LILCO LONG ISLAND LIGHTING

LONG ISLAND LIGHTING COMPANY

175 EAST OLD COUNTRY ROAD · HICKSVILLE, NEW YORK 11801

Direct Dial Number 516/733-4698

MK II-084-LIC

July 8, 1981

Mr. Karl Kniel, Chief
Generic Issues Branch
Division of Safety Technology
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: ACRS Information Request
Mark II Pool Dynamic Loads

Dear Mr. Kniel:

The enclosed information is provided in response to your letter of May 20, 1981 requesting Mark II Owners Group comments on two questions raised by the ACRS at the April 28-29, 1981 Fluid Dynamics Subcommittee meeting. The ACRS questions relate to potential pool bypass from stuck open wetwell-to-drywell vacuum breakers and bypass through ruptured main vent downcomers. Our enclosed response addresses both the questions on main vent vacuum breaker performance and main vent downcomer fatigue evaluation from LOCA chugging events.

In addition, the Staff requested that we comment on containment fatigue analysis. The Mark II Owners felt further evaluation of fatigue on the containment is not necessary based on the following:

1. The low number of equivalent full strength stress cycles obtained for the pool loads using very conservative assumptions as compared to the allowable number of stress cycles before design stress reduction is required.

2. The stresses on the containment induced by chugging are relatively low and have no significant effect on fatigue.

3. The further reduction possible by taking advantage of a mass flux threshold (which means that chugging loads only occur over a fraction of the entire duration of the SBA).

XG01
s/1

We trust that the enclosed information has been responsive to your request.

Very truly yours,

H. Chau
Chairman
Mark II Containment Owners Group

HC/mvf

Enclosure

xc: Mark II Owners Group
Mr. W. M. Davis (GE)
Mr. C. Anderson (NRC)

ACRS INFORMATION REQUEST
MARK II POOL DYNAMIC LOADS

Question 1

The Mark II containment wetwell/drywell vacuum breakers may be called upon to function repeatedly during intermittent steam condensation phenomena. Failure of a vacuum breaker to close during this time could result in pool bypass, thus jeopardizing the integrity of the containment. Provide valve service information for the range of wetwell/drywell vacuum breaker operation under pool dynamic loading. This information should be sufficient to describe the opening and closing characteristics of these valves during intermittent steam condensation.

Answer 1

The scenario postulated by the ACRS at the April 28 and 29, 1981 fluid dynamics subcommittee meeting requires the following occurrences:

(1) LOCA

(2) During chugging, steam bubble collapse causes underpressure in the vent of sufficient strength to open the check valves in the vacuum breaker assembly (i.e., cycling of the valve occurs).

(3) Cycling of the vacuum breaker continues for some period of time.

(4) A vacuum breaker assembly is damaged from this continued cycling and both swing check valves in the assembly fail in the open position.

(5) A small portion of the steam being discharged from the drywell to the suppression pool bypasses the pool and begins to increase overall containment pressure.

(6) If plant operator actions are not adequate to mitigate the pool bypass, steam flow continues so that containment integrity is jeopardized.

In order to comply with single failure criteria, each Mark II vacuum breaker assembly is comprised of two swing check valves in series. The normal position for both check valves is closed. Valve discs are held closed by spring actuated lever arms. Each valve would open under a negative differential pressure (drywell to wetwell)

Answer 1 (Cont'd.)

of less than 0.5 psid. The valves are self-actuated by the differential pressure across the valve ports. Closing of the valves, by gravity and action of the spring, occurs after relief of the negative pressure differential. Position indication is provided for each valve, utilizing contact probes on the valve disc base wired to indicator lights in the control room. Air cylinders are provided for remote operation of each valve from the control room. The vacuum breaker asembly is a safety-related component and, as such, is included in the on-going equipment requalification program required of all Licensees. This includes dynamic qualification to the building response from the dynamic Mark II loads, but does not include aerodynamic loading as is postulated by the given scenario.

Two of the Mark II plants (Zimmer and LaSalle) have vacuum breakers located in dedicated drywell floor or containment penetrations. As such, they do not experience the direct effects of downcomer steam condensation loading and are not expected to experience valve cycling.

Four of the Mark II plants (Susquehanna, Shoreham, Hanford and Limerick) have vacuum breakers located on their downcomer pipes. A check has been made with the valve manufacturer to determine if any information exists which would define the opening and closing characteristics of these valves during intermittent steam condensation. Such information does not presently exist. A program to determine the valve loading and valve capability during intermittent steam condensation is being developed. This issue will be addressed as part of the equipment qualification programs for these plants.

The remaining two plants (Nine Mile Point 2 and Bailly) are reviewing their designs to determine the best approach to preclude vacuum breaker cycling.

ACRS INFORMATION REQUEST
MARK II POOL DYNAMIC LOADS

Question 2

The steam chugging loads proposed as design loads by the Mark II Owners Group for containment evaluation were developed to represent limiting conditions during a postulated loss-of-coolant accident. As such, they are applied one time to the downcomers. The Mark II Owners have indicated that chugging induced fatigue loads are insignificant due to the large reduction in loads with time and the relatively low number of fatigue cycles. Additional information is needed to evaluate this position. Provide the following information for a typical plant. For a range of break sizes, estimate the number of "Pool Chug" cycles. This analysis should be extended sufficiently in time to include operation of the emergency core cooling system and the associated vessel steaming rates. If there exists a vent flow threshold below which the chugging loads are insignificant, this should be clearly identified in the analysis. The information should be provided for both the chugging downcomer lateral loads and the pool chugging loads.

Answer 2

The Mark II Owners Group has been addressing the concern of fatigue on the Downcomers and Main Steam vent discharge lines (SRVDLs). Recently, particular attention has been directed at the fatigue effect of chugging related loads.

A full ASME Section III Class 1 fatigue evaluation is performed on the downcomers and the SRVDLs. All significant loading conditions including pool dynamic loads (chugging, CO, lateral loads, SRV, etc.), seismic, pressure, thermal expansion and thermal transient stresses are considered. Load combinations for IBA, SBA, DBA, and normal/ upset plant operations are evaluated based on the events conservatively defined in the DFFR, Rev. 3 charts.

Results of extensive tests have shown that all chugs do not occur at a maximum amplitude over the entire chugging duration; hence, a procedure was developed for fatigue evaluation in which an equivalent number of full amplitude load cycles is obtained and used to determine an equivalent number of stress cycles. This is similar to the procedure used in Appendix N of ASME BPVC Section III to determine the equivalent number of full strength stress reversal cycles per earthquake. This equivalent number, which would give the same fatigue effect as the actual chugs with varying pressures, can be obtained from the "Equivalent Occurrence Factor" (EOF).

Answer 2 (Cont'd.)

$$EOF = \frac{\sum_i \left[N_i * \left(\frac{P_i}{P_{max}} \right)^{4.3} \right]}{\sum_i N_i}$$

where: P_i = Individual chug peak overpressure

N_i = Number of occurrences at pressure P_i

P_{max} = Maximum peak over pressure

4.3 = Fatigue exponent given in Appendix II of ASME BPVC Section III

Furthermore, preliminary investigations on a spectrum of break sizes have indicated the existence of low mass flux threshold between 0.2 and 0.3 lbm/ft^2-sec below which the chugging downcomer lateral loads and the pool chugging loads are insignificant. As a consequence, the effective chugging load cycles will occur for only a fraction of their recommended DFFR duration. Typical results of analysis on a representative plant for a range of small break sizes have shown that significant chugging will occur for less than one-quarter of the entire specified SBA duration.

Nevertheless, assuming no low mass flux threshold for the chugging load distribution data considered,

$$EOF = 0.02$$

hence, the equivalent number of full load chugs for the SBA is 200.

In a similar fashion, operating with a family of typical loading time histories, the equivalent number of stress cycles per chugging event can be determined. This can be done using either the actual systems response or, conservatively, from operating on a family of single degree of freedom oscillators. This was done for a sample chug and the number of equivalent stress cycles per chug was found to be 3. Based on this, the total number of chugging stress cycles is 600.

Similar calculations were performed to assess the fatigue impact of the other significant pool related loads. For the case of lateral loads, the EOF was determined to be 0.04. This resulted in a reduction similar to that found for the chugging load.

Answer 2 (Cont'd.)

An earlier sample computation to assess the general impact of this approach for a typical Mark II Plant was performed using conservative and arbitrarily assumed values for full amplitude chug cycles and stress cycles of 1000 and 7000, respectively. These numbers of cycles are conservative when compared to expected values by more than an order of the magnitude. For this sample computation, the fatigue usage factor on the main vent is less than 0.55 (including lateral load fatigue effects) and on the SRVDL was less than 0.45.

Even with a conservative load amplitude from tests at higher mass fluxes used in combination with a very conservative number of chugging cycles for fatigue evaluation, the fatigue usage factors are well within the acceptable limits.