Docket No. 50-263

APR 17 1975

Northern States Power Company
ATTN: Mr. L. O. Mayer
Director of Nuclear Support
Services
414 Nicollet Mall
Minneapolis, Minnesota 55401

Gentlemen:

Pursuant to §50.54(f) of 10 CFR Part 50, the Nuclear Regulatory Commission (NRC) staff requires that certain information related to the design of the containment for your facility be submitted promptly to NRC for its review. This requirement results from recent developments associated with the large-scale BWR Mark III testing being conducted by the General Electric Company. These tests indicate that suppression pool hydrodynamic loads during a loss-of-coolant accident (LOCA) should be considered in the detailed design of components and structure of the Mark III containment. In addition, there appears to be a potential for the occurrence of similar dynamic loads on plants with a Mark I type of containment. Therefore, we require that you provide the information specified in Enclosure 1 concerning the potential magnitude of these hydrodynamic loads, and the effects of these loads, in combination with other design loads, on the design of your containment structures.

Enclosure 1 specifies the information required to complete our review of the effect of pool dynamic loads on the design of your containment structures. Enclosure 2 contains background information on the status of efforts directed at determining pool dynamic loads. For general information, we have also provided in Enclosure 3 a description of the various phenomena during a postulated LOCA which result in possible hydrodynamic loads. Please note that certain key phrases in Enclosure 3 have been underlined. These phrases (1) identify those specific hydrodynamic loads which, as a minimum, should be considered in your review of containment design, and (2) establish the standard nomenclature by which phenomena should be discussed or referenced in your documentation.

Your response to the request should be filed within sixty days of the date of receipt of this letter. If you cannot meet this schedule, please advise us within fifteen days. The scheduling of work on this matter should parallel related efforts on other containment design/operational control aspects, i.e., relief valve vent clearing and steam quenching vibration phenomena.

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Please contact us if you desire additional discussion or clarification of the information requested.

Sincerely,

Original signed by
Dennis L. Ziemann

Dennis L. Ziemann, Chief
Operating Reactors Branch #2
Division of Reactor Licensing

Enclosures:
1. Required Information
2. Background
3. Description of Potential Pool Dynamic Phenomena

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This request for Generic Information was approved by GAO under a blanket Clearance No. B-180225 (R0072); this clearance expires July 31, 1977.

cc w/enclosures:
See next page

See memo of 4/19/75 from G. Lear

OFFICE▶	RL:ORB #2	RL:ORB #2	for other concurrences		
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DATE▶	4/17/75	4/18/75			

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ENCLOSURE 1

REQUIRED INFORMATION

(1) Provide large size plan and section drawings of the suppression chamber which illustrate the structures, equipment, and piping in and above the suppression pool. These drawings should be in sufficient detail to describe all equipment and structural surfaces which could be subjected to suppression pool hydrodynamic loadings.

(2) Provide a chronology of all potential pool dynamic loads during a LOCA which identifies the source of the load (see enclosure 3), the time interval over which the load is active, and the structures which are affected. (For an example, see GESSAR, Response 3.82.)

(3) For each structure or group of structures identified in paragraph (2) above, provide the anticipated load as a function of time due to each of the pool dynamic loads which could be imparted to the structure.

(4) For each structure or group of structures identified in paragraph (2) above, provide the total load as a function of time due to the sum of anticipated pool dynamic loads.

(5) Describe the manner in which the pool dynamic load characteristic shown in (4) above is integrated into the structural design of each structure. Specify the relative magnitude of the pool dynamic load compared to other design basis loads for the structure.

(6) Describe the manner by which potential asymmetric loads were considered in the containment design. Characterize the type and magnitude of possible asymmetric loads and the capabilities of the affected structures to withstand such a loading profile. Include consideration of seismically induced pool motion which could lead to locally deeper submergences for certain horizontal vent stacks.

(7) Provide justification for each of the load histories given in (3) above by the use of appropriate experimental data and/or analyses. References to test data should indicate the specific test runs and data points and the manner by which they were converted to loads. As an interim measure, use of available experimental data may be acceptable; however, if it appears necessary, additional tests directly applicable to the LOCA pool dynamic load phenomenon and its analyses will be required.

(8) Provide a description of the structural analysis methods, and a summary of the results of your structural design evaluation which either demonstrate that the containment design can withstand the pool dynamic loads imposed upon the structure within adequate margins, or the design modifications required to meet allowable design limits.

ENCLOSURE 2

BACKGROUND

Pool Dynamics

The need to consider suppression pool hydrodynamic loads in the design of certain parts of the Mark III containment developed during the early phases of the large-scale Mark III test program being conducted by the General Electric Company. A series of air tests were performed in March 1974 to scope the range and magnitude of pool dynamic loads. It was recognized that more definitive tests were required and therefore comprehensive tests in 1/3 scale were initiated in the summer of 1974 and are currently still in progress. Parallel efforts to develop analytical models for the various pool dynamic phenomena have been implemented by the General Electric Company, several architect/engineers, and by NRC consultants.

The NRC staff has maintained contact with GE regarding the planning and progress of the pool dynamics testing and associated analyses. Due to the commonality of the water pressure suppression feature in Mark I, II, and III type containments it was apparent that pool dynamic loads could also be a consideration for Mark I and II plants. GE, in fact, is in the process of planning a series of tests for ASEA/Atom of Sweden. The purpose of these tests would be to determine pool dynamic loads for a structure located immediately above the suppression pool for a containment with vertical vent pipes. The basis for applying chis data to specific Mark I and II designs has not yet been established.

ENCLOSURE 3

DESCRIPTION OF POTENTIAL POOL DYNAMIC PHENOMENA

Following a design basis loss-of-coolant accident in the drywell, the drywell atmosphere will be rapidly compressed due to blowdown mass and energy addition to the drywell volume. This compression would be transmitted in the form of a compressive wave and propogate through the vent system into the suppression pool. The pool response to this effect could include a load on the suppression chamber walls.

With pressurization of the drywell, the water in the downcomers will be depressed and forced out through the vent system into the suppression pool. This movement of pool water can result in a water jet impingement load on the suppression chamber.

Following clearing of the vents an air/steam/water mixture will flow from the drywell through the vents and be injected into the suppression pool below the surface. Depending on the characteristics of the suppression system (i.e., the vent area compared to the drywell volume and break flow area) drywell overexpansions could occur. Overexpansion of the drywell results when the initial vent flow, following vent clearing, evacuates the drywell more rapidly than the volume is replenished by blowdown mass and energy input. If the drywell volume is relatively small compared to the area of the vents, then there is insufficient capacity to absorb the transition in venting rates and loads due to drywell overexpansion oscillations can occur on the suppression chamber and vent system.

During vent flow the steam component of the flow mixture will condense in the pool while the air, being noncondensible, will be released to the pool as high pressure air bubbles. Initial air bubble loads would be experienced by all pool retaining structures and could be of an oscillatory mode due to overexpansion and recompression of the bubbles.

The continued addition and expansion of air within the pool causes the pool volume to swell and therefore an acceleration of the surface vertically upward. This response of the pool is referred to as bulk pool swell since the air is confined beneath the pool and is driving a solid ligament of water. Bulk pool swell air bubble and flow drag loads are imparted to the suppression chamber walls and to structures, components, etc., which may be located at low elevations above the normal pool surface. Bulk pool swell impact loads will also result for low elevation structures and components.

Due to the effect of buoyancy, air bubbles will rise faster than the pool water mass and will eventually break through the swollen surface and relieve the driving force beneath the pool. This breakup of the water ligament leads to the upward expulsion of a 2-phase mixture of air and water and is referred to as pool swell in the froth mode. Structures which are located at higher elevations above the initial pool surface could experience a pool swell froth impingement load due to impact of 2-phase flow.

Froth flow will continue until the fluid kinetic energy has been expended, followed by fallback of the water to the initial suppression pool level. Structures located above the pool could be subject to water fallback loads. Following the initial pool swell event the suppression system will settle into a generally coherent phase during which significant vent flow rates are maintained from the drywell to the pool. A resultant effect is the occurrence of high vent flow steam condensation loads, which can be of an oscillatory nature, on pool retaining structures. As the reactor coolant system inventory of mass and energy is depleted, near the end of blowdown, venting rates to the suppression pool diminish allowing water to reenter the downcomers. During phases of low vent mass flux the suppression system behaves in an oscillatory manner, referred to as chugging, whereby periodic clearing and subsequent recovery of vents occurs since the vent flow cannot sustain bulk steam condensation at the vent exit. The resultant local fluctuations in pressure and water levels generate chugging oscillation loads, predominantly on the vent system.

It should be further noted that the magnitude and range of any of the hydrodynamic loads discussed above can be aggravated by an asymmetric response of the suppression system, either in the circumferential or radial direction. One possible initiator of such response would be seismically induced pool motion which could lead to locally deeper submergences for certain downcomers and therfore larger pool swell loads. Full account of this potentiality should be made in establisning hydrodynamic load capabilities for the suppression chamber structures design.