UNITED STATES
NUCLEAR REGULATORY COMMISSION
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APR 1 1975

R. C. DeYoung, Assistant Director for Light Water Reactors, Group 1, RL
V. A. Moore, Assistant Director for Light Water Reactors, Group 2, RL
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STANDARD LETTER TO APPLICANTS AND LICENSEES CONCERNING POOL DYNAMIC LOADS FOR PLANTS WITH MARK I AND II TYPE CONTAINMENTS

We have provided as an attachment a draft of a generic letter requesting CP and OL holders for plants with Mark I and II type containments to reassess the structural design margins available to accommodate potential suppression pool dynamic loads. This letter complements our correspondence of February 25, 1975 (R. L. Tedesco to R. C. DeYoung and V. A. Moore), which addressed similar concerns for plants with Mark III type containments. We have also provided you with standard letters concerning relief valve loads for Mark II plants (R. L. Tedesco to R. C. DeYoung and V. A. Moore, April 10, 1975) and Mark III plants (R. L. Tedesco to R. C. DeYoung and V. A. Moore, April 10, 1975), while Operating Reactors sent similar letters to Mark I licensees in February 1975.

During large-scale Mark III testing being conducted by GE it was determined that suppression pool dynamic loads could bear significantly on the structural design of components of the containment. In addition, GE believes that a potential for the occurrence of similar loads on Mark I and II containments exists. Since the extent to which pool dynamic loads were considered in the initial designs of Mark I's and II's however is not clear at this time, we believe that a letter of the form enclosed should be sent to each applicant/licensee on plants with Mark I and II type containments. The letter provides suitable background material to assure a clear understanding of the issues at hand, and a list of requested information which we will require to complete our review including a request for the status of construction (if applicable). In certain cases slight modifications may be necessary to make the letter applicable to a particular plant. In these instances the LPM should coordinate such change with R. Cudlin. We would also request that copies of all pool dynamics correspondence with applicants/licensees be sent to CSB. The review of applicant's responses should in each case be initiated by a TAR from DRL to DTR and should include SEB, MEB and CSB.

In light of recent developments on several Mark II plants and our meeting with GE on April 10, 1975, we believe that timely action is required.

D-14

R. C. DeYoung
V. A. Moore
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This woul[illegible] include a decision whether to issue letters or a "show cause" order and in either case, the allowable time frame for response.

Robert L. Tedesco, Assistant Director
for Containment Safety
Division of Technical Review

Enclosure:
As stated

cc: E. Case
F. Schroeder
A. Giambusso
S. Hanauer
R. Boyd
G. Lainas
J. Kudrick
J. Shapaker
L. Slegers
R. Cudlin
C. Grimes
C. Anderson
J. Glynn
RL B/C's
OR B/C's
R. Maccary

Attachment

SAMPLE LETTER TO APPLICANT

Gentlemen:

Recent developments which have been associated with the large-scale Mark III testing being conducted by the General Electric (GE) Company indicate that suppression pool hydrodynamic loads could bear significantly on the structural design of components of the containment. In addition, GE has communicated with us to the effect that they believe that there is a potential for the occurrence of similar dynamic loads on plants with Mark I and Mark II containments. Therefore, we are requesting that you provide us with information on the adequacy of the design of your containment to withstand dynamic loads and the potential magnitude of such loads in addition to the design loads.

Background information of enclosure (1) to this letter contains the status of efforts directed at determining pool dynamic loads. Enclosure (2) specifies the information which we will require to complete our review of these aspects of your containment design. For general information, we have also provided as enclosure (3) a description of the various phenomena during the accident sequence which result in dynamic loads. You will observe that certain key phrases have been underlined. These phrases both identify those specific hydrodynamic loads which, as a minimum, should be included in the development of the structural design adequacy and establish the standard nomenclature by which these phenomena should be referenced in your documentation.

You should provide us within seven (7) days after receipt of this letter a schedule for submittal of the requested information. Based on your response we will establish a review schedule which will allow completion of our evaluation in these areas.

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

Sincerely,

Enclosures:
(1) Background
(2) Request for Information
(3) Description of Potential Pool Dynamic Phenomena

Enclosure (1)

BACKGROUND

Pool Dynamics

The concern that suppression pool hydrodynamic loads could bear significantly on the structural design of certain parts of the Mark III containment surfaced 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, the NRC's consultants, and by several architect/engineers.

The staff has maintained periodic 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 using their Mark III facility. 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. Applicability of this data to Mark I and II designs has not yet been established.

Enclosure (2)

REQUEST FOR INFORMATION

We request that the following information be provided for our review:

(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 sufficient to describe all equipment and structural surfaces which could be subjected to suppression pool hydrodynamic loadings.

(2) Provide a graphical chronology of all potential pool dynamic loads which identifies the source of the load (i.e., pool swell froth impingement), the time interval over which the load is active, and the structures which are affected. (Reference GESSAR, Response 3.82.)

(3) For each structure or group of structures 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 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.

(8) Provide a summary of the structural analysis methods, and 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.

(9) For those structures subject to pool dynamic loads provide the status of their construction.

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 to the water in the weir annulus 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 to 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 bottom of 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. Overventing 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 capacitance 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 therefore larger pool swell loads. Full account of this potentiality should be made in establishing hydrodynamic load capabilities for the suppression chamber structures design.

Two further pool dynamic loading events, associated with relief valve operations, have been identified in addition to those associated with the design basis loss-of-coolant accident. Pressure waves are generated within

the suppression pool following opening of a relief valve due to the expulsion of an initial high pressure steam/air mixture into the pool from the relief valve discharge line. This phenomenon yields steam vent clearing loads which are imparted to pool retaining structures. These same structures can also be subject to loads which accompany extended relief valve discharge into the pool (or vent flow from the drywell) if the pool water is at elevated temperatures. This effect is known as steam quenching vibrations.