pond operation study were not improperly influenced by data from a substantially different climatic region than the Midland Plant.

1.2 GENERAL

Midland's cooling pond is a closed cycle cooling system. This means that the cooling water for the condensers is withdrawn from the pond, and the heated water from the condensers is discharged to the pond. In comparison with the condenser flows only very small quantities of water are added to the pond by the make-up system or removed from the cooling pond through evaporation, seepage or the blowdown discharge system. Since it is a closed cycle system, the temperature in the pond will adjust to a point where virtually all the heat rejected by the plant to the pond will be transferred to the atmosphere.

Thermal performance studies are used to evaluate the ability of a power plant cooling system to dissipate the heat rejected to the cooling water, while maintaining acceptable condenser inlet temperatures. These studies determine the condenser inlet temperatures for a given pond size and configuration, plus the water loss by evaporation for the power plant.

The results from a thermal performance study can be used as input into a fog and ice study, but in itself, a thermal pond performance study does not predict fog and ice generation. Likewise, the results from a thermal performance study can be used as input into a cooling pond operation study but, in itself, a thermal performance study does not "control" thermal discharges to the river.

Thermal performance studies normally employ analytical techniques incorporated in a mathematical computer model. In the case of cooling ponds, physical thermal-hydraulic models may also be used to determine parameters that cannot be obtained by analytical treatment alone. Midland's cooling pond thermal performance was evaluated using both a physical model and a mathematical computer model.

2.0 THE MIDLAND COOLING POND PHYSICAL MODEL

A physical model of a cooling pond is a scaled down replica of the actual pond. The Midland cooling pond model with a horizontal scale of 1:200 and a vertical scale of 1:25, was constructed of concrete and was about 35 feet square in size (Figure 1). It was located at the Alden Research Laboratories, Worchester Polytechnic Institute in Holden, Massachusetts (Reference 1). The concrete was shaped to match the actual pond topography. Typical model depths were about one foot. The Midland Plant circulating water flows and water temperatures (determined by plant heat load) used in the model were scaled according to standard model-prototype relationships.

The physical model study (Reference 1) was performed primarily to optimize the baffle dike arrangement in the cooling pond. Arrangement of the cooling pond baffle dike affects the thermal efficiency of a cooling pond by preventing direct recirculation of the heated water into the intake, and promoting effective use of the entire pond surface to dissipate heat (Figure 2). Relative temperature distributions within the cooling pond were also obtained from the model study, and were used in the analytical evaluation described below.

The equilibrium temperature (E) is defined as that temperature that a water body would eventually achieve when natural (i.e. non plant source) heat added to the water body through the surface equals the heat removed from the surface. Added natural heat in a cooling pond comes from two sources, net solar radiation and net atmospheric radiation. Heat removal processes are evaporation, back radiation and conduction. The latter processes are all a function of the water surface temperature. The surface heat exchange coefficient (K) is a function of the local meteorological data and the pond water surface temperature. The coefficient depends primarily on the wind speed, and to a lesser extent on the pond surface temperature and the air temperature.

For a given plant heat load it can be seen, from the above discussion, that the key unknown is pond surface temperature, T_S, which will vary within the pond. The relative temperature distribution within the pond depends primarily on the pond configuration, including pond shape, depth, internal baffle dikes, and intake/discharge arrangements. This relative temperature distribution is known from the Midland physical model study.

Using this information and segmenting the cooling pond in the mathematical model into a number of small areas according to the relative temperature distribution from the Midland physical model study and applying the surface heat transfer equation discussed above, the condenser inlet temperatures can be determined. This is done through an iterative process since the total net surface heat transfer from all the pond segments must be equal to the plant heat load. Computers perform the large number of calculations required.

The meteorological data used in the mathematical model came from the following sources:

Wind Speed	-	Tri-City Airport (Saginaw) or Midland at Dow Chemical
Air Temperatures	-	Midland (National Weather Service)
Relative Humidity	-	Midland in conjunction with Flint, Michigan

Solar Radiation - East Lansing, Michigan

Cloud Cover - Tri-City Airport (Saginaw)

Barometric Pressure - Tri-City Airport (Saginaw)

Two kinds of mathematical evaluations were performed for Midland. Steady-state analyses, with input from the physical model study, were used to determine a range of condenser inlet temperatures. This information confirmed the selection of the condenser characteristics and adequacy of the pond surface area. The data presented in the Tables (4.1, 4.2) in the DES at pages 4-6 and 4-7 and in the FES at pages 4-24 and 4-25 are the result of these steady-state analyses.

A second mathematical model, the transient numerical model (Reference 2), was developed for the purpose of evaluating the pond response to short-term variations in meteorological conditions. This evaluated the peak condenser inlet temperatures by using time varying data of much shorter duration than used in the steady-state model.

None of the meteorological data used in these Midland mathematical models came from climatic regions other than Midland, and its vicinity. Thus, the results of the Midland thermal performance studies are specific to Midland.

4.0 VERIFICATION OF MATHEMATICAL MODELS

The energy balance technique is well accepted in practice as a method of evaluating cooling pond thermal performance. This technique has been verified through successful plant operation or tested against field data at operating plants. The plants where this technique has been verified are located around the United States and cover a wide range of climatic conditions and geographic locations. The aforementioned plants include the Four Corners plant in New Mexico and the Dresden and Powerton plants in Illinois. Testing analytical results against field data provides a means of checking the reliability of the analytical procedures.

4.1 Four Corners Data

The Four Corners Plant, 2050 MW_e (5 units), uses a 1200 acre pond for plant cooling. Condenser inlet temperature data and meteorological data were obtained in July and August 1970. With the heat load, physical configuration and meteorological data measured at the Four Corners plant, the equilibrium temperature and surface heat exchange coefficients were analytically determined using the energy balance technique and the average condenser inlet temperature was determined for the period of record. This was then compared to the condenser inlet temperature found in the field. The difference between the calculated and field determined condenser inlet temperatures was less than $2^{o}F$, a reasonable result. The average observed condenser inlet temperature was slightly less than the calculated temperature.

4.2 Dresden and Powerton Data

In 1978 researchers at MIT (Reference 3) applied a mathematical model, similar to that used for Midland in that it used the energy balance techniques, to data obtained for both the Dresden and Powerton cooling ponds. Intake (condenser inlet) temperatures predicted by the MIT model for both Dresden and Powerton were very close to the measured field data, generally within $\pm$ 1-2°F.

The MIT mathematical model differs from the Midland model primarily in the empirical relationship used in computing evaporation. Evaporation is the most significant parameter in computing the surface heat exchange coefficient. In October 1982, as a sensitivity check, Bechtel incorporated this relationship, verified against the Dresden and Powerton data, into the Midland mathematical model described previously in this testimony. Forty one years of meteorological data applicable to the Midland site were then used to generate monthly average condenser inlet temperatures for Midland. These predicted temperatures were very close to those given in Table 4.2 in the DES (see Table 1).

This indicates that, with the Midland mathematical model altered to incorporate a different empirical relationship for evaporation from the Dresden plant in Illinois, the overall results from the altered model are comparable to those presented in the DES.

5.0 COOLING POND OPERATION STUDY

Blowdown from the cooling pond to the Tittabawassee River is not controlled based on the results of the cooling pond thermal performance study. Pond blowdown to the river is controlled by NPDES Permit limitations to ensure compliance with State Water Quality Standards. Actual pond blowdown to the river is physically controlled by an automatic makeup and blowdown system (AMBS) which among other things relies on direct measurement of the temperature of the cooling pond near the blowdown intake.

As discussed on p 4-11 of the DES (p 4-8 of the FES), in 1979 a study of cooling pond operation was performed, which included as one component a thermal performance analysis of the cooling pond similar to the 1973 Bechtel thermal performance study described above. The 1979 cooling pond operation study demonstrated that the restrictions imposed by the NPDES Permit would not significantly impact the operation of the Midland plant. This 1979 study is not used in the design or operation of the AMBS in controlling pond blowdown to the river. In addition, for the same reasons as stated above with respect to the 1973 thermal performance study, the 1979 cooling pond operations study was not based on data from a "substantially different climatic region."

6.0 CONCLUSIONS

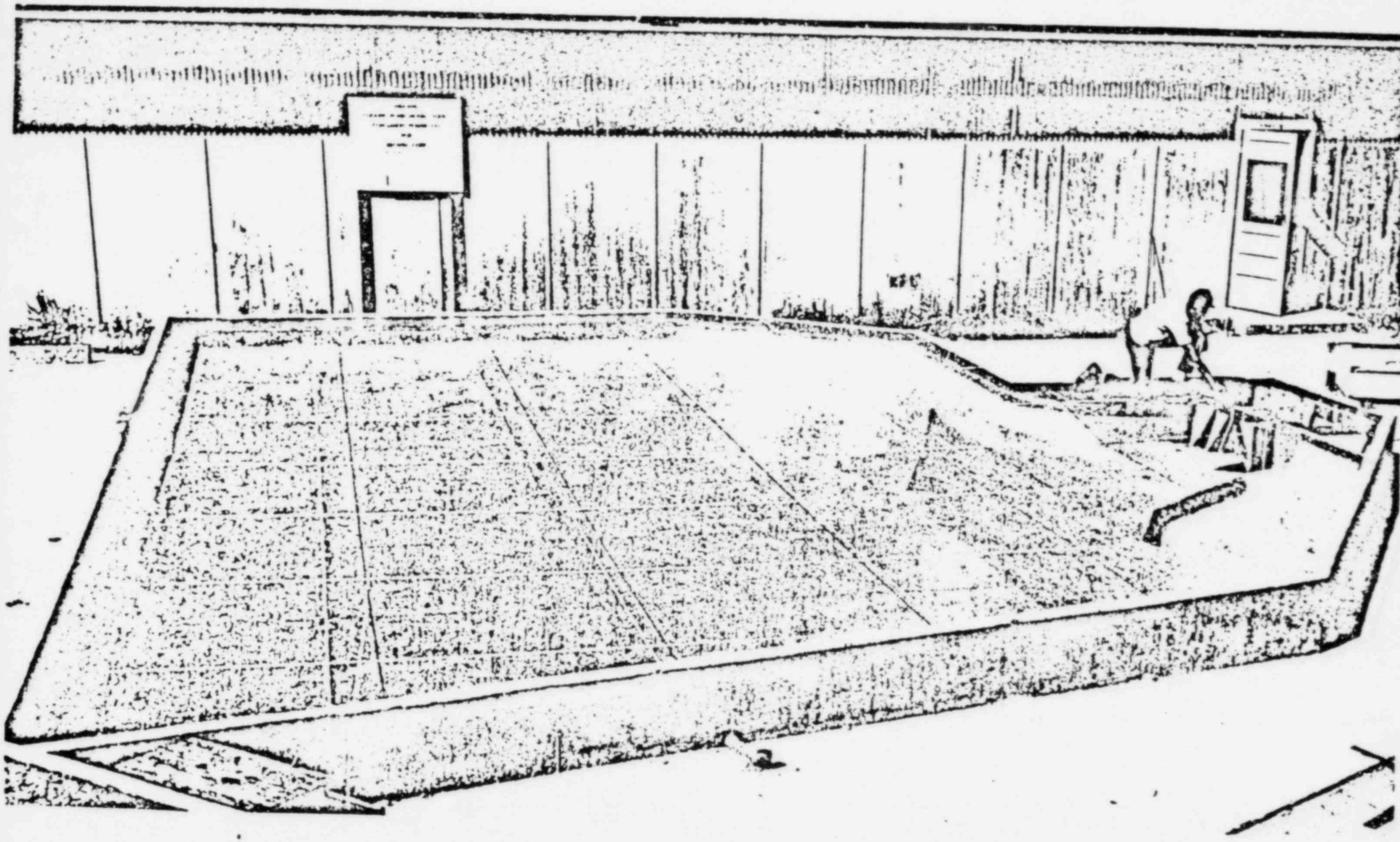
In conclusion, the analytical techniques employed for Midland are not specific for any one part of the country. They become site specific, however, when the meteorological, and heat load data, and cooling pond design conditions are selected for use in the analytical evaluation. As indicated in the previous paragraphs, the Midland physical model was specifically designed to provide data for use in evaluating the Midland cooling pond. These data, along with the use of site specific meteorological data, were then used to estimate the condenser inlet and pond blowdown temperature. These Midland thermal performance results were and remain totally unaffected in any way by the application of the Midland mathematical model to the Four Corners plant. This comparison with Four Corners data simply provides reassurance that the mathematical model used for Midland is reasonable.

TABLE 1
APPLICATION OF DRESDEN
EVAPORATION RELATIONSHIP
TO MIDLAND

Monthly Average Condenser Inlet Temperatures

	Midland (Midland DES Table 4.2)	Midland With Dresden Relationship
JAN	63.5	61.4
FEB	64.5	64.2
MAR	69.0	68.8
APR	76.5	77.0
MAY	86.0	84.5
JUNE	92.0	92.5
JULY	94.5	95.1
AUG	94.5	94.8
SEPT	88.0	88.9
OCT	81.0	81.0
NOV	71.5	71.6
DEC	65.0	63.9

TABLE1



Midland Model

FIGURE 1

MIDLAND COOLING POND MODEL AT ALDEN RESEARCH LABORATORIES

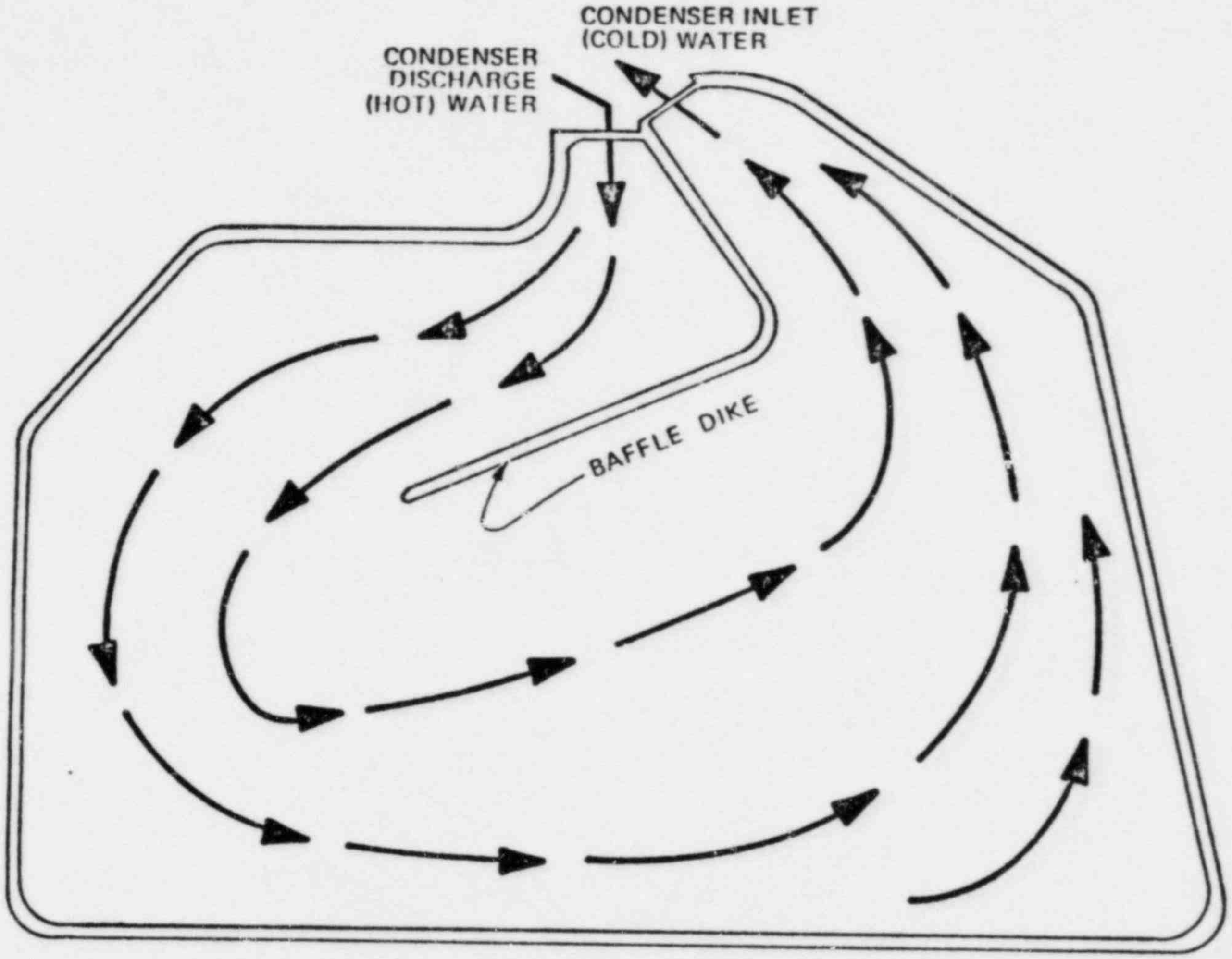


FIGURE 2

MIDLAND COOLING POND CIRCULATION PATTERN

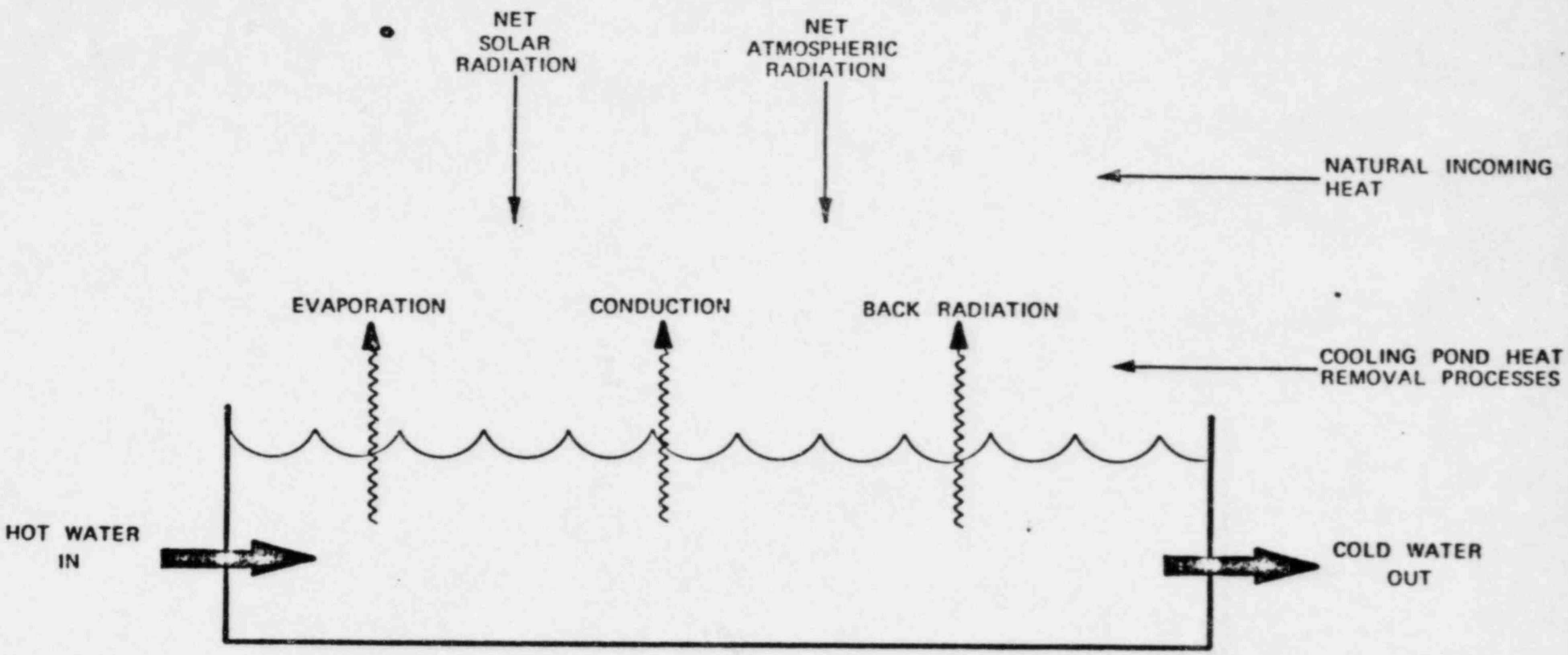


FIGURE 3

MIDLAND COOLING POND ENERGY (HEAT) BALANCE

DONALD H. EVANS — ENGINEERING SUPERVISOR HYDRAULICS/HYDROLOGY

EDUCATION: B.S.C.E., Colorado University 1966

M.S.C.E., Massachusetts Institute of Technology, 1972

C.E., Massachusetts Institute of Technology, 1973

Other: Bechtel Management Certificate, 1980

REGISTRATION: Civil Engineer, California 1976

AFFILIATIONS: American Society of Civil Engineers, SIGMA XI

SUMMARY: 16 years: Supervisor hydraulics/hydrology; performed studies and related tasks in the technical areas of hydraulics, hydrology, hydrothermal design and water resources. Commissioned officer, U.S. Navy Civil Engineering Corps., directing civil engineering projects and personnel.

EXPERIENCE: 1973 - Present: Design and analysis of hydrologic and hydraulic features on international and domestic projects, predominantly power projects. Power plant systems analyzed and evaluated have included nuclear steam generator feedwater systems, nuclear service water systems, nuclear component service water systems, nuclear containment spray systems, and circulating water systems for nuclear and fossil fueled power plants. Hydrologic studies have involved site drainage design, storm synthesis for nuclear and non-nuclear projects, sediment and scour problems and slope protection. Hydrothermal analyses have included evaporation and seepage studies with appropriate field monitoring, cooling pond analysis, and diffuser design based on hydraulic and thermal design criteria. Other assignments have included resident engineer for a slope protection model study, an oil shale feasibility study, and computer coordinator during a period of conversion from one computer system to another.

1970 - 1973: Graduate research assistant. M.I.T. Assignments included water resource system analysis of a large river basin and experimental analyses of thermal discharges.

1966 - 1970: Officer in the U.S. Navy Civil Engineer Corps. Assignments in the SEABEE's included officer-in-charge of a SEABEE team in Thailand where numerous civil engineering projects, such as water wells, small dams, roads, bridges and schools were constructed. Served as public affairs officer and assistant company commander of equipment operations (Vietnam). Also served as officer-in-charge of construction for administration of all navy contracts in Bermuda.

DONALD H. EVANS

PUBLICATIONS:

"Blowdown With Check Valve Slam" by P.H. Rothe, D. H. Evans, and C. J. Crowley, presented at the Joint ASME/ASCE Mechanics Conference, Boulder, Colorado, June 1981.

"Experimental Investigation of Submerged Multi-part Diffusers for Condenser Water Discharge" by R.F. Harleman, Gerhard Jirha and Donald H. Evans, MIT Report 165, February 1973.

"Application of Linear Routing Systems to Regional Groundwater Problems", by D. D. Evans, Brendan M. Harley, and Rafael Bras, MIT Report 15, September 1972.