JCP&L / GPU

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December 7, 1979

Director of Nuclear Reactor Regulation
ATT: Mr. Dennis L. Ziemann
Operating Reactors Branch No. 2
Division of Operating Reactors
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Oyster Creek Nuclear Generating Station
Docket No. 50-219
SEP Structural Topics

Dear Mr. Ziemann:

Transmitted herewith are our responses to your letter of July 16, 1969 which requested additional information concerning the following SEP structural topics:

TOPIC III - 2	Wind and Tornado Loads
TOPIC III - 3A	Effects of High Water Level on Structures
TOPIC III - 7B	Design Codes, Design Criteria, Load Combination and Reactor Cavity Design Criteria
TOPIC III - 7D	Containment Structural Integrity Tests

As noted in the Attachment, with respect to the requested information for TOPIC III - 7B, efforts are continuing to address the remaining aspects (Question 4) of your request. The remaining information will be forwarded to you as soon as it is available.

Very truly yours,

Ivan R. Finfrock, Jr.
Vice President

Attachments A through J

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Docket No. 50-219

ATTACHMENT A

OYSTER CREEK NUCLEAR GENERATING STATION

SEP STRUCTURAL TOPICS

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December, 1979

OYSTER CREEK NUCLEAR GENERATING STATION
Additional Information
Structural Topics

III-2 Wind and Tornado Loads

Question 1: Indicate which standards or codes (including date of edition) were used in the design of each Category I structure for wind loads.

Response : The design bases for structures are the ASA developed standards for wind loadings. The buildings are designed to withstand at least 30 psf between elevations 30 to 49 fees above grade and 45 psf between elevations 100 to 499 feet.

Those systems necessary for safe shutdown of the reactor and the primary containment system will operate satisfactorily during or following higher winds than the design wind loading. The reactor coolant system, primary containment, and most support systems are located in the massive reinforced concrete section of the reactor building below the refueling floor. These systems are easily capable of withstanding extremely high winds. The control room, occupation of which is required at all times, is a reinforced concrete structure. The heavy diesel generator with its fuel supply tanks easily withstand high winds. Power lines from the diesel generator to the reactor building and instrument and control lines from the control room to the reactor building are buried underground.

Question 2: Provide the information on how the tornado loadings which consist of the translational and tangential wind, the depressurization, and the tornado missile forces were considered in the design of each Category I structure.

Response : Amendment 11 (Page I-1-1-) to the FDSAR for Oyster Creek Nuclear Power Plant provides answer to this question. A copy of the amendment is attached to this letter (ATTACHMENT B).

III-3A Effects of High Water Level on Structures

Question : For each of the Category I structures state the water level that was considered in the design.

Response : Our response to Question 9C given in supplement No. 6 (Addendum No. 1) to the application for a full term licenses dated November 21, 1973 provides answer to the question concerning the effects of high water level on structures. The response is attached to this letter (ATTACHMENT C).

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In addition, flood level studies were performed for the proposed Forked River Nuclear Station and the results were reported in the Forked River PSAR. The Forked River Station site is located next to the Oyster Creek Station site and they share a common intake canal. All of the Class I structures are flood protected to the grade elevation of 23 ft. and 6 inch above mean sea level. The flood level studies reported in the Forked River Station PSAR are attached to this letter (ATTACHMENT D).

III-7B Design Codes, Design Criteria, Load Combination and Reactor Cavity Design Criteria

Question 1: With regard to the design of the steel containment, provide the design specifications and appropriate design reports. This information should include the information requested in items two through six below.

Response : Primary Containment Design Report is provided in the Amendment 15 to FDSAR for the Oyster Creek Nuclear Power Plant. The report describes the design basis, design evaluation, fabrication methods, inspection, and testing of the primary containment for the Oyster Creek Nuclear Power Plant.

Question 2: List the codes and standards (including edition date) used for design and construction of all Category 1 structures.

Response : ATTACHMENT E to this letter lists the codes and standards used for design and construction of Category I structures.

Question 3: List all loads and load combinations considered in the design of each Category I structure, including any missile or pipe break effects. Define the term "Operating load" listed in load tables 1-A-4 and 1-A-5 of Amendment 22.

Response : Loads and load combinationa are listed in Tables 1-A-1 through 1-A-5 of Amendment 22 to FDSAR for the Oyster Creek Nuclear Power Plant (tables are attached - ATTACHMENT F).

"Operating Load" includes the gravity loads from all equipment and piping supports, the restraint to thermal movement of the structure, and the weight of water over the reactor during refueling and in the storage pools.

Question 4: Provide the pertinent material properties of the steel and concrete used in the design of all safety related structures (i.e. fy, fc, etc.).

Response : We are in the process of gathering information to answer this question. The information will be forwarded to you when they are available.

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Question 5: Describe the method of combining stresses induced by seismic actions with the stresses resulting from non-seismic loads.

Response : Tables V-3-2 and V-3-3 are provided in the Oyster Creek Nuclear Plant FDSAR which show loading conditions for seismic and non-seismic stresses for both Primary Containment and Reactor Building. Copies of the tables are attached to this letter (ATTACHMENT G).

Question 6: Provide a summary of stresses or strains at critical locations in all Category 1 structures for each load combination considered in the design.

Response : A summary of stresses or strains for Category 1 structures for Oyster Creek Nuclear Generating Station is not available though we maintain the original stress calculations for the plant structures using load combinations acceptable at the time of the plant construction. We also do not have stress for single loading in our records. Due to a large volume of calculation available, summerizing them would require considerable time and effort.

We were told by an NRC staff that the purpose of this question is to combine the non-seismic stresses derived in our original analysis with the seismic stress obtained by the NRC's current analysis in order to evaluate the structures. It is our understanding that such an evaluation is not proper and simple since the analyses are based on different criteria, loads combination, method of combination, etc. In order for us to respond properly to this question, we need your clarification as to how the requested information will be used in your evaluation.

III-7D Containment Structural Integrity Tests

Question : Provide any reports that describe the procedures and results of the primary containment structural integrity test.

Response : For information concerning the containment structure integrity test, please refer to the following enclosures:

ATTACHMENT H: Expansion of the Drywell Containment Vessel

ATTACHMENT I: Loads on spherical shells. Chicago Bridge & Iron Company (1964)

ATTACHMENT J: Initial overload tests and leakage rate determination of the pressure suppression vessels. Chicago Bridge & Iron Co. (1966)

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ATTACHMENT B

OYSTER CREEK NUCLEAR GENERATING STATION

TORNADO LOADINGS

December, 1979

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QUESTION

2. Provide the probability of tornado occurrence in the vicinity of the Oyster Creek Nuclear Power Plant site including an evaluation of the consequences of a tornado striking Class I structures and Class I equipment. Consider the effects of high wind velocities, rapid depressurization, and missiles on a parametric basis and provide an estimate of the maximum wind velocities and pressure drop that the Class I structures can withstand without failure. Provide an analysis of the protective capability for Class I buildings and equipment against various sized missiles that can be caused by tornadoes moving at various velocities.

ANSWER

The tornado frequency for Oyster Creek is 2190 years. This means a probability of 1.81% for a 40 year life.

The 100 year wind storm would be a storm with the greatest intensity that can statistically be expected to occur. The wind velocities and wind pressure would be:

Height Zone (ft)	0-50	50 to 150
Velocity (mph)	100	125
Building pressure (psf)	40.3	62.8

These building pressures are based on 1.1 gust factor and 1.3 shape factor for a rectangular building. In the analysis, normal allowable working stress levels were increased by one-third for loading combinations of dead load, live load and wind load.

For the concrete system consider the wind acting normal to one wall; the forces distributed between the reactor biological shield wall (37%) and the two exterior walls parallel to the wind (63%).

For the steel, horizontal wind loads are transmitted to the column and distributed to the concrete and roof system. The load on the roof is transmitted to vertical cross bracing at the faces of the building and analyzed in tension only.

The following table includes the design criteria and stresses the reactor building is subjected to during a 100 year wind storm. The results of this investigation indicate the reactor building will be able to safely withstand the 100 year wind storm.

To find the maximum wind force the primary structure system can withstand it is necessary to evaluate the most critically loaded structural elements. The results of the investigation indicate the horizontal deflection of the upper steel framework is the limiting factor. Using the maximum deflection of the structure as a basis, the wind forces can be increased to approximately 280 mph.

	Stress (psi)			Deflection (in.)			Foundation	
	Concrete		Steel					
	Shear	Flexural	Tension	Conc.	Steel	Total	(KSF) Load	F.S.
Evaluation Criteria	50	450	7350			1.8	35.2	3.0
Biological Shield Wall	6.7	18						
Exterior Walls	18.0	48						
Diagonal Bracing			3000					
Concrete at EL. 119'-3'				0.017				
Steel at EL. 168'-0"					0.252			
Total Defl. at EL. 168'-0"						0.27		
Foundation Loading								
D.L. + 0.8LL							8.75	
Wind Load (max)							± 0.44	
Total Foundation							9.19	3.84

The significance of this wind load should be noted. Because of this extraordinary loading of extremely short duration the design allowable stresses can be assumed to reach and possibly exceed (based on energy considerations) the material yield point. If permanent damage to the steel superstructure is disregarded the rest of the structure (including the concrete biological shield) can safely withstand the forces caused by a wind with a velocity in excess of 500 mph. This is true even if the steel structure is assumed to still transmit forces to the concrete portion of the structure.

The tabulation below lists the various Class I structures with their respective maximum permissible wind velocity and depressurization values. The allowable stresses do not exceed 90% of yield for reinforcing steel and 85% of the ultimate concrete strength and include the combined effect of dead loads plus normal operating loads.

Class I Structures	Wind/mph	Pressure/psi
Reactor Building Exterior Concrete Walls	300	2.0
Reactor Building Insulated Metal Siding	160	0.53
Reactor Building Roof Decking	**280	0.96
Reactor Building Steel for Craneway Enclosure	*190	0.68
Control Room - North Wall	160	0.53
Remainder	300	2.0
*** Intake Structure	300	2.0
Ventilation Stack	180	2.0
Battery Room (interior room)		
Diesel Generator and Oil Tank Vaults	300	2.0

* Based on siding drag - without siding steelwork can withstand 300 mph
** Based on maximum suction value = 0.40 ρ
*** See answer to Questions IV-1 and IV-7.

Generally Class I equipment is enclosed in the listed Class I structures and is therefore protected within the limits shown. The outdoor Service Water Pumps and Startup Transformer are capable of withstanding 200 mph winds and a depressurization 2 psi.

The method of analysis to determine the protective capability of Class I buildings and equipment against various sized missiles and missile penetration at tornado velocities was based on the Modified Petry Formula (Navy Bureau of Yards and Docks NP3726).

The missiles assumed were a wood utility pole, 35 feet long by 14 inches in diameter having a velocity of 200 mph and a 1-ton missile, such as a compact-type automobile traveling at 100 mph with a contact area of 25 sq. ft.

The results of the analysis indicate that no perforation of the 18-inch thick reactor building walls or the 12-inch thick control room walls will occur, although spalling of the inside concrete face would be expected.

The control room, battery room, emergency diesel generator building, emergency switch gear and related wiring has been designed for tornado protection and will be incorporated in the final design.

There is essentially no missile protection of the magnitude discussed above in the metal siding walls of the reactor building above the refueling floor and the equipment access opening. There is also no missile protection for the Class I pumps at the intake structure.

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ATTACHMENT C

OYSTER CREEK NUCLEAR GENERATING STATION

EFFECTS OF HIGH WATER LEVEL ON STRUCTURES

90000066

December, 1979

QUESTION

9c. Either show that all plant features outside of the barrier provided by the reactor-turbine building complex are not necessary for cooldown, or that all features outside the reactor-turbine building complex can withstand very severe wave action, or provide a detailed wave analysis that will demonstrate that during a postulated PMH wave action on these exterior facilities will nct impair their functionality.

RESPONSE

The plant features outside of the barrier provided by the reactor-turbine building complex are as follows:

Circulating water system pumps

Emergency service water and service water pumps

Standby diesel electrical power building

The locations of these plant features are shown in Figure C-1. The circulating water and service water pumps are mounted on a deck at Elevation +6 feet MSL above the intake structure. An elevation section of the intake structure is shown in Figure C-2. The standby diesels are located on the plant grade at Elevation +23 feet MSL alongside the discharge canal.

These features, being located in the lee of the reactor-turbine building complex are exposed only to wave action which can be generated over flooded terrain and within the intake/discharge canals themselves during the postulated PMH. A detailed analysis of PMH wave action in the lee was undertaken beginning with an evaluation of the open coast surge, routing of the open coast surge through the bay into the intake/discharge canals and estimation of the extent of flooded terrain. Simultaneously, the PMH wind field was transmitted inland along a projection of its overwater path and the component winds are determined along the appropriate fetches for wave generation.

Consideration of the topography of the intake/discharge canal area and the postulated component winds show that wave action at the plant features under

study must be generated on a northerly fetch which extends along the intake canal for about 1200 feet and then continues an additional effective distance of 4300 feet over flooded terrain. Wave action cannot enter the final 1200 feet of intake canal from any other direction as previous studies of wave action in the canal have shown. (reference Docket No. 50-363, Supplement No. 2 for the Forked River Nuclear Power Station.)

The detailed study of wave action revealed the following sequence of events which could be attributed to the postulated PMH. The PMH surge hydrograph and time history of wave action in the intake canal in front of the intake structure are shown in Figure C-3. Time zero corresponds to the arrival of the peak surge at the open coastline. As the terrain to the north of the curving intake canal is roughly at Elevation +15 feet MSL, the waves in the intake canal can be influenced by the overland fetch from time -0.3 hour to +2.4 hours only, corresponding to surge levels in excess of +15 feet MSL. The waves moving directly down the intake canal could break and dissipate energy by turbulence on the embankment at the end of the canal, or could be reflected to produce standing waves by interference with the incident waves, or could be transmitted over the embankment with attendant energy loss. The waves which are reflected, either by the canal embankment or by the intake structure for the Forked River Nuclear Plant on the opposite side of the canal from the intake structure under study, could reach the circulating water and service water pumps. Generally, wave reflection from embankment slopes and irregular structures results in a decrease in reflected wave height when compared to incident wave height. In this study, the assumption was made that the reflected wave is reduced to approximately 75 percent of the incident wave height. In addition, waves moving along the intake canal can also diffract into the intake structure. The diffracted wave will be reduced in the area of the pumps to approximately 25 percent of the incident wave height. The result of the superposition of the diffracted waves

and the reflected waves in the vicinity of the pumps could produce wave heights equal to the incident wave heights in the canal. The refraction of the waves as they move over the deck of the intake structure towards the pumps has little or no effect on the significant wave, while the maximum wave will undergo a slight reduction in height. The wave heights in the vicinity of the intake structure are considered conservative estimates as no credit was taken for the presence of the numerous pipes and obstructions on the intake structure deck in front of the pumps which would dissipate the waves due to friction and turbulence.

The critical wave action in the intake canal will occur at time +0.5 hour which corresponds to a surge elevation of +20.5 feet MSL in the lee of the structure, a significant wave height of 2.0 feet with a period of 2.4 seconds, and a maximum wave height of 3.3 feet with a period of 3.9 seconds. The maximum wave height in the vicinity of the pumps will be reduced to 3.0 feet due to the effects of refraction as mentioned previously.

The SWL of 20.5 feet was determined from the PMH surge hydrograph by eliminating 1.0 feet of water level rise which was attributed to wave setup. The local wind setup and storm surge components remain undiminished. The justification for eliminating the wave setup component in these calculations is that wave action and the resulting setup on the lee side of the plant are negligible when compared to the 1.0 feet postulated for the exposed side of the plant. At time +0.5 hour the embankment at the end of the canal would be overtopped by roughly 10 feet of water and most of the wave action in the canal can be expected to be transmitted over the embankment into the discharge canal. The height of the transmitted significant wave is 1.6 feet and the transmitted maximum wave, 2.6 feet. The crest elevation of the transmitted maximum waves should not exceed Elevation +22.0 feet MSL and hence, they should not affect the diesel building

located along the discharge canal at Elevation +23 feet MSL. As the wave crest should be normal to the canal side slopes at this point, wave runup may be neglected.

Part of the wave action in the intake canal, however, will be directed towards the intake structure. Both the circulating water and service water pumps will be completely submerged at this time. Assuming that each of the larger circulating water pumps may be approximated by a vertical cylinder, 8 feet in diameter and 14 feet high, the maximum horizontal thrust force due to a maximum wave 3.0 feet high and 3.9 seconds in period is about 2400 pounds. The corresponding maximum moment is 66,500 foot-pounds. These maximum values occur when the water surface is at the stillwater level (i.e., midway between wave crest and trough) and are directed alternately towards and against the wave travel. Drag forces and transverse forces were negligible. These reflected/diffracted waves will run over the intake structure and the lower grade at Elevation +15 feet MSL and eventually runup the reactor-turbine building grade. Considering the runup on a smooth, impermeable composite slope with its crest at Elevation +23 feet MSL and 2.5 feet of freeboard, a maximum wave height of 3.0 feet and period of 3.9 seconds, the maximum distance the runup may be expected to reach on the plant grade is 55-65 feet from the edge of the grade. The reactor-turbine building complex is located at least 75 feet from the edge of the grade and hence, the waves should not affect these structures. This assumes that the grade will have proper drainage towards the canal.

At the time of maximum stillwater level at the site, +1.0 hour, the significant wave height in the canal would be reduced to 1.7 feet. This case, as well as the remaining cases of wave action in the canal system during the rising and falling surge, are less critical than the situation described previously in detail

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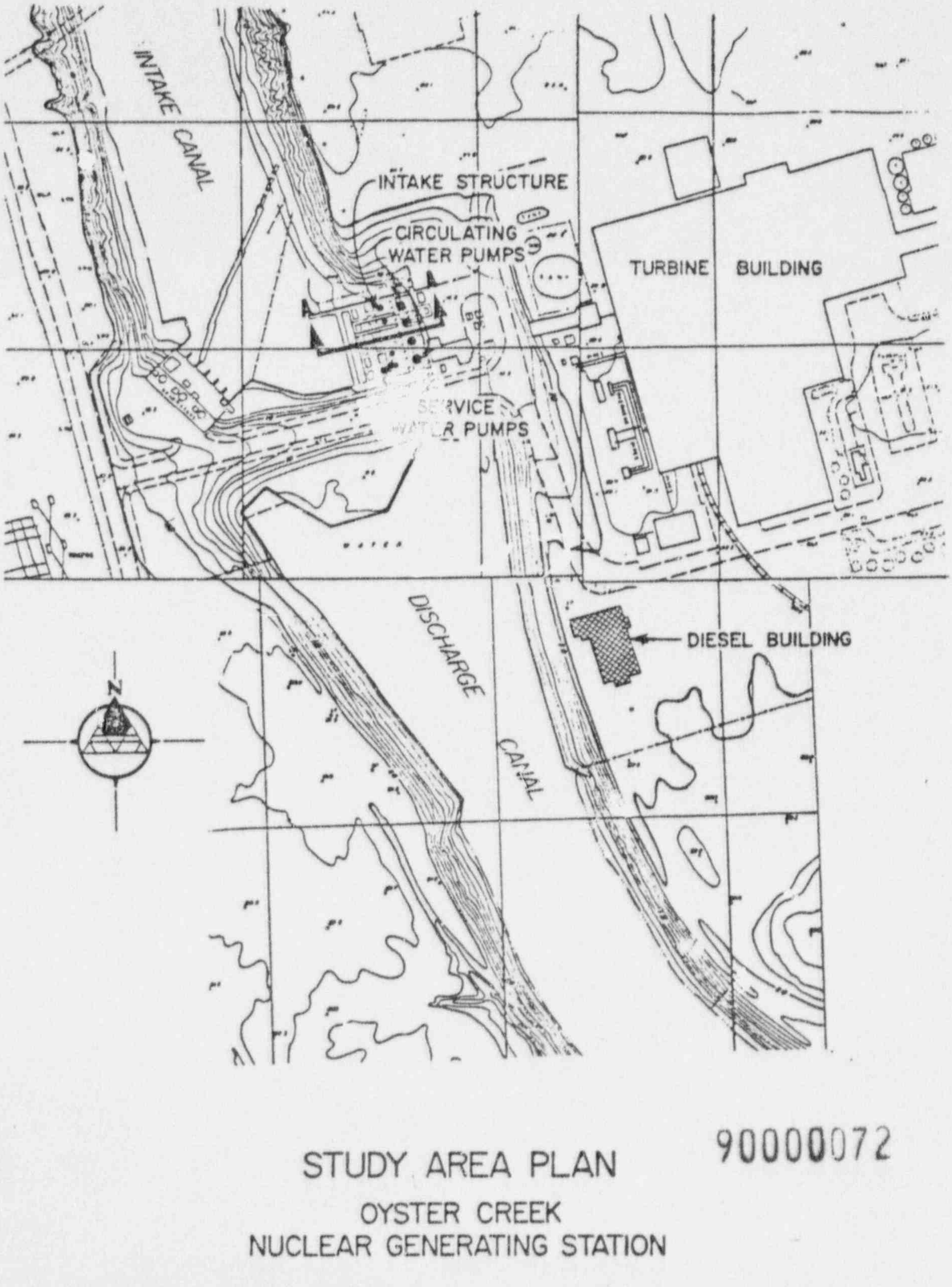
The wave runup elevations and wave forces are considered conservative estimates as no credit was taken for the presence of obstructions on the intake structure deck or the lower plant grade, which are clearly indicated on Figure C-1 and which certainly would contribute to decreased runup and forces due to friction and turbulence.

In conclusion, the wave analysis demonstrates that there will be no impairment of the functionality of the diesel generators in the event of a PMH flood. With regard to the emergency service water pumps, the service water pumps and the circulating water pumps, the storm surge during a PMH would submerge the intake structure and consequently the pumps located at this elevation. In this event, the plant would shutdown and decay heat removal could be facilitated by use of the emergency condensers.

The condensate storage tank and the plant ventilation systems would not be affected.



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STUDY AREA PLAN

OYSTER CREEK
NUCLEAR GENERATING STATION

POOR ORIGINAL

DAMES & MOORE

FIGURE C-1

946.7 (REV. 1)

BY ____________ DATE ____________

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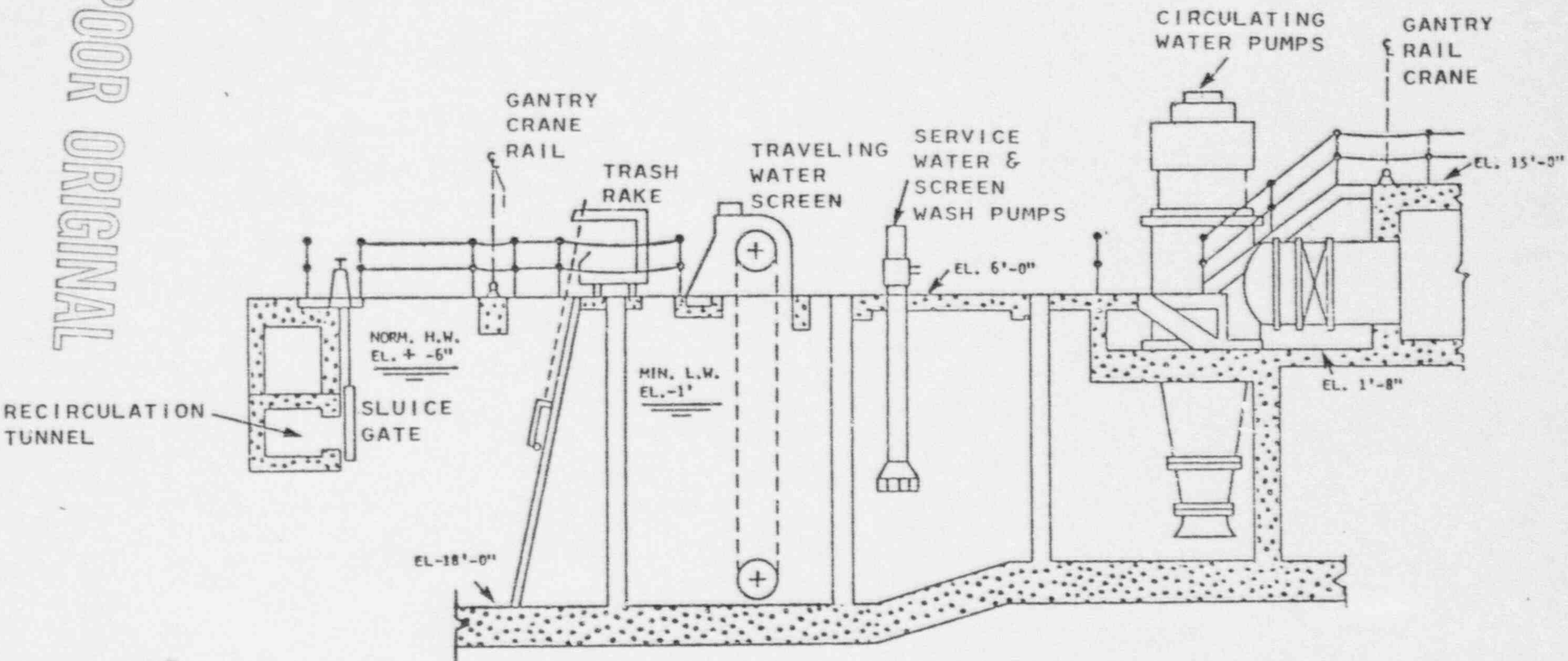
REVISIONS

BY __________ DATE ______

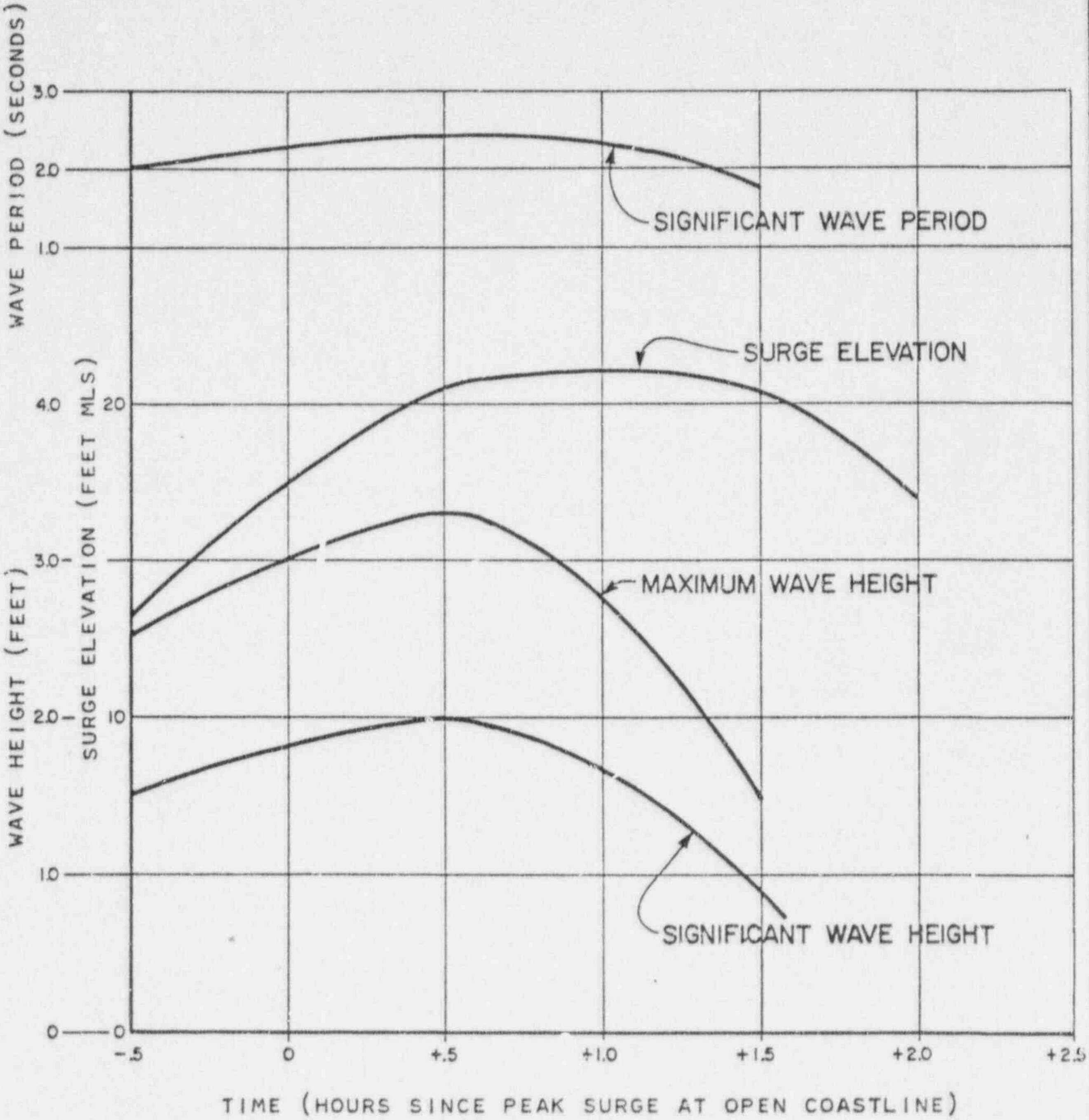


INTAKE STRUCTURE, SECTION A-A

OYSTER CREEK NUCLEAR GENERATING STATION

DAMES & MOORE

FIGURE C-2



PMH SURGE HYDROGRAPH AND WAVE CHARACTERISTICS

IN THE INTAKE CANAL
IN FRONT OF THE INTAKE STRUCTURE
OYSTER CREEK NUCLEAR GENERATING STATION

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DAMES & MOORE

FIGURE C-3

REVISIONS BY ____ DATE ____
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