UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

THREE MILE ISLAND NUCLEAR STATION, UNIT 2
DOCKET NO. 50-320

TESTIMONY OF NRC STAFF ON EFFECTS OF WEATHER MODIFICATION ON FLOOD PROTECTION

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This testimony addresses Contention 3, which reads:

The flood protection system for Unit 2 is inadequate. This is because the flood data presented and the floods designed against are based on historical data which do not include the intentional efforts of man to effect weather modification. Such efforts at weather modification render the historical data of questionable value. No operating license should be granted until the effects of human efforts at weather modifications are understood.

The design of the flood protection at Three Mile Island (TMI) is based on the Probable Maximum Flood (PMF). 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 exceedence. The PMP approaches the maximum possible precipitation, within the limits of current hydrometeorological knowledge. The PMP estimates used by the staff were prepared by the Hydrometeorological Branch, NOAA and reported in Hydrometeorological Report No. 40, "Probable Maximum Precipitation, Susquehanna River Drainage above Harrisburg, Pa."

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The basic approach for developing PMP estimates consists of using extreme record storm rainfalls as an indirect measurement of parameters and mechanisms causing extreme rainfalls. There is a large sample of storms that have produced very heavy rainfall, such that the near optimum rainfall-producing mechanisms and efficiencies 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. After the maximum rainfall depths for the many transposed storms are determined, the points are enveloped according to duration and area, and smoothed lines are drawn at or above the maximum points.

It can be seen from the above discussion that maximum observed storm rainfalls are adjusted upward to reflect the amount of precipitable water that "could have been" in any given storm. Thus, no activity of man could be expected to increase the moisture in the storms.

In addition to the extreme amount of precipitation that is assumed in the storm, there are many additional conservatisms built into PMF estimates. These conservatisms include: (1) occurrence of antecedent rainfall, (2) critical storm centering, (3) critical rainfall sequence, (4) computation of water surface profiles, (5) coincident wind-wave activity, and (6) freeboard provided at TMI above the PMF level. Brief discussions of these factors and their effects follow.

1. Antecedent Rainfall. About 3 to 5 days prior to the occurrence of the PMP, it is assumed that approximately 50% of the PMP occurs. This is to saturate the ground so that the postulated PMP rainfall will run off more readily and also to produce a high base flow in the streams to which the PMF will be added.
2. Storm Centering. The rainfall is assumed to occur in a elliptical pattern; this pattern is adjusted, by trial and error, to produce the worst flood.
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. 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 becomes further saturated and the streams have more initial flow in them prior to the larger amounts of rain falling. The chance of rain falling exactly in this critical sequence is very small, based on observations of many intense storms.
4. Water Surface Profiles. After the PMF discharge is computed, standard-step backwater models, which numerically solve the equations of gradually varied steady flow, are used to compute the water surface elevations of the flood. The models must, however, be calibrated based on historical floods and river flows, to determine

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the friction coefficient of the river (commonly known as Manning's 'n' value). 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 the 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 decreases with increases in velocity and stage. We have concluded that the friction coefficients used are very conservative and that the computed river stage at TMI is conservative.

5. <u>Freeboard above PMF Level for Coincident Wind-Wave Activity</u>. An extra margin of about four feet of freeboard is provided to accommodate the wave effects produced by a 40 mph wind blowing from the most critical direction, coincident with the peak PMF level. More freeboard is provided at some other locations. A significant increase in the PMF discharge is required to produce a flood which exceeds the freeboard provided.

In summary, we conclude that the PMP estimates used in our analyses envelop the efforts of man to effect weather modification by considering the maximum moisture that could have been in a historical storm. We conclude that the PMF for TMI, which includes the conservatisms discussed above, meets the criteria of Regulatory Guide 1.59, "Design Basis Floods for Nuclear Power Plants."

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