



U.S. NUCLEAR REGULATORY COMMISSION
STANDARD REVIEW PLAN
OFFICE OF NUCLEAR REACTOR REGULATION

SECTION 2.4.5

PROBABLE MAXIMUM SURGE AND SEICHE FLOODING

REVIEW RESPONSIBILITIES

Primary - Site Analysis Branch (SAB)

Secondary - None

I. AREAS OF REVIEW

In this section of the safety analysis report (SAR) the hydrometeorological design basis is developed to determine the extent of flood protection required for safety-related plant systems. The areas of review include the probable maximum hurricane or other probable maximum wind storms, antecedent water levels, storm tracks, methods of analysis, coincident wind-generated wave action and wave runup on safety-related structures, potential for wave oscillation at the natural periodicity, and the resultant design bases for surge and seiche flooding.

II. ACCEPTANCE CRITERIA

Hydrometeorological estimates and criteria for development of probable maximum hurricanes for east and Gulf coast sites, squall lines for the Great Lakes, and severe cyclonic wind storms for all lake sites by the Corps of Engineers, National Oceanic and Atmospheric Administration (NOAA), and the staff are used as standards for evaluating the conservatism of the applicant's estimates of severe windstorm conditions, as discussed in Regulatory Guide 1.59. The Corps of Engineers and NOAA criteria require variation of the basic meteorological parameters within given limits to determine the most severe combination that could result. The applicant's estimates should be at least as conservative as the most critical combination of these parameters.

Data from publications of NOAA, the Corps of Engineers, and other sources (such as tide tables, tide records, and historical lake level records) are used to substantiate antecedent water levels. These antecedent water levels must be as high as the "10 percent exceedence" monthly spring high tide plus a sea level anomaly based on the maximum difference between recorded and predicted average water levels for durations of two weeks or longer for coastal locations or the average monthly recorded high water for the Great Lakes. In a similar manner, the storm track, wind fields, effective fetch lengths, direction of approach, and frictional surface and bottom effects are evaluated by independent staff analysis to assure

USNRC STANDARD REVIEW PLAN

Standard review plans are prepared for the guidance of the Office of Nuclear Reactor Regulation staff responsible for the review of applications to construct and operate nuclear power plants. These documents are made available to the public as part of the Commission's policy to inform the nuclear industry and the general public of regulatory procedures and policies. Standard review plans are not substitutes for regulatory guides or the Commission's regulations and compliance with them is not required. The standard review plan sections are keyed to Revision 2 of the Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants. Not all sections of the Standard Format have a corresponding review plan.

Published standard review plans will be revised periodically, as appropriate, to accommodate comments and to reflect new information and experience.

Comments and suggestions for improvement will be considered and should be sent to the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Washington, D.C. 20555.

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that the most critical values have been selected. Models used to estimate surge hydrographs that have not previously been reviewed and approved by the staff are verified by reproducing historical events, with any discrepancies in the model being on the conservative (i.e., high) side.

Criteria and methods of the Corps of Engineers as generally summarized in Reference 30 are used as a standard to evaluate the applicant's estimate of coincident wind-generated wave action and runup.

Criteria and methods of the Corps of Engineers and other standard techniques are used to evaluate the potential for oscillation of waves at natural periodicity.

Criteria and methods of the Corps of Engineers (Ref. 30) are used to evaluate the adequacy of protection from flooding, including the static and dynamic effects of broken, breaking, and nonbreaking waves.

The analysis will be considered complete and acceptable if the following areas are addressed and can be independently and comparably evaluated from the applicant's submission (the following presumes that it has been determined that surge and seiche flooding estimates are necessary to identify flood design bases):

1. All reasonable combinations of probable maximum hurricane, moving squall line, or other cyclonic wind storm parameters are investigated, and the most critical combination is selected for use in estimating a water level.
2. Models used in the evaluation are verified, or have been previously approved.
3. Detailed descriptions of bottom profiles are provided (or are readily obtainable) to enable an independent estimate of surge levels to be made.
4. Detailed descriptions of shoreline protection and safety-related facilities are provided to enable an independent estimate of wind-generated waves, runup, and potential erosion to be made.
5. Ambient water levels, including tides and sea level anomalies, are estimated as described above.
6. Combinations of surge levels and waves that may be critical to plant design are considered, and adequate information is supplied to allow a determination that no adverse combinations have been omitted.
7. If Regulatory Guide 1.59, Position 2, is elected by the applicant, the design basis for flood protection of all safety-related facilities identified in Regulatory Guide 1.29 must be shown to be adequate in terms of time required for implementation of any emergency procedures. The applicant must also demonstrate that the less severe design basis

selected will provide for all potential flood situations that could negate the time and capability to initiate flood emergency procedures.

In general, the staff will make an independent estimate of surge, seiche, and wave action effects (static and dynamic). If the estimated effects are comparable with those of the applicant, or if the applicant's estimates are greater, the proposed design basis will be considered confirmed.

III. REVIEW PROCEDURES

The review procedure is outlined on Figure 2.4.5. In general, the conservatism of the applicant's estimate of flood potential from surges and seiches is judged against the criteria indicated above and as discussed in Regulatory Guide 1.59. If the site is not near a large body of water the staff findings may be prepared a priori. Methods of the Corps of Engineers and National Oceanic and Atmospheric Administration (NOAA) (HUR 7-97 and amendments) are used to develop the critical probable maximum hurricane (PMH) parameters for the site. The Corps of Engineers model SURGE (or other verified models) may be used to estimate the maximum surge stillwater elevations at coastal sites. Coincident wind-generated waves and runup are estimated from publications by the Corps of Engineers (Ref. 30). Reports of NOAA and the Corps of Engineers are used to estimate probable maximum wind fields over the Great Lakes. Models such as Platzmann's, or other verified models, are used to estimate the maximum surge or seiche stillwater elevation for Great Lakes sites; coincident wind-generated waves and runup are estimated as above.

Seiching potential is evaluated by comparing the natural period of oscillation (resonance) of the water body with the estimated meteorologically-induced wave periods. Resonance of a water body may be calculated by the methods presented in Ref. 30, or standard texts. Generally, a demonstration that the water body cannot generate or sustain waves of the required period (for resonance) is satisfactory to conclude that atmospheric pressure and wind-generated wave amplification is not possible. If resonance is possible, the maximum seiche must be considered in the selection of the critical flood design bases.

Consultants may be employed by the staff in either an advisory role on specific aspects of the analysis, or to make a separate independent analysis, depending upon the complexity of the analysis and available staff manpower. The consultants may be from the Corps of Engineers Coastal Engineering Research Center (CERC) or private contractors.

The above reviews are performed only when applicable to the site or site region. Some items of review may be done on a generic basis.

IV. EVALUATION FINDINGS

For construction permit (CP) reviews the findings will consist of a statement summarizing the applicant and staff estimates of critical water level (including wind-generated wave levels) at the site. If the estimates are similar, staff concurrence will be stated. If the staff predicts substantially higher water levels, and the proposed plant may be adversely affected, a statement requiring use of the staff estimate for the design basis

will be made. If the flood conditions do not constitute a design basis, the statement will so indicate.

For operating license (OL) reviews of plants which have received detailed reviews during the CP review, the CP conclusions will be referenced. However, a review will be made to assure that protection against the design-basis water level conditions established in the CP review has been properly implemented. In addition, a review of surge and seiche history since the CP review will be made. Any new information or improvements in predictive models will be noted. If no detailed CP review was undertaken, this fact will be indicated in the OL findings.

If Regulatory Guide 1.59, Position 2, is elected by the applicant for protection, a statement describing lesser design bases will be included in the findings with the staff conclusion of adequacy.

A sample statement for an OL review follows:

"The design basis hurricane-induced high and low stillwater levels were established during the CP review at elevations 22.0 feet MSL and -7.5 feet MSL, respectively. These levels are based upon the estimated water levels, exclusive of wave action, that would occur during passages of a probable maximum hurricane (PMH)^{1/} to the south and north, respectively, of the plant. At the request of the staff, the applicant analyzed the wave conditions on safety-related facilities that could accompany the 22 foot MSL surge level. The results of these analyses indicate the most severe wave action would be restricted to the canal, and that high ground levels would limit wave heights in the vicinity of exposed safety-related buildings, except the service water intake, to 1.6 feet. For the intake, the applicant has estimated waves 3 feet high. The resulting wave runup levels were estimated to reach a maximum elevation of 28.3 feet MSL on the intake, and 25.6 feet MSL on other exposed buildings."

^{1/}A PMH is considered to be the worst hurricane reasonably possible of occurrence."

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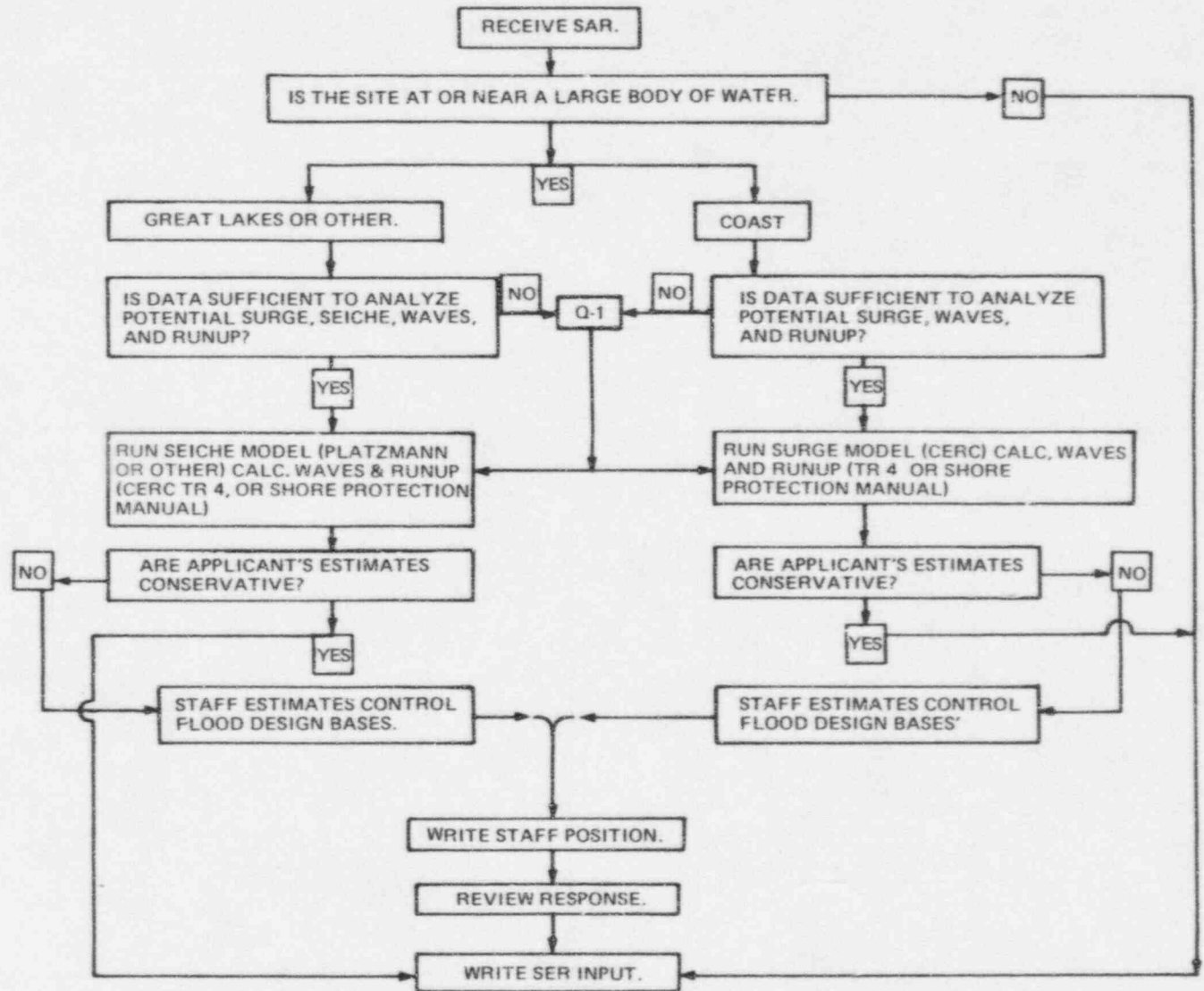
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FIGURE 2.4.5
STANDARD REVIEW PLAN 2.4.5
PROBABLE MAXIMUM SURGE AND SEICHE FLOODING



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