HYDROLOGIC ENGINEERING SUMMARY
DAVIS-BESSE NUCLEAR POWER STATION UNIT NO. 1
DOCKET NO. 50-346

2.4 Hydrologic Engineering

2.4.1 Hydrologic Description - The site for Davis-Besse Nuclear Power Station (DBNPS) is located on the Southwestern shore of Lake Erie. The major station structures are located approximately in the center of the site area, 3000 feet from the shoreline. All elevations are referenced to the International Great Lakes Datum (IGLD), which was established in 1955 by the U.S. Department of Commerce. The low water datum (LWD) for Lake Erie is 568.6 feet IGLD. The original topography of the site was relatively flat with elevations varying from 568.6 feet IGLD to about 575 feet IGLD. The plant area is located on an existing slightly elevated upland section and is separated from the lake by an adjacent marsh area and a narrow beach ridge between the marsh and lake. Plant grade is to be 584 feet IGLD with entrance levels to plant structures at 585 feet IGLD. The southern site boundary borders the Toussaint River, which is approximately 3,000 feet from the major plant structures. A wave protection dike has been installed along the north and eastern side of the built-up plant area to an elevation of 591 feet IGLD. All surface water from these elevated areas will be collected and carried in storm drains to ditches that empty into either the marsh area or the Toussaint River.

An intake canal has been installed between the intake structure at the plant site and the beach ridge. The intake canal is connected to Lake Erie with an eight foot diameter underground and underwater pipe that extends 3,000 feet out into the lake. This is the single water source of cooling water for the service water system and is utilized for both normal and emergency shutdown conditions. A Category I open forebay area ahead of the intake structure serves as a reservoir for an insured source of water in case of an extreme lowering of the lake due to meteorological conditions, or collapse of the intake canal or the submerged pipes.

Lake Erie is the primary source of potable water in the area. The five nearest lake users are located between 3.6 and 12 miles from the station discharge. The Sand Beach community, with 122 residences, is located along the beach ridge, commencing at the northern site boundary at the shoreline. Approximately 50 percent of these residences obtain household water for all purposes from beach wells located in the lakefront sand. These wells are 3 to 6 feet deep, located 10-20 feet from the lake shoreline and for all practical purposes would be considered surface water supplies.

2.4.2 Flooding - Several potential flood producing sources were investigated by the applicant. The potential sources include Lake Erie, the Toussaint River, and the site drainage in the vicinity of safety-related structures as follows:

a. Lake Erie - The applicant has investigated probable maximum stillwater lake levels based on record lake levels plus wind tides and transverse seiche. The maximum lake level of 573.5 feet IGLD was recorded in June 1973. The applicant has calculated a maximum wind tide of 9.3 feet due to a probable maximum meteorological event (PMME) and using a procedure developed by

Platzman (1). A probable maximum transverse seiche of one foot was used based on a recorded value of 0.8 foot in the western basin by Hunt (2). These values were added to a lake level of 573.4 feet IGLD (0.1 foot lower than record) to yield a maximum stillwater lake level of 583.7 feet IGLD, 0.3 feet lower than the plant yard grade of 584.0 feet IGLD. The applicant calculated a maximum wave height of 10.7 feet due to the PMME, however this wave will break offshore due to limited depth of water. The top of the wave protection dike is based on a 8.5 foot wave generated landward of the shoreline. This wave will produce a runup of 6.6 feet on the 3 to 1 dike slope. This yields a maximum runup elevation of 590.3 feet IGLD, which is 0.7 feet below the top of dike elevation of 591.0 feet IGLD. The lakeside face of the dike will be protected with a 3-foot layer of random placed angular quarry stone on a 6-inch layer of 2-inch minus granular material.

b. <u>The Toussaint River</u> empties into Lake Erie southeast of the site. The stream has a drainage area of about 143 square miles and an average slope of about two feet per mile. The stream is ungaged and there are no dams on it. The lower six miles of the stream is much wider than the remainder and is controlled by the level of the Lake Erie. The applicant has conservatively estimated the peak flow rate for the Probable Maximum Flood (PMF), using the Probable Maximum Precipitation (PMP), to be 78,500 cubic feet per second (cfs). The applicant conservatively assumed there would be no flow to the lake during the PMF and the maximum stage associated with this "dammed up" condition would be 579.0 feet IGLD.

c. Site Drainage - The applicant proposed that site drainage facilities be designed such that a local PMP will not constitute a threat to the safety-related facilities. The applicant has conservatively assumed that all site storm drainage systems are blocked and filled with water at the start of a local PMP. Runoff under this assumption would reach 584.5 feet IGLD, which is 0.5 feet above the high point of all roads and grounds and 0.5 feet below the floor grade of all safety-related buildings. All Category I structures have a 2.5 foot parapet at the periphery of their roofs. Those roofs that have penetrations, have a curb around the penetration and horizontal roof drains with their invert at least 12 inches below the top of curb, in addition to the regular roof drainage system. The horizontal drain pipes are designed to drain the local PMP should all the regular roof drains become clogged. The staff has reviewed the applicants flood design considerations and conclude that all safety-related structures are safe from all flood potential up to probable maximum magnitude.

2.4.3 Ice Flooding - The applicant has concluded that ice flooding of safety-related structures from either Lake Erie or the Toussaint River will not present any hazards because of the distance between the plant site and relevant water bodies, and the freeboard between plant grade and the stillwater lake and river levels. He has also stated that even if the ice should reach the dikes on the north and east side of the plant, they are designed to withstand the ice pressures. We concur with the applicants conclusions.

2.4.4 Water Supply - All cooling water requirements are from Lake Erie. The intake canal forebay is designed as seismic Category I, and will be used as a heat sink reservoir in the event of low water or an accident. The applicant has used a procedure developed by Platzman (1) to determine the maximum wind tide fall at the site due to a PMME. The maximum wind tide fall was calculated at Toledo. Since the Davis-Besse site is located about 80% of the way from the wind tide node (Point in lake where no wind tide change in lake level occurs) to Toledo, wind tide variations at the Davis-Besse site were reduced by 20% from Toledo wind tides. This procedure gives a maximum wind tide drop with WSW winds of 9.3 feet. The maximum variation of record in the mean monthly level of Lake Erie is 1.2 feet below the LWD. The applicant has used a value of 1.5 feet below the LWD as an antecedent condition to the above procedure. A transverse seiche causing an additional tide drop of 1.0 foot was also assumed. These lake level losses total 11.8 feet and give a minimum stillwater lake level of 556.8 feet IGLD. The applicant's analysis of low water conditions is acceptable, however, plant operation will be contingent on the applicant providing an acceptable seismic Category I ultimate heat sink. The present UHS design and analysis is not acceptable.

The applicant has estimated that the intake forebay, which is the seismic Category I ultimate heat sink, will have sufficient water and surface area to provide emergency cooling for 39 days at a temperature no greater than 130°F (maximum allowable plant return water temperature). The applicant used the METMIN (Ref 3) generic transient heat program to analyze the forebay temperatures. The analysis assumes a seismic event, with the lake at elevation 562 feet IGLD, that blocks 2/3 of the portion of the intake canal that is not seismic Category I. The remaining 1/3 of the water volume in the canal plus the volume in the seismic Category I forebay area was used as the initial water volume for the analysis. The additional surface area in the failed portion of the intake canal was not used for heat transfer.

The staff has made independent lyses to determine the maximum return water temperature for a plant shutdown due to LOCA and simultaneous loss of 2/3 of the intake canal volume. Our analyses were based on the same parameters used by the applicant. The results of these analyses indicate that the water in the forebay area will reach a peak temperature of 137°F in about 5 days following plant shutdown for a LOCA. It should be noted that the staff also calculated a temperature of about 130° with the METMIN program, however, the results of this program are neither realistic nor conservative for the type of problem presented by the Davis-Besse 1 UHS. The nature of the METMIN program is to compute temperature using the entire water volume in the most efficient way possible. This is not realistic for this UHS, since approximately 1/3 of the total water volume is in the 2000 ft reach of the intake canal, which is not efficient for heat transfer.

The staff used several different models to determine the adequacy of the UHS as follows: (1) a revised HYETA (Ref 3) program (HYETA 2) was used to determine the extent of heat diffusion in the long narrow intake canal as well as to determine a conservative value of the maximum temperatures at the plant intake. The results of this analysis showed that only 900 feet of the canal (from the end of the seismic Category I forebay) was effective for heat transfer and dissipation. A maximum temperature of about 137°F occured 113 hours after the LOCA. (2) Simplified stratified pond, mixed pond, and plug flow models were also used as a check on the reasonableness and conservatism of the HYETA 2 analysis. The stratified pond model is the most realistic approach for the Davis-Besse pond. This model computed a maximum temperature of about 132°F, 112 hours after the LOCA. This is considered a lower limit, not a conservative answer.

Based on these independent analyses, the staff has concluded the Ultimate Heat Sink is not adequate to maintain the plant in a safe shutdown condition for 30 days. The applicant will be required to either, provide an alternate seismic Category I water supply, or revise plant operation procedure (with appropriate bases) and/or provide emergency operating procedures and equipment necessary to maintain the UHS water temperatures at or below 130°F and within 4 days of plant shutdown under emergency conditions.

2.4.5 Groundwater - The major groundwater sources in the area are the water-bearing Silurian and Dovanonian formations consisting of thick layers of limestone and dolomite. The major water bearing confined aquifer is between elevations 500 and 555 feet (IGLD). Wel' yields from the carbonate aquifer vary considerably in the vicinity of the site.

Yields of 150-600 gallons per minute (gpm) can be obtained from wells in the region west of the site (toward Toledo), and as much as 500-1000 gpm can be obtained from wells in the region east of the plant site (toward Port Clinton). Approximately 8 miles southwest of the site, the expected yield decreases to 50-200 gpm. Water from wells in the site locality is used primarily for certain domestic and sanitary purposes, and farm irrigation. In most instances, as a result of hardness, objectionable odor, and bitter taste, groundwater is not domestically used for washing, cooking or drinking. In the vicinity of the site the groundwater gradient is about 2 feet per mile toward Lake Erie, which is generally the same slope of streams in the area. The site is underlain by glaciolacustrine and till deposits (total thickness of approximately 17 feet) which overly the Tymochtee formation. These deposits basically consist of silty clay with very low permeability which has created an artesian groundwater condition in the water-bearing Tymochtee and underlying carbonate bedrock formations. The applicant has estimated the average groundwater flow velocity to be about 5 feet per year, assuming the carbonate bedrock aquifer to be homogeneous and isotropic with an average permeability of 1×10^{-2} cm/sec and an average gradient of 2 feet per mile. There are 30 wells within a three mile radius of the site, 13 of which are no longer being used and the reamining 17 are only used intermittently for irrigation and sanitation purposes. The applicant has concluded that the possibility of extensive contamination of the groundwater aquifer is low because: (1) the redundant safety features incorporated into the construction of the station; (2) the piezometric gradient and corresponding groundwater flow velocities are small at the present time; (3) the groundwater gradient is toward the lake and (4) there are no users between the site and the lake and the impervious surface deposits of predominately clay composition will retard the rate of flow to the aquifer and the dissolved radionuclides will react with the clay.

The staff made an independent analysis of the potential for groundwater contamination from an accidental liquid radwaste spill and concluded the following:

(1) The foundation of the radwaste building is at elevation 545 feet IGLD and the top of the confined aquifer, in the plant area, is at elevation 555 feet IGLD. Consequently, any postulated accidental liquid radwaste spill from the radwaste tanks in the radwaste building would be leaked to the confined aquifer, if leakage was possible. The hydrostatic pressure associated with the confined aquifer in the vicinity of the radwaste building would be about elevation 570 feet IGLD. This positive pressure on the radwaste building foundation would preclude leakage from the building into the confined aquifer, and in fact would induce leakage of groundwater into the radwaste building in the event of a seismic disturbance that could cause cracking of the structure.

(2) Additionally, the groundwater gradient is about 2 feet per mile toward Lake Erie and there are no wells between the plant site and Lake Erie that draw from the confined aquifer.

In the interest of conservatism, travel times and dilution factors were calculated for three points, as described below.

(1) The Lake Erie near field release point. The interface between Lake Erie and the confined aquifer was conservatively assumed to be 3000 feet from the lake shore. Consequently, groundwater (postulated to be contaminated) would travel 6000 feet horizontally from the plant to Lake Erie and then vertically 30 feet to the lake surface. The dilution factor and travel time are estimated to be 2750 and 72 years respectively.

(2) The beach wells. The dilution factor of 5.5×10^6 and travel time of 72 years were based on the assumption that radwastes would have to travel from the radwaste building, through the confined aquifer to the Lake Erie interface (approximately 6000 feet), then 3000 feet through Lake Erie to the beach wells, since the beach wells are not hydraulically connected to the confined aquifer.

(3) The Lake Erie Industrial Park. This is a surface water source located about 3.6 miles east of the plant site. The values for dilution factor and travel time from our analysis are estimated to be 9.8×10^6 and 72 years respectively.

The maximum probable static water level is elevation 583.7 (see section 2.4). The maximum water level due to wave runup on the break wall is calculated to be elevation 590.5. The station is protected along the north, east, and partially on the south side by an earthen breakwall built up to elevation 591.0. There will be no effective dynamic force applied on the critical structures associated with the maximum probable hydrodynamic water level and waves except the front wall of the intake structure which is designed for this loading condition. All seismic class I structures are designed for a maximum probable static water level of elevation 584.0.

2.4.6 Hydrologic Related Technical Specifications. The applicant's analysis of the UHS is based on a water level of 562.0 feet IGLD. Should the lake level fall below this level (or other levels pending resolution of the UHS design), shutdown of the station will be required and described in the technical specifications.

2.4.7 Conclusions. We have reviewed the applicant's flood analysis for the Davis-Besse Site, including maximum wind tide and wind waves on Lake Erie due to a PMME; PMF levels for the Toussaint River; ice effects on Lake Erie and the Toussaint River; and flood conditions at the site and on rooftops due to a local PMP and have concluded that the analyses and flood protection measures are acceptable.

We have made an independent analysis of the potential for contamination of groundwater wells and surface water intakes in the vicinity of the site and have conlcuded that in the event of an accidental liquid radwaste spill, leakage to the groundwater aquifer is improbable, however, even if leakage to the aquifer were to occur, effects at the nearest water user would be negligible.

We find the applicant's analysis of low water conditions at the site to be acceptable, contingent on the applicant providing an acceptable seismic Category I UHS, since extreme low lake levels would preclude the use of the intake crib as a source of water and would require temporary plant shutdown.

Our review and independent analyses of the ultimate heat sink indicates that the present heat sink design and conditions of operation are not adequate to provide plant cooling water at a temperature less than 130°F (maximum allowable for equipment design) for a 30 day period. We will require an alternate seismic Category I water supply or other acceptable proposal by the applicant that will insure a 30-day water supply for the UHS at an acceptable temperature.

REFERENCES

1. Platzman, G. W., A Procedure for Operational Prediction of Wind Setup on Lake Erie, Technical Report No. 11, to the Environmental Science Service Administration, the University of Chicago, Nov. 1967.

2. Hunt, I. A., Winds, Wind Set-Ups and seiches on Lake Erie, U.S. Lake Survey, Research Report 1-2, Corps of Engineers, January 1959.

3. Generic Emergency Cooling Pond Analysis, U.S. Atomic Energy Commission, May 1972 - October 1972.