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NORTHERN STATES POWER COMPANY
Minneapolis, Minnesota 55401

July 6, 1979

Mr. James G. Keppler
Director - Region III
Office of Inspection and Enforcement
United States Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Dear Mr. Keppler:

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

The following information is submitted in response to items 1-6 of IE Bulletin 79-02 (Revision No. 1):

1. Anchor bolt loads in Seismic Category I Systems were recalculated by Bechtel Power Corporation using a method which accounts for base plate flexibility. Depending on the complexity of the individual base plate configuration, one of the following methods of analysis was used.

   a. A review of base plates used in supporting subject piping systems indicates that the typical plate is 1/2 to 2 inches thick, anchored by 8 bolts or less and unstiffened. Bechtel developed an analytic method which treats the typical plate as a beam on multiple spring supports subjected to moments and forces in three orthogonal directions. Certain empirical factors are used in the model to account for the effect of concrete foundation and the two way action of load transfer in a plate. These factors provide a method for introducing the interaction effect of such parametric variables as plate dimensions, attachment size, bolt spacing and stiffness on the distribution of external loads to the bolts. These factors are based on analytical considerations and results of representative finite element analyses of base plates (using the ANSYS Code). A number of case studies indicate excellent correlation between results of the described analytic method and those of the finite element method.

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   A computer program for the analytical method described above has been implemented for determining bolt loads for typical applications. This program requires plate dimensions, number of bolts, bolt size, bolt spacing, bolt stiffness, applied loads, and allowable bolt shear and tension loads as inputs. Output includes

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bolt forces and a shear-tension interaction value based on allowable loads.

b. Other cases were solved either through finite element analysis (using the ANSYS Code) or by an approach based on the strength design methods given in the ACI 318-77 Code.

The analysis did not include piping 2 inches and under since the original design used the "chart" method. Additional description of the methods used for the original design will be submitted with the report of completion of planned actions required by item 5 of the Bulletin. It is believed that the methods used for piping 2 inches and under were conservative.

2. Bolts loads calculated according to the methods described above were compared to bolt ultimate capacities to verify compliance with the factors of safety recommended by the Bulletin. Ultimate capacity for a given bolt is based on consideration of concrete edge distance, bolt spacing, embedment depth and manufacturer's ultimate capacity. Shear-tension interaction in the anchor bolts is accounted for in the following equation:

$$\left(\frac{T}{Ta}\right)^2 + \left(\frac{S}{Sa}\right)^2 < 1.0$$

T and S are calculated tensile and shear forces and T_a and S_a are the respective allowable values.

Results of the analyses are as follows:

Number of Base Plates Evaluated	606
Acceptable Base Plate (Safety Factor $\geq$ 4 or 5)	543
Acceptable Base Plate (Safety Factor $\geq$ 2)	55
Unacceptable Base Plate (Safety Factor < 2)	8

A factor of safety of two, for the faulted load combination, is considered acceptable when an effective program of anchor bolt verification (i.e., testing to design load) has been implemented.

The 8 base plates where the factor of safety for the expansion bolts is less than two were evaluated by Bechtel to determine their effect on the structural integrity of the piping systems. These 8 base plates and the results of the evaluation are described in Attachment 1.

3. In the original design of piping systems, deadloads, thermal loads, seismic loads and dynamic loads (steam hammer in the main steam system), were considered in the generation of static equivalent pipe support design loads. To the extent that these loads include cyclic considerations, these effects were included in the design of hangers, base plates and anchorages.

   The safety factors used for concrete expansion anchors installed on supports for safety related piping systems were not increased for loads which are cyclic in nature. The use of the same safety factor for cyclic and static loads is based on the FFTF Tests*. The test results indicate:

   a. Expansion anchors successfully withstood two millions cycles of long term fatigue loading at a maximum intensity of 0.20 of the static ultimate capacity. The vibratory loads were simulated by an alternating load of a steady sine wave alternating between 500 lbs (to avoid impact) to 0.20 of the static ultimate capacity. When the maximum load intensity was steadily increased beyond the aforementioned value by 2,000 lbs at each load step and cycled for 2,000 times at each load step, the observed failure load was about the same as the static ultimate capacity.

   b. The dynamic load capacity of expansion anchors under simulated seismic loading was about the same as their corresponding static ultimate capacities. The seismic loadings are conservatively simulated by about 6,800 cycles of a sine wave which varied from 500 lbs (to avoid impact) to 0.20 of the static ultimate capacity.

4. It is not necessary that bolt preload be equal to or greater than bolt design load. Pipe supports and anchors are subjected to static and dynamic loads. The dynamic loads are seismic loads which are short duration cyclic loads. This type of cyclic load is not a fatigue load, so the amount of preload on bolts will not greatly affect anchorage performance.

   If the initial installation torque on the bolt accomplishes the purpose of setting the wedge, then the ultimate capacity of the bolt is not affected by the amount of preload present in the bolt at the time of cyclic loading. For shell type anchors, there is no

* Drilled - In Expansion Bolts Under Static and Alternating Loads, Report No. BR-5853-C-4 by Bechtel Power Corporation, October, 1976.

installation torque so the requirements for preload do not exist. For vibratory loads during plant operation, the expansion anchors have successfully withstood long term fatigue as discussed in the previous section.

In accordance with the requirements of the Bulletin a testing program has been initiated to verify correct installation of anchor bolts and conformance with design documents. At the time of this writing, over 17% of all base plates for piping 2 1/2 inches and greater in Seismic Category I Systems have been inspected and tested.

5. Documentation of completed sampling inspections and tests is on site and available for NRC inspection. Results of this test program are reviewed on a continuing basis (as are the results of all tests and inspections) to assure that continued operation is justified. As of the time of this writing no deficiencies have been detected which could cause the structural integrity of the associated system to be compromised. It is expected that testing of accessible hangers will be completed by August 17, 1979. Testing of inaccessible hangers will be concluded by the end of the next extended outage. Further reports will be submitted upon completion of these actions.

6. Not applicable.

If additional information is required, please communicate directly with plant management.

Yours very truly,

FOR L J Wachter
Vice President-Power Production
and System Operation

cc: US NRC
Office of Inspection and Enforcement
Division of Reactor Operations Inspection
Washington, D. C. 20555

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Attachment 1

Base Plate Safety Evaluation

HANGER NO.	SYSTEM	EVALUATION
SR129	Primary Containment Atmosphere Control	Original analysis performed was a static. Reanalyzed using response spectra without this restraint. Piping meets code allowables.
SR28A SR28B	Core Spray	Not included as seismic restraints. The failure of these restraints do not affect the seismic analysis and piping code allowables are not for seismic loads.
TWH98	RHR Pump Discharge	Gravity support. No effect on seismic. Does increase the weight stress but piping is within code allowable.
TW9	Torus Water	Same as TWH98
SWH48	RHR Service Water	Same as TWH98
SWH49	RHR Service Water	Same as TWH98
TWH168	RHR Pump Discharge	Original loads were based on a conservative estimate. These loads were revised to more accurately reflect the as designed conditions from pipe stress analysis. With this revision the factor of safety is greater than 2.