UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

JUL 26 1979

Mr. J. R. Wallis
President-Elect
Section of Hydrology
American Geophysical Union
c/o P.O. Box 218
Yorktown Heights, NY 10598

Dear Mr. Wallis:

Your letter of May 18, 1979 to Chairman Hendrie has been referred to me for response. During the licensing reviews of the site the staff shared your concern over site flooding. As I interpret your letter, your principal concerns are (1) inappropriate use of statistical estimates to assess flood risks at nuclear power facilities, (2) the "flexibility" of the MPF estimate at Three Mile Island, (3) whether we are aware of how the flood estimates are developed, and (4) why an alternate site was not chosen. I appreciate the opportunity to consider and respond to your comments, and I'm providing the following background information and explanations.

While we do not concur with your characterization of the Water Resources Council's flood frequency estimating technique, we agree that contemporary statistical techniques are not appropriate for estimating rare flood events because (1) available streamflow records are short-term and may not be representative of the extreme flood producing potential of a watershed; and (2) we can establish no rational basis for the selection of confidence levels to minimize the residual error in estimates of severe flood event magnitude or likelihood.

These shortcomings preclude the quantification of flood risks from extreme events in any meaningful way. The deterministic approach which we use also prohibits useful quantification of risk. (Our approach is discussed below.) Because we view the quantification of risk as a desirable goal, NRC has initiated a research program towards this end. To date, the results are not promising. All this does not imply, however, that the risk of flooding is high. It simply means that the probability of occurrence while small is, in your words, unknowable.

The Probable Maximum Flood (PMF) estimate, which you term the MPF, did not change as a result of Tropical Storm Agnes. The applicant based the original peak flood discharge estimate of 1.1 million cubic feet per second (cfs) on a preliminary and unapproved Corps of Engineers analysis. The Island flood protection levee system was designed for that discharge. The NRC staff independently reviewed the PMF estimate and questioned its adequacy. At about this time, the Chief of Engineers, Corps of Engineers, was completing a review of the original Baltimore District 1.1 million cfs estimate. The Corps of Engineers concluded that the Susquehanna River PMF estimate (transferred to TMI) would be about 1.6 million cfs. The NRC staff independently reviewed the estimate and concurred.

7908150449

196 068

7908150449

Tropical Storm Agnes occurred after these events. A subsequent comparison of the storms generated by Agnes and the resulting Susquehanna River flood reaffirmed the appropriateness of the PMF estimate.

We have concluded that the risks at Three Mile Island associated with the occurrence of a PMF are small because, in part, of the conservatism exercised by the Corps of Engineers, the utility, and the NRC staff in the development of PMF estimate and in the flood protection provided. You have provided no information which, in our view, alters that conclusion.

The PMF is derived by maximizing various flood-producing factors, in conjunction with an occurrence of the Probable Maximum Precipitation (PMP). The PMP is defined as the greatest depth of precipitation for a given duration, drainage area, and time of year for which there is virtually no risk of exceedance. The PMP approaches the maximum possible precipitation within the limits of current hydrometeorological knowledge. The PMP estimates used by the NRC staff were prepared by the National Oceanic and Atmospheric Administration (NOAA) and reported in Hydrometeorological Report No. 40, "Probable Maximum Precipitation, Susquehanna River Drainage above Harrisburg, Pa." The approach used by NOAA for developing PMP estimates consists of using extreme record storm rainfalls as an indirect measurement of parameters and mechanisms causing extreme rainfalls. A large sample of storms that include extreme record rainfalls are analyzed such that the optimum rainfall-producing mechanisms and efficiencies are considered to have been experienced. After transposing the storms to the area in question, they are further adjusted to produce maximum moisture. Moisture maximization is accomplished by adjusting the historical storms to conditions represented by the maximum moisture that could have been contained in the storm, based on the maximum observed 12-hr. persisting dew points in the region of interest. After the maximum rainfall depths for the many transposed storms are determined, the points are enveloped according to duration and area.

In addition to this maximum precipitation there are many additional conservatisms in PMF estimates. These conservatisms include: (1) the occurrence of antecedent rainfall, (2) critical storm centering, (3) critical rainfall sequence, (4) critical runoff parameters, (5) conservative computation of water surface profiles, (6) coincident wind-wave activity, and (7) freeboard provided at TMI above the PMF level. Each of these important conservatisms is discussed below:

1. Antecedent Rainfall - About 3 to 5 days prior to the occurrence of the PMP, it is assumed that another rainfall event with approximately 50% of the PMP occurs. This assumption is made to saturate the ground so that the postulated PMP rainfall will run off more readily, and also to produce a high base flow.

2. Storm Centering - The rainfall is assumed to occur in a multiple elliptical pattern based on recorded historical storms; this pattern is adjusted and centered over the drainage basin to produce the worst flood.

696 069

3. Critical Rainfall Sequence - The rainfall amounts in the total PMP are distributed with time in such a manner as to produce the greatest flood peak. For example, very large amounts of rainfall are assumed to occur later in the storm rather than at the beginning. This means that the ground would become further saturated and the streams would have more initial flow in them prior to the occurrence of larger amounts of rain. The chance of rain falling exactly in this critical sequence is very small based on observations on many intense storms.

4. Critical Runoff Parameters - The more critical runoff considerations include infiltration rates, unit hydrograph peaking and stream routing and combining. Each consideration is conservatively assessed.

5. Water Surface Profiles - After the PMF discharge is computed, standard-step backwater models are used to compute the water surface elevation for the peak flood profile. The models are calibrated based on historical floods and river flows to determine friction coefficients (commonly known as Manning's 'n' values). For TMI, these coefficients were determined by the applicant during the safety review for Unit 1. The determination was based on the 1936 and 1964 floods, which had discharges of 750,000 and 464,000 cfs, respectively, at a Harrisburg gaging station. The coefficients were then checked against the 1972 Agnes flood, which had a discharge of 1,020,000 cfs. It was found that the applicant's model, using friction coefficients calibrated with the 1936 and 1964 floods, overpredicted the river stages which actually occurred in 1972. This is in accordance with theory, in that the friction coefficient generally decreases with increases in stage. We have concluded that the friction coefficients used are very conservative and that the computed river stage at TMI is conservative.

6. Freeboard Above PMF Level for Coincident Wind-Wave Activity - An extra margin of about four feet above the PMF level is provided at the TMI, Unit 2 reactor to accommodate the wave effects produced by a 40 mile per hour sustained wind blowing from the most critical direction, coincident with the peak PMF level. More freeboard is provided at other TMI plant locations. A significant increase in the discharge would be required to produce a flood which exceeds the freeboard provided.

The levees at TMI were designed for the original PMP estimate of 1.1 million cfs. The levees would be overtopped by a flood of 1.6 million cfs. However, the levees have been designed to be overtopped, beginning at the downstream end, where the freeboard provided for the levees is less than that provided upstream. The basis for this design was to preclude a "dam failure wave" that could impinge on plant structures if upstream portions failed first. At any rate, it can be seen that failure of the levees is anticipated, but resulting water levels would not endanger plant facilities because of the extra freeboard margin provided at plant structures and flood protection provided at vital structures.

696 070

We have no basis for concluding why sites other than Three Mile Island were considered less viable since our practice is not to require alternative site considerations from a safety viewpoint.

Thank you for the opportunity to consider and respond to your concerns about the flood vulnerability at Three Mile Island.

Sincerely,

/s/

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

DISTRIBUTION
Chairman Hendrie
Commissioners
H. Denton
E. Case
D. Dunch
R. Boyd
V. Stello
R. Mastson
R. DeYoung
D. Muller
R. Vollmer
R. Denise
W. Kreger
L. Hulman
W. Bivins
T. Johnson
PE
OGC
SECY Mail Facility (3) (79-1501)
G. Ertter (EDO #06338)
M. Groff (EDO #06338)
Central Files
NRC PDR w/incoming

NRR Reading
HMB Reading

Response has been cleared w/Commission and approved for dispatch.
(per SECY 7/26/79)

SEE PREVIOUS YELLOW FOR OTHER CONCURRENCES

OFFICE ▶	DSE	NRR	EDO			
SURNAME ▶	LGHulman:CRESS	HRDenton				
DATE ▶	6/ /79	6/ /79				

NRC FORM 318 (9-76) NRCM 0240

☆ U.S. GOVERNMENT PRINTING OFFICE: 1979 - 289 - 769

696 071

yellow

We have no basis for concluding why sites other than Three Mile Island were considered less viable since our practice is not to require alternative site considerations from a safety viewpoint.

In the foregoing, I have responded to your concerns and ass. tions regarding the flood vulnerability at Three Mile Island, and have presented the bases for our flooding criteria and evaluation.

Sincerely,

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

DISTRIBUTION
H. Denton
E. Case
D. Bunch
R. Boyd
V. Stello
R. Mattson
R. DeYoung
D. Muller
G. Ertter (EDO #06338)
M. Groff (EDO #06338)
R. Vollmer
R. Denise
W. Kreger
L. Hulman
T. Johnson
W. Bivins
Central File
NRR Reading
HMB Reading
NRC PDR

CRESS:mim	DSE	DSE	DSE	DSE	ELD	NRR	EDO
PH2014-A	WSBivins	LGHulman	Kreger	DMuller		HDenton	
6/6/79	6/7/79	6/7/79	6/ /79	6/10/79	6/11/79	6/ /79	6/ /79

FROM:	ACTION CONTROL	DATES	CONTROL NO.
J.R. Wallis International Business Machines	COMPL DEADLINE	6/5/79	06338
	ACKNOWLEDGMENT		DATE OF DOCUMENT
TO:	INTERIM REPLY		5/11/79
Chairman Hendrie			PREPARE FOR SIGNATURE OF: ☐ CHAIRMAN ☐ EXECUTIVE DIRECTOR
	FINAL REPLY		OTHER: Denton
	FILE LOCATION		

DESCRIPTION ☐ LETTER ☐ MEMO ☐ REPORT ☐ OTHER

Questions concerning the flood risk at the TMI site

SPECIAL INSTRUCTIONS OR REMARKS

Answer to be cleared with Commission. EDO will handle before dispatching.

SECY 79-1501

CLASSIFIED DATA			
DOCUMENT/COPY NO.		CLASSIFICATION	
NUMBER OF PAGES		CATEGORY	
POSTAL REGISTRY NO.		☐ NSI ☐ RD ☐ FRD	

ASSIGNED TO:	DATE	INFORMATION ROUTING
Denton	5/22/79	

LEGAL REVIEW ☐ FINAL ☐ COPY

ASSIGNED TO:	DATE

NO LEGAL OBJECTIONS
NOTIFY:
☐ EDO ADMIN & CORRES BR
EXT.
COMMENTS, NOTIFY:
EXT.

JCAE NOTIFICATION RECOMMENDED: ☐ YES ☐ NO

NRC FORM 232
(11-75)

EXECUTIVE DIRECTOR FOR OPERATIONS

PRINCIPAL CORRESPONDENCE CONTROL

DO NOT REMOVE THIS COPY

POOR ORIGINAL

No. 79-1501 Logging Date 5/21/79

NRC SECRETARIAT

TO: ☐ Commissioner _____ Date _____

☒ Exec. Dir./Oper. ☐ Gen. Counsel

☐ Cong. Liaison ☐ Solicitor

☐ Public Affairs ☐ Secretary

☐ _____

Incoming: J.R. Wallis , Pres.

From: American Geophysical Union

To: Chairman Hendrie Date 5/18/79

Subject: Provides info. on TMI flood plain

☐ Prepare reply for signature of:

☐ Chairman

☐ Commissioner _____

☐ EDO, GC, CL, SOL, PA, SECY

☐ Signature block omitted

☐ _____

☐ Return original of incoming with response

☒ For direct reply* Suspense: May 31

5/24/79 9:30

☐ For appropriate action

☐ For information

☐ For recommendation

Remarks: Cpys to: Chm, Cmrs, PE, OGC

For the Commission: Combs

*Send three (3) copies of reply to Secy Mail Facility

ACTION SLIP

NRC 62

EDO CONTROL NO. 6303 DUE: 6/7

THIS EDO CONTROL SHOULD RECEIVE HIGHEST PRIORITY IN HANDLING AND PREPARATION OF RESPONSE. PERSON RESPONSIBLE FOR PREPARING REPLY SHOULD CALL M. GROFF, EXT. 27750, IMMEDIATELY UPON RECEIPT.

ASSIGNED TO: [illegible] DATE: 5/23/85 TIME: 1:45 p

TIME AND DATE ASSIGNED

	Received	Dispatched
Division Director – Denise	5/23 - 2:05	5/23 - 2:05
Assistant Director	5/24 8:00	5/24 - 8:21 AM
Branch Chief – HUMAN Bivins	5/24 - 8	5/24 - 8:30
Other	5/24 - 8:30	6/7
OELD		

TIME AND DATE FORWARDED FOR CONCURRENCE

	Received	Dispatched
OELD		
Other		
Branch Chief	6/7 9:00	6/7 9:30
Assistant Director	6/7 - 10:00	
Division Director		

THIS SLIP SHOULD STAY WITH THE PACKAGE AT ALL TIMES AND BE RETURNED WHEN COMPLETED.

HR Denton

Harold R. Denton, Director
Office of Nuclear Reactor Regulation

090 075