NSP

NORTHERN STATES POWER COMPANY

MINNEAPOLIS MINNESOTA 55401

Regulatory File Cy

February 6, 1976

Mr Victor Stello, Director
Division of Operating Reactors
U S Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr Stello:

MONTICELLO NUCLEAR GENERATING PLANT
Docket No. 50-263 License No. DPR-22

Documentation of Basis for Continued Operation

Subsequent to your April, 1975 request for additional information concerning the design and performance of Mark I containment systems, utility owners of plants with these systems commissioned General Electric to undertake a Mark I containment evaluation program. The Nuclear Regulatory Commission has been informed of progress of this program from time to time through the series of reports and letters submitted by General Electric. In a January 28, 1976 meeting in the NRC Bethesda, Maryland office with representatives of the General Electric Company (GE) and representatives of the owner utilities you were presented with the latest information developed by the Mark I containment evaluation program. At the conclusion of this meeting, you advised us of your finding of no requirement for immediate shutdown of any Mark I plant then operating, and you requested that each licensee provide a letter documenting their basis for continued operation. This letter is the Northern States Power Company (NSP) response to your request concerning the Monticello Nuclear Generating Plant.

Under the Mark I containment evaluation program conducted by GE the load basis was developed from model test data, and torus structural capability was analyzed with respect to these loads. The conclusion of this evaluation was that the Monticello containment would perform without loss of function in the course of the DBA-LOCA event. NSP agrees with this conclusion.

The basis for our concurrence with this conclusion involves many facets. For purposes of explanation the discussion is organized as follows:

(a) Torus support system structural response to the defined loads.

(b) Conservatisms in the presently defined loads.

(c) Probability of the event associated with origin of significant loads.

I. Torus Support System Structural Evaluation

The results of the structural evaluation by GE are in the form of ratios of applied load to lower bound ultimate capability of structural elements of the torus support system. These elements included the torus ring, shell, upper column connections, columns, lower column connection and column base plate anchor bolting. The ring, shell and upper column connection assemblies were found to have large margins with respect to the analyzed loads, both upward and downward, and are not an area of concern.

For down loads, the load capacity ratio of structural elements of the Monticello torus support system having a ratio above 0.9 were as follows:

Component	Ratio
Columns	0.92
Lower pin connection clevis lugs	1.00

For the columns there may be a potential for limited and local yielding near the top connection, as a result of combined bending and axial forces. However, this would be expected to be minimal because of the short duration pulse-character of the load. Yield across the total column cross-section would not be expected because the axial load is not sufficient to produce this result.

The clevis lugs of the lower column pin connection could potentially be subject to moderate local yield in bearing, but again this would be minimal because of the pulse-character of the down load.

For upward loads, the column base anchor bolts would be the only element of potential concern; the GE-Bechtel evaluation indicated that maximum elongation of these embedments would be 0.13 inches, or about one third of the elongation associated with ultimate pullout capability for a 1-1/2 inch embedded bent anchor as reported by Bechtel. This conclusion with respect to applied load can be considered conservative because of the pulse nature of the uplift load component attributable to vent header response reactions.

As a parallel effort to the GE-Bechtel evaluations, and for further assurance of these conclusions, NSP retained NUTECH as a consultant to perform an independent structural evaluation for the same applied loads. The results of the NUTECH evaluation are in concurrence with those of GE-Bechtel.

Notwithstanding that torus uplift is expected to be 0.13 inches or less, NSP has performed a field survey of all ECCS piping connected to the torus, and an analysis of the capability of this piping to withstand such uplift has been completed. The results of this preliminary piping analysis are that the limiting case line can

withstand uplift displacement in excess of twice the calculated torus displacement (Section III, Class 2 allowable stress of 2.4 S_h, considering weight, seismic and pressure).

Several other general aspects of conservatism are worthy of consideration on a qualitative basis:

(a) the ultimate capacity of structural elements as determined by analytical methods is generally found to be conservative in comparison to actual failure tests;

(b) the mechanical properties of the materials used in the structural elements of the torus support system generally expected to range from several percent to twenty percent greater than the minimum specification for the material designation;

(c) dynamic yield properties for these materials are generally accepted to be about ten percent above static yield strengths for the rapid strain rates expected to occur in these elements during LOCA.

II. Load Considerations

One-twelfth scale tests of a Mark I torus were run to obtain upwarded and downward loads on the torus due to postulated LOCA events. Recognizing the uncertainties inherent in numerical scaling techniques, the methods used in the determination of upward and downward pressure loads exceed a most probable load analysis approach by incorporating many conservatisms in data interpretation and analytical technique.

1. Upward Load Conservatisms

The upward pressure load is sensitive to the pressure history of the drywell following a postulated LOCA because the driving force for the pool swell and the resulting torus air space compression are increased with a greater drywell pressurization rate. The upward pressure load on the torus has been defined for the Short Term Program by application of the calculated FSAR drywell pressurization rate. Specifically, the 1/12th scale tests were run and analyzed to obtain loads based on the FSAR pressurization history. However, since this pressure history has been used to assure the adequacy of the drywell design pressure, it is biased towards high values for that purpose. The FSAR pressure history assumes an instantaneous break (mass fluxes evaluated using the Moody Critical flow model assuming slip), no steam condensation in the drywell, and a homogeneous air-steam-liquid flow mixture in the vent. This results in a high pressurization rate and increases the upward load definition.

As an example of the conservatism for the upward pressure load produced by the application of the FSAR pressurization rate, consider the reduction in mass flux which occurs with the application of the homogeneous rather than the slip formulation of the Moody Critical flow model. Even for the 20 Btu/lb mass subcooled liquid in the recirculation system, the homogeneous model shows a reduction in the mass flux from 8100 to 7100 lb m/sec. ft^2. Using the sensitivity curves, this flow reduction produces a reduction in the upward pressure load of 2 percent. The other conservatisms in the FSAR pressure history will add to this margin.

Another conservatism for the upward load used in the Short Term Program is the assumption of a 100% air flow in the vent system. This conservatism conflicts directly with the homogeneous air-steam-liquid vent flow assumptions used to define the FSAR pressurization rate. More consistent assumptions aimed at determining the most probable load basis are possible. One alternative is to apply the FSAR homogeneous air-steam-liquid vent flow assumption for both the pressure history and the non-condensible flow rate into the bubble. The other alternative is to assume 100% air vent flow for both the pressure history and the flow rate into the bubble. If, for example, the former is evaluated, the non-condensible bubble flow rate is reduced by a factor of three and the sensitivity analysis for (A_{pool}/A_{vent}) shows that the maximum upward load will be reduced by a factor of two.

Another contribution to the total upward load on the torus structure is the impact load on the vent header. The impact pressure on the vent header for the Short Term Program was determined by applying the impact velocity measured in the 1/12th Scale tests and the results of the PSTF impact data. However, the PSTF data was obtained for the impact of a slug having a thickness greater than the diameter of the target. In contrast, the 1/12th Scale slug thickness is thinner than the vent header. The reduced slug thickness in the torus allows the liquid to be quickly decelerated under the header immediately following impact. This deceleration, which was observed in the 1/12th Scale tests, would be expected to yield a lower impact load. Indeed, the impact pressure history measured in the 1/12th Scale test by a strain gage on the vent header was a factor of three less in magnitude and three times longer in duration. The more conservative vent header impact pressure was used in the analysis as an added conservation. The 1/12th Scale test results will be substantiated by future 1/6th Scale testing.

2. Downward Load Conservatisms

Similar conservatisms have been used in defining the downward pressure load on the torus. The calculated FSAR pressure rate was also used to establish the downward pressure load on the torus. If the finite opening time of the break, reduced mass flux at the break, and steam condensation in the drywell were accounted for, the drywell pressure at vent clearing would be less and the downward pressure load would be reduced. The reduction in the downward pressure load for using a mass flux of 7100 instead of 8100 lb m/sec. ft^2 is 6 percent.

The data used from the 1/12th Scale tests to define the downward pressure loads was also analyzed in a conservative manner. There was some variation in the maximum downward pressure loads measured for the medium orifice runs considered as a group and for the large orifice runs considered as a group. Instead of averaging the loads measured for the medium and large orifice runs, the greatest magnitude downward pressure loads were identified for both orifice sizes. The Reference Plant downward pressure load was then determined by interpolating between the maximum of the maximum downward pressure loads.

The analysis of the 1/12th Scale test results also did not take credit for any reduction in the downward force due to three dimensional effects and pressure attenuation. The submerged pressure transducers are located at the mid-width of the test section and will sense most directly the pressure of the bubble formed at the downcomers and the water jet forces. Both the bubble pressure and the water jet force will attenuate as one moves circumferentially away from directly below the downcomers. However, since the pressures measured by the transducers were assumed to act uniformly over the width of the test section, a higher than actual reaction force was calculated.

In the typical torus, the downcomers are not spaced uniformly leaving a large section below the vent pipe where the influence of the downcomers is decreased. The downward pressure load produced by the bubble pressure at the downcomers and the water jet forces will be reduced in this section because of the increased distance to the nearest downcomers. However, the pressure loads should not be significantly increased where the downcomers are closely spaced because the measured pressure load of 16.33 psid approaches the driving pressure - the drywell pressure is 17.0 psid at the time of vent clearing. Therefore, due to three dimensional effects and variable downcomer spacing the maximum downward pressure cited for the reference plant of 16.33 psid is conservative.

III. Probability of the Event Associated with Origin of Defined Loads

The defined loads used in the structural evaluation were based on containment pressurization rates resulting from the DBA-LOCA event; that is, the worst case break of a 28 inch recirculation line at the reactor vessel nozzle.

This piping would require a major failure such as complete severence and separation or a large axial break to produce the containment loading used in the evaluation. We believe that the probability of such failures for this line size would be on the same order as reactor vessel failure estimates which are associated with an extremely low probability.

In the case of Monticello, six of the thirty-nine welds on the 28 inch piping have been the subject of ISI examination since initial service. The nozzle to safe end and safe end to pipe welds on both recirculation loops were included in these ISI examinations; we believe that these inspections in the location of the "worst case" break, significantly reduce the probability of that event.

Considering 22 inch recirculation line breaks, and adjusting containment loadings using GE senstivity curves to this break size for Monticello, we conclude that relative to DBA-LOCA loads the upward loadings would be reduced by 18% and the downward loadings would be reduced by 25%. We believe this illustrates that breaks on the 22 inch line sizes are associated with sufficiently reduced dynamic loadings on the torus structure to be below the potential range of immediate concern. Three of the nineteen welds on 22 inch piping have received ISI inspection since initial service.

Stepping to the next larger line size, 18 inch lines, the torus dynamic loadings would be further reduced from the DBA-LOCA event by 55% for upward loads and 67% for downward loads.

IV. Conclusions

In light of these considerations we believe that the probability of a DBA-LOCA event is extremely low, and that the only LOCA break that could produce loadings as used in the evaluation are associated with those approaching the "worse case" event related to 28 inch lines close to their reactor connection. Second, we believe that the structural evaluation illustrates with reasonable conservatism that the containment system can perform its function under the load basis used in the evaluation. Third, we believe that the derivation of loads developed for this evaluation includes significant conservatisms. On this basis we conclude that the Monticello Nuclear Generating Plant can continue operation for an interim period without undue risk to the health and safety of the public.

Notwithstanding these conclusions for interim operation, NSP recognizes that the margins of structural capability for the torus support system must be improved to a range which approaches the margins required for normal design practice. With this objective, NSP has undertaken a course of action to develop detailed engineering designs and determine feasibility of installation of these designs for modifications to improve the structural elements of the torus support system that are subject to high loadings. The modifications being considered involve reinforcement of torus support columns, reinforcement of lower column to base connection, and improvement of column base anchoring. NSP is prepared to discuss this action plan at your convenience.

Yours very truly,

L L Taylor /for

L O Mayer, PE
Manager of Nuclear Support Services

LOM/LLT/ak

cc: J G Keppler
G Charnoff
MPCA
Attn: J W Ferman

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY

MONTICELLO NUCLEAR GENERATING PLANT

Docket No. 50-263

License No. DPR-22

LETTER DATED FEBRUARY 6, 1976
RESPONDING TO NRC REQUESTS
FOR INFORMATION ON CONTAINMENT DESIGN

Northern States Power Company, a Minnesota corporation, by this letter dated February 6, 1976 hereby submits information in response to NRC requests for information made during a meeting with the Mark I Containment Owners' Group on January 28, 1976.

This request contains no restricted or other defense information.

NORTHERN STATES POWER COMPANY

By L. J. Wachter
L J Wachter
Vice President, Power Production
& System Operation

On this 6th day of February, 1976, before me a notary public in and for said County, personally appeared L J Wachter, Vice President, Power Production and System Operation, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company, that he knows the contents thereof and that to the best of his knowledge, information and belief, the statements made in it are true and that ic is not interposed for delay.

Denise E. Branau

DENISE E. BRANAU
NOTARY PUBLIC – MINNESOTA
HENNEPIN COUNTY
My Commission Expires Oct. 10, 1981

UNITED STATES NUCLEAR REGULATORY COMMISSION

NORTHERN STATES POWER COMPANY

MONTICELLO NUCLEAR GENERATING PLANT

Docket No. 50-263

License No. DPR-22

LETTER DATED FEBRUARY 6, 1976
RESPONDING TO NRC REQUESTS
FOR INFORMATION ON CONTAINMENT DESIGN

Northern States Power Company, a Minnesota corporation, by this letter dated February 6, 1976 hereby submits information in response to NRC requests for information made during a meeting with the Mark I Containment Owners' Group on January 28, 1976.

This request contains no restricted or other defense information.

NORTHERN STATES POWER COMPANY

By /s/ L J Wachter
L J Wachter
Vice President, Power Production
& System Operation

On this 6th day of February, 1976, before me a notary public in and for said County, personally appeared L J Wachter, Vice President, Power Production and System Operation, and being first duly sworn acknowledged that he is authorized to execute this document on behalf of Northern States Power Company, that he knows the contents thereof and that to the best of his knowledge, information and belief, the statements made in it are true and that it is not interposed for delay.

/s/ Denise E Branau
Denise E Branau
Notary Public, Hennepin County, Minnesota
My Commission Expires October 10, 1981

NRC DISTRIBUTION FOR PART 50 DOCKET MATERIAL
(TEMPORARY FORM)

CONTROL NO: 1310

FILE:

FROM:	DATE OF DOC	DATE RECD	LTR	TWX	RPT	OTHER
Northern States Power Co. Minneapolis, Minn. L.O. Mayer	2-6-76	2-10-76	XXX			

TO:	ORIG	CC	OTHER	
V. Stello	None	40		SENT NRC PDR XXX SENT LOCAL PDR XXX

CLASS	UNCLASS	PROP INFO	INPUT	NO CYS RECD	DOCKET NO:
	XXX			40	50-263

DESCRIPTION:

Letter re. our letter of 4-75..notarized 2-6-76.. Letter furnishing additional info. concerning the Documentation of Basis for Continued Operation.. (40 Cys. Received)

ENCLOSURES:

ACKNOWLEDGED
DO NOT REMOVE

PLANT NAME: Monticello

SAFETY — FOR ACTION/INFORMATION — ENVIRO SAB 2-10-76

ASSIGNED TO

BRANCH CHIEF Ziemann w/6

PROJECT MANAGER Buckley

LIC. ASST. Jiggs W/16 CYS ACRS

ASSIGNED BRANCH CHIEF

PROJECT MANAGER

LIC ASST. W/ ACRS

INTERNAL DISTRIBUTION

REG FILE
NRC PDR
OELD
SSIC/STAFF
IAE (2)
MIPC

PROJECT MANAGEMENT
BOYD
P. COLLINS
HOUSTON
PETERSON
MELTZ
HELTEMES

SYSTEMS SAFETY
HEINEMAN
SCHROEDER

ENGINEERING
MACCARY
KNIGHT
SIHWEIL
PAWLICKI

REACTOR SAFETY
ROSS
NOVAK(3)
ROSZTOCZY
CHECK

PLANT SYSTEMS
TEDESCO
BENAROYA
LAINAS
IPPOLITO

OPERATING REACTORS
STELLO

OPERATING TECH.
EISENHUT
SHAO
BAER
SCHWENCER
GRIMES

SITE SAFETY & ENVIRO ANALYSIS
DENTON
MULLER

ENVIRO TECH.
ERNST
BALLARD
SPANGLER

SITE TECH.
GAMMILL
STEPP
HULMAN

SITE ANALYSIS
VOLLMER
BUNCH
J. COLLINS
KRECKER

AT&I
SALTZMAN
RUTBERG

MISCELLANEOUS
CASE

EXTERNAL DISTRIBUTION

LOCAL PDR Minneapolis, Minn.
TIC
NSIC
ASLB

NATIONAL LAB W/ CYS
REGION V-I&E-(WALNUT CREEK)
LA PDR
CONSULTANTS

BROOKHAVEN NAT. LAB
ULRIKSON (ORNL)