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JAN 14 1977

Docket No. 50-410

Niagara Mohawk Power Corporation
ATTN: Mr. Gerald R. Rhode
Vice President - Engineering
300 Erie Boulevard West
Syracuse, New York 13202

Gentlemen:

MARK II CONTAINMENT - REQUESTS FOR ADDITIONAL INFORMATION

As a result of our review of the Mark II Containment Dynamic Loads Reports listed in enclosure 1, we find that we need additional information to continue our evaluation. The additional information we require is identified in enclosure 2. Most of the items listed in the enclosure were discussed with representatives from the General Electric Company and the Mark II Owners Group during our meetings on October 27, and 28, 1976.

All items in the enclosure except requests 020-58 thru 020-68 are generic to the review of all Mark II containments. Therefore, the enclosure is being sent to all Mark II owners.

We would expect the information generated in response to the generic requests in enclosure 2 would be transmitted directly to us by General Electric Company for the Mark II owners. However, we would also expect each of the owners to adopt the responses by reference. Requests 020-58 thru 020-68 are plant unique and each Mark II owner should provide responses to these.

Please indicate within 10 days of receipt of this letter when we can expect to receive the responses to both the generic items and the plant unique items. If you require any clarification of these requests please contact us immediately.

Sincerely,

Original signed by:

S. A. Varga, Chief
Light Water Reactors Branch No. 4
Division of Project Management

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Enclosure:
Request for Additional
Information

OFFICE➤		DPM/LWR #4	DPM/LWR #4		
SURNAME➤		WKane;pav	SAVarga		
DATE➤		01/14/77	01/14/77		

Niagara Mohawk Power Corporation - -

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ENCLOSURE 1

MARK II POOL DYNAMICS LOADS

PROGRAM

REPORTS

(1) Mark II Containment Supporting Program Report, NEDO-21297

(2) Mark II Containment Dynamic Forcing Function Information Report, NEDO-21061 - Revision 2 and NEDE-21061-P - Revision 2

(3) Mark II Pressure Suppression Test Report (Phase I 4T Tests), NEDE-13442P-01

(4) Mark III Confirmatory Test Program One-Third Scale Pool Swell Impact Tests, Test Series 5805, NEDE-13426P

(5) Test Results Employed By GE for BWR Containment and Vertical Vent Loads, NEDE-21078

(6) Mark II Phase I 4 T Tests Application Memorandum (June 14, 1976)

ENCLOSURE 2

REQUEST FOR ADDITIONAL INFORMATION
MARK II CONTAINMENT
DYNAMIC FORCING
FUNCTIONS INFORMATION REPORT (DFFR)

M020 CONTAINMENT SYSTEMS BRANCH

M020.27 The calculated drywell pressure transient typically assumes that the mass flow rate from the recirculation system or steamline is equal to the steady state critical flow rate based on the critical flow area of the jet pump nozzle or steam line orifice. However, for approximately the first second after the break opening, the rate of mass flow from the break will be greater than the steady state value. It has been estimated that for a Mark I containment this effect results in a temporary increase in the drywell pressurization rate of about 20 percent above the value based solely on the steady state critical flow rate. The drywell pressure transient used for the LOCA pool dynamic load evaluation, for each Mark II plant, should include this initially higher blowdown rate due to the additional fluid inventory in the recirculation line.

M020.28 The importance of the effect of wetwell backpressure on Mark II pool dynamic loads (i.e., pool swell and steam loads) was discussed in the 4T test report NEDE-13442P-01 and in the June 14, 1976 4T test application memorandum. The 4T test matrix including Phases I through III does not include tests that allow separation of pool dynamic effects attributible to vent submergence and wetwell back-pressure. We require that additional 4T tests, with these parameters uncoupled, be performed for the purpose of developing plant specific pool swell and steam loads.

M020.29 Thrust loads on the vent system of a Mark II containment are reaction forces due to vent flow caused by the LOCA pressure transient. These loads would be transmitted to the diaphragm separating the drywell and wetwell volumes through the vent deflectors and the vent deflector supports. Analyses of these thrust loads have not been provided in the DFFR. We require that these thrust loads be investigated. Provide a description of the method of analyses, the magnitude, and duration of this load for each Mark II plant.

M020.30 Significant differences in the pool area/vent area ratio exist from location to location within a given Mark II plant. These differences may lead to cross flow and lateral drag forces on the vents during pool swell. Based on the DFFR Section 4.4.7 it would appear that this lateral drag load on the vents would be computed based on the maximum pool surface velocity and the density of water. Confirm this interpretation of the DFFR. In addition, provide the magnitude and duration of this load for each Mark II plant. Alternatively provide justification for not including this load.

M020.31 We require that 3D tests be performed to substantiate the pool swell loads. These loads are currently based on a one dimensional pool swell model and single vent 4T tests. The following items should be considered as a part of the 3D test program.

(1) A comprehensive scaling analysis of the test facility and error analysis of the test data.

(2) A determination of the sensitivity of pool swell loads to assymetries in vent flow loads and the drywell/wetwell pressure transient.

(3) A determination of the effect of spatial variations of the pool area to vent area ratio within a given plant on the pool swell phenomena.

M020.32 The DFFR includes the statement on Page 4-43 that a typical jet impingement load on the basemat can be computed utilizing the velocity attenuation given in Figure 12.3 of Reference 13. Clarify this reference since reference 13 does not contain a Figure 12.3.

M020.33 The diaphragm pool swell upward load was based on the unheated drywell test Run 33. This test was conducted with a vent submergence of 11 feet. Figure 5-28 in Reference NEDE-13442P-01 shows that the diaphragm upward load increases with increasing vent submergence. The current peak upward design load for the diaphragm does not appear to include sufficient margin for both this effect and uncertainty in the measured load. Address this concern and provide an error analyses to substantiate the peak upward design load for the diaphragm.

M020.34 The DFFR in Section 4.2.2 states that downcomer and pool boundary loads will not be considered during periods of high steam flow since the load derived from the 4T tests are lower than corresponding low steam vent flow lateral loads. It is our position that high steam flow loads should be considered since these loads, in combination with other loads, may be significant. It was stated in the 4T

applications memorandum that no significant downcomer lateral loads were observed at high steam vent flow. However, in NEDO-21078 Figure 3-19 foreign licensee data indicate significant lateral loads at a vent flow of 20.7 lb/ft^2 in tests conducted with an air mixture of 1%. Specification of a high vent flow downcomer load should reflect this data as well as the 4T data. For structures in the pool it is our position that the ± 4 psi; 4HZ load derived from PSTF tests should be used. This load should be confirmed by data from the 4T tests.

M020.35 With regard to the pool swell dynamic analytic model described in Section 4.4 of the DFFR, we have a number of concerns. We request modifications and/or clarification of the methodology in response to the concerns listed below:

(1) Assumption 5 on page 4-16 of the DFFR sets the bubble air temperature equal to the (isentropic) drywell air temperature. This assumption is unrealistic from a physical standpoint, and whether or not it is conservative is not obvious a priori. It is our position that this assumption should either be replaced by an application of the first law of thermodynamics to the bubble or show that the use of the drywell air temperature results in conservative pool swell calculations.

(2) The point at which breakthrough occurs is crucial in determining the loading conditions experienced by the containment structure. It is our position that the evidence presented to date does not provide a rational basis for estimating when this event occurs. We cannot conclude on the current breakthrough model without adequate test confirmation. Thus, we require confirmation of the breakthrough model with test data.

(3) In general, confidence in the pool swell model can only develop when comparison of theory and experiment shows favorable results. It is our position that, at this time, such demonstration has not been made. We require confirmation of the pool swell model with test data.

(4) Equation (4.12) of the revised version of DFFR differs from its counterpart in the earlier version, Equation (4.4.10). The latter is correct if P_D is interpreted as the instantaneous total pressure in the drywell. The version presented in Equation (4.12) is correct if P_D is the static pressure evaluated at inlet conditions. Clarification is requested.

(5) Equation (4.10) does not consistently account for compressibility effects between the drywell total conditions and the inlet static conditions. These effects should either be accounted for or show that these effects result in conservative pool swell calculations.

(6) The sensitivity of the pool swell model predictions to the choice of initial condition (e.g., initial pool velocity and bubble pressure) and vent friction factor has not been examined. It is our position that a parametric numerical study be undertaken to examine the sensitivity of pool swell calculations to these parameters.

M020.36 The Mark II containment supporting program as described in NEDO-21297 identifies in Section II.2.A.1 development of a pool swell velocity breakthrough model. Provide a detailed description of this model and an evaluation of this model using the 4T test data. The model should be verified over a range of conditions to reflect the variations in the design between Mark II plants.

M020.37 The DFFR in Section 4.3 states that the downcomer lateral load specification during low steam flow is 8800 lbs. The basis for this specification is the foreign licensee data reported in NEDO-21078. It is our position that these data are not directly applicable for Mark II plants. Accordingly, we require a clear demonstration that this design load represents an upper bound when all the loads are derived from the 4T test program.

M020.38 Provide a description of the analytical efforts described in the 4T test applications memorandum Section 6.0 to investigate the statistical nature of multiple vent chugging.

M020.39 The 4T test report NEDE-13442P-01 does not provide sufficient information on pool boundary loads. In the final 4T test report provide a quantitative evaluation of the effect of the following parameters on pool boundary loads:

(1) pool temperature;

(2) vent air admixture;

(3) vent mass flux;

(4) wetwell air space backpressure;

(5) downcomer submergence;

(6) vent proximity to pool boundary.

The pool boundary design load should consider load sensitivity to the above parameters and differences between the 4T test facility and specific Mark II plant designs.

M020.40 A preliminary uniform and assymetric chugging wall load distribution for the Mark II systems was provided in Section 6.0 of the 4T test applications memorandum. This load was developed from 4T test data. The 4T test represents a unit cell with a single downcomer. We require that the boundary loads be based on steam tests which include both single and multiple downcomers.

M020.41 In NEDO-21297, the Mark II containment supporting program report, Section III.2.A.4.a, it is stated that the applicability of PSTF data to Mark II geometry and structures is provided in NEDE-13426P and NEDC-20989-2P. This information does not appear to have been provided in these reports. We require that you provide this information. In addition, provide the basis for the 50% design margin applied to impact loads as described in Section 4.4.6.1 of the DFFR.

M020.42 For water impact loading of structures, one should consider whether it is necessary to specify the actual loading history or simply the total impulse. If the loading history is needed, the DFFR (NEDO-21061-Rev. 2) proposes the use of impact pressure correlations (figures 4-34, 35, 36) and pulse duration (Figure 4-37) corresponding to PSTF conditions (NEDE-13426P). Both parameters depend on the length of target and the shape of the approaching pool. Provide the basis that allows one to assume that these conditions are the same in an actual Mark II pool and the PSTF.

For flat targets in the range of 13-20 inches, the total impulse due to water impact, as calculated from the pressure correlations (Figures 4-36) and pulse duration (Figure 4-37) in the DFFR, is not conservative compared to PSTF data. For example, for 20 inch I beams, the Mark II impulse is only 60% of the PSTF data (as determined from Figure 6-8 NEDE-13426P). This non-conservatism eliminates the 50% design margin used by GE to specify the design loads.

M020.43 Justify use of the PSTF impact data for cylinders and I beams associated with the downcomer lateral support system. Show that this data which was obtained from tests on simple geometries applies to the structures comprising a typical downcomer support system.

M020.44 Table 5-1 and Figure 5-1 through 5-16 in the DFFR provides a listing of the loads and the load combinations to be included in the assessment of specific Mark II plants. This table and these figures do not include loads resulting from pool swell waves following the pool swell process or seismic slosh. We require that an evaluation of these loads be provided for the Mark II containment design.

M020.45 The 4T test report NEDE-13442P-01 exhibits certain deficiencies which should be corrected in the final version, for example:

(1) More extensive presentation of measured results should be included in the final report. As an example, the data given in Figure 5-15 should be provided for all test runs.

(2) More detailed description in terms of configuration, principle of operation, calibration, orientation and location of instrumentation should be included in the final report.

M020.46 Provide raw data generated during a selected 4T test run. Signal traces of the conductivity probes are of particular interest, but wetwell and drywell pressure histories and pitot-static probe traces should also be provided. Both short term and long term histories should be included. The specific run selected for this purpose is Run 5101-29.

M020.47 Figure 3.3 Type 2 shows the ramsheads oriented radially toward the containment wall. The bubble discharged from the ramshead directed toward the boundary may behave differently from the bubble discharged from the ramshead oriented tangentially or in parallel with the boundary. Since the experiments for the SRV tests such as Quad City and the Monticello tests have been performed for the ramshead oriented in parallel with the boundary, discuss and justify the applicability of the test data for ramshead directed toward the boundary.

M020.48 Provide a brief description and the name of the computer code used for the S/R valve load calculations. Include an analysis based upon the following input data:

(1) Parameters given in Table 2-4 of the topical report NEDE-21062-P.
(2) Bubble formation efficiency = 0.1.
(3) Locations of the pressure transducers No. 1 and No. 5 as shown on figure 2-7 of NEDE-21062-P.
(4) Compare the calculated results to those in NEDE-21062-P and justify any differences.

M020.49 Provide a transient analysis of the vent clearing, pool dynamic, and bubble pressure phenomena as a result of SRV multiple actuation. Include the following:

(1) Descriptions of the analytical model, including all assumptions and equations.

(2) Graphs showing the vent clearing time and pool dynamic bubble pressure as a function of sequential actuation. The number of sequential actuations should be large enough to clearly indicate that the bubble pressure due to multiple actuation has reached the maximum value.

(3) Graphs showing the peak wall pressure, positive as well as negative, as a function of the sequential actuation of the relief valves.

(4) Verification of the analytical results by comparison with experimental data. If the experiments were conducted in a different configuration and/or in a different geometry of suppression pool, justification of applicability of the experimental data to the SRV system for each plant should be provided.

M020.50 Provide justification for the assumptions used in the SRV bubble dynamic model. Include the following:

(1) A detailed discussion of the development of bubble formation efficiency. It should be noted that the bubble formation efficiency could be a function of air and water temperatures, air pressure, pipe size, pool geometry, submergence, and the degree of air and steam mixing. Therefore, this empirical correlation developed from some particular test data may not be universally applicable.

(2) Justification for using a drag coefficient of 2.5 for computing bubble depth.

(3) Justification for assuming that the dynamics of a bubble are not affected by the presence of other bubbles.

(4) Justification for assuming that the pool boundaries do not affect the motion of the bubble and the discharge rate of air during the process of bubble formation.

M020.51 The analytical model assumes that the bubble will be formed at a point 4 feet from the exit of the ramshead. It is noted that this assumed bubble initial position was derived from Quad City test data. Therefore, it should be treated as an empirical correlation rather than a constant. Discuss and justify the applicability of this empirical correlation for the Mark II containment.

M020.52 Provide the following additional information on using the influence coefficient method for ramshead loads computation:

(1) Discuss and justify analytically and experimentally the selection of the influence parameters.

(2) Discuss and justify analytically and experimentally the use of the linear superposition principle for computing the ramshead loads.

(3) The nomenclature for those variables shown on Table 3-4.

M020.53 Provide a detailed description of the computational method of bubble frequencies due to multiple valve actuation. Include the following information:

(1) All equations and assumptions used;
(2) The transient of the primary system from which the sequence of SRVs initiation is assumed.

M020.54 DFFR Section 3.3 presents the quencher loads based on the statistical method described in GESSAR-238 NI Appendix 3B, Amendment 43. As a result of our review, however, we find this statistical method is not applicable for the Mark II containment because some of the key parameters, such as the air volume, exceeds the test envelope. Extensive extrapolation of the test data is thus required. We believe that the current data base is not sufficient to justify the applicability of the statistical method of predicting quencher loads for the Mark II Containment. Therefore we require additional test data, such as could be provided by the CAORSO test,

M020.55 The computational method described in DFFR Section 3.4 for calculating SRV loads on submerged structures is not acceptable. It is our position that the Mark II containment applicants should commit to one of the following two approaches:

(1) Design the submerged structures for the full SRV pressure loads acting on one side of the structures; the pressure attenuation law described in Section 3.4.1 of NEDO-21061 the ramshead and Section A10.3.1 of NEDO-11314-08 for the quencher can be applied for calculating the pressure loads.

(2) Follow the resolution of GESSAR-238 NI on this issue. The applicant for GESSAR-238 NI has proposed a method presented in the GE report, "Unsteady Drag on Submerged Structures," which is attached to the letter dated March 24, 1976 from G. L. Gyorey to R. L. Tedesco. This report is actively under review.

M020.56 The response to question 020.26 wherein we requested a differentiation between primary and secondary loads is unacceptable. The original design assessment reports for individual plants with Mark II containments specified substantial changes in Mark II containment structures to accommodate pool dynamic loads. We recognize that a specified pool dynamic load may not be a primary load on all Mark II plants because of differences in the design of Mark II plants. However, if it is a primary load on any Mark II plant, it should be treated as such in the generic Mark II pool dynamic load program.

Based on our preliminary review of the original design assessment reports, the OFFR and the reports submitted to us dealing with the definition of the Mark II pool dynamic loads we have concluded that the following loads should be viewed as primary loads for the Mark II containment design.

(1) SRV loads for both the ramshead and quencher designs.

(2) Steam chugging loads including loads on the downcomers and the pool boundary.

(3) Pool swell loads including impact and drag loads.

Our generic review of these Mark II pool dynamic loads will consider them to be primary loads unless it can be shown that a given load is secondary in terms of structural capability or load magnitude.

M020.57 A number of pressure suppression tests will be conducted within the next few years. Results of many of these tests should be applicable to the Mark II containment design. For each of the tests listed below discuss the participation or monitoring activities of the Mark II owners group.

(1) Japan Atomic Energy Research Institute multivent small scale and full scale 1/18 sector tests.

(2) Mark I 1/4 scale air, 2 vent full scale steam, and multivent steam tests.

(3) German tests

(4) Livermore air and steam tests

(5) EPRI 1 vent 1/13 scale Mark II tests and Mark I-scale tests.

(6) LOFT suppression tests

(7) Mark III multivent steam tests.

M020.58 Relating to the pool swell calculations, we require the following information for each Mark II plant:

(1) Provide a description of and justify all deviations from the DFFR pool swell model. Identify the party responsible for conducting the pool swell calculations (i.e., GE or the A&E). Provide the program input and results of bench mark calculations to qualify the pool swell computer program.

(2) Provide the pool swell model input including all initial and boundary conditions. Show that the model input represents conservative values with respect to obtaining maximum pool swell loads. In the case of calculated input, (i.e., drywell pressure response, vent clearing time), the calculational methods should be described and justified. In addition, the party responsible for the calculation (i.e., GE or the A&E) should be identified.

(3) Pool swell calculations should be conducted for each Mark II plant. The following pool swell results should be provided in graphical form for each plant:

(a) pool surface position versus time;

(b) pool surface velocity versus time;

(c) pool surface velocity versus position; and

(d) pressure of the suppression pool air slug and the wetwell air versus time.

(4) The calculated drywell pressure response and the enthalpy flux in the downcomer vent should be compared to the 4T 2 1/2 in. and 3 in. venturi data.

M020.59 In the 4T test report NEDE-13442P-01 Section 3.3 the statement is made that for the various Mark II plants a wide diversity exists in the type and location of lateral bracing between downcomers and that the bracing in the 4T tests was designed to minimize the interference with upward flow. Provide the following information for each Mark II plant:

(1) A description of the downcomer lateral bracing system. This description should include the bracing dimensions, method of attachment to the downcomers and walls, elevation and location relative to the pool surface. A sketch of the bracing system should be provided.

(2) An assessment of the effect of the bracing system on the pool swell phenomena and drywell pressure response.

(3) The basis for calculating the impact or drag load on the bracing system or downcomer flanges. The magnitude and duration of impact or drag forces on the bracing system or downcomer flanges should also be provided.

(4) An assessment of the effect of downcomer flanges on vent lateral loads.

M020.60 In the 4T test report NEDE-13442P-01 Section 5.4.3.2 the statement is made that an underpressure does occur with respect to the hydrostatic pressure prior to the chug. However, the pressurization of the air space above the pool is such that the overall pressure is still positive at all times during the chug. We require that each Mark II plant provide sufficient information regarding the boundary underpressure, the hydrostatic pressure, the air space and the SRV load pressure to confirm this statement or alternatively provide a bounding calculation applicable to all Mark II plants.

M020.61 Significant variations exist in the Mark II plants with regard to the design of the wetwell structures in the region enclosed by the reactor pedestal. These variations occur in the areas of (1) concrete backfill of the pedestal, (2) placement of downcomers, (3) wetwell air space volumes; and (4) location of the diaphragm relative to the pool surface. In addition to variation between plants, for a given plant, variations exist in some of these areas within a given plant. As a result, for a given plant, significant differences in the pool swell phenomena can occur in these two regions. We will require that each plant provide a separate evaluation of pool swell phenomena and loads inside of the reactor pedestal.

M020.62 For the suppression pool temperature monitoring system, provide the following additional information:

(1) Type, number and location of the temperature instrumentation that will be installed in the pool.

(2) Discuss and justify the sampling or averaging technique that will be applied to arrive at a definitive pool temperature.

M020.63 For limiting the suppression pool temperature, provide the following additional information:

(1) Present the temperature transient of the suppression pool starting from the specified temperature limits for the following transients:

(a) Stuck open relief valve.

(b) Primary system isolation

(c) Initiation of auto depressurization system

(2) Describe the instrumentation which will alert the operator to take action to prevent the pool temperature limit to be exceeded.

(3) Describe the operator actions and operational sequence for those transients stated in Item 1 above. Provide and justify the assumption of time for initiating each action and the corresponding pool temperature.

M130.0 STRUCTURAL ENGINEERING

M130.8 Responses to previous SEB questions, 130.1 and 130.2 are insufficient. DFFR Tables 2-1 and 5-1 have not provided any load profiles and time histories. DFFR Figs. 5-1 through 5-16 have no indications of how the load time histories are combined. Provide the information requested.

M130.9 Clarify the last sentence on Page 5-20 of the DFFR. Will structures be designed using load combinations 4a, 5a and 7a of Table 5-2?

M130.10 It is questionable that the base mat or drywell floor may be modeled as a thin shell as described in DFFR Section 5.4.2. Support this assertion or modify the section to eliminate the thin shell modeling option.

M130.11 The reference in DFFR Section 5.5 to use of the strength allowable of ACI-218-71 is not considered appropriate. The specific strength acceptable criteria should be specified. An acceptable set of such allowable are those incorporated into US NRC SRP 3.8.

M130.12 Reference is made in DFFR Section 5.4.3 to studies of structural response to SRV load. Provide citations for this reference and where such studies are not readily available, copies are requested.

M130.13 The 4T test applications memorandum states that high magnitude short duration dynamic lateral loads were observed. Provide a description of the method used to convert from a dynamic lateral load to an equivalent static lateral load. In addition, provide a description of the methods used to assess the effect of load structure interaction in the 4T tests and in the various Mark II vent designs.

M130.14 The 4T test applications memorandum states that pool boundary loads resulting from chugging are based on 4T test data in conjunction with engineering application techniques to account for differences between the 4T facility and the full scale systems. Provide a description of these techniques. In addition, discuss load/structure interaction considerations given to pool boundary loads for each Mark II plant.

M130.15 The 4T test report NEDE-13442P-01 does not provide sufficient information related to pool boundary loads. The final 4T test report should provide a quantitative evaluation of the effect of stiffness of the wetwell wall on pool boundary loads.