VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

W. L. STEWART
VICE PRESIDENT
NUCLEAR OPERATIONS

December 6, 1983

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
Attn: Mr. James R. Miller, Chief
Operating Reactors Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Serial No. 682A
PSE&C/HSM/jdm:0012N
Docket Nos. 50-338
50-339
License Nos. NPF-4
NPF-7

Gentlemen:

ADDITIONAL INFORMATION
PROPOSED OPERATING LICENSE AMENDMENT NPF-4 AND NPF-7
NORTH ANNA POWER STATION UNIT NOS. 1 AND 2

In your letter dated November 10, 1983, you requested additional information on the proposed spent fuel capacity expansion at North Anna Unit Nos. 1 and 2. The answers to these requests are attached. Referring to our letter dated September 13, 1983, Serial No. 456 (numbers of questions are as noted in that letter as are attached references).

If you require further information on this matter, we would be pleased to meet with your staff at their convenience.

Very truly yours,

W. L. Stewart

W. L. Stewart

Enclosure

cc: Mr. James P. O'Reilly
Regional Administrator
Region II
U.S. Nuclear Regulatory Commission
Atlanta, Georgia 30303

Mr. M. B. Shymlock
NRC Resident Inspector
North Anna Power Station

A001
1/1

1a. Question A.2: a.

Answer is not complete. Are all rack materials procured, fabricated, welded and inspected in accordance with the ASME B&PV code. If not, provide a complete explanation.

Answer:

All stainless steel material was procured to ASME material standards, or the ASTM equivalent. In addition, fabrication practices, welding and weld inspection were performed to the appropriate ASME codes as specified in VEPCO specification NP-51.

1b. Question A.2: a.

Provide a tabulation of specifications, ultimate stresses, yield stresses and allowable stresses for all materials used in the fabrication of the racks.

Answer:

Attachment 1 (see attached) lists the minimum yield and ultimate stresses for the various materials used in the fabrication of the North Anna racks. The allowable values for various load combinations are listed in table 8.2 of Reference 1.

1c. Question A.2: b.

Referring to sheets 31 through 34 of NES Report 81A0876; how was the fact that the corners of some cells are not welded to the rest of the racks accounted for in the construction of the finite element model of the rack. Refer also to Detail G on NES drawing 80E6267, Revision 5. Provide a complete discussion.

Answer:

In the modeling of the rack, no credit is taken for the cell walls which are not connected to the adjacent cells. Therefore, these walls are not included in the ANSYS model described on sheets 31 through 34 of Reference 1.

The contribution of these walls to the total moment of inertia of the rack is very small compared to the walls which are welded together to form continuous panels. Moreover, such modeling is conservative since it results in a lower fundamental frequency. Note that the fundamental frequency of the rack is well beyond the peak of the design response spectra, and a lower estimate of frequency results in higher seismic forces.

1d. Question A.2: b. and A.2: d.

Sections 7.1.1 and 5.2 of NES Report 81A0876 do not provide a clear explanation of the design procedure. It is unclear how the dynamic analyses and static analysis were used in the design of the racks. What is required is a step-by-step explanation, along with an explanation of all assumptions of the design procedure including the purpose of the non-linear dynamic analysis, linear dynamic analysis and static analysis.

Answer:

The design procedure is as follows:

(i) A detailed static analysis model is prepared, from which essential characteristics are extracted for use in the dynamic analysis models described below.

(ii) A dynamically equivalent response spectrum analysis model (linear) is established based on the data generated in step (i). Seismic analysis is then performed using response spectrum analysis methods.

The corresponding inertia forces at each mass point are statically applied to the detailed model created in step (i) and the stress analysis is performed for various load combinations.

(iii) To establish the sliding distance for the rack, a separate, non-linear dynamic analysis model is prepared. A time history analysis is performed to establish the sliding of the racks under various conditions of friction.

(iv) Tipping and subsequent fall back loads are computed using energy-balance principles. The maximum energy imparted to the rack is established by the analysis in step (ii). The validity of the results in step (ii) are verified by comparing the maximum base shear and base moment resulting from the two separate approaches (steps (ii) and (iii)).

1e. Question A.2: e.

Table 8.2 of NES Report 81A0876 does not provide the required information; stresses in welds and for connection plates between the rack cells are not listed. Also, allowable stresses for the "Rack Leg" in bending are noted to be higher than yield strength for 304 Stainless steel (see also sheet 20 of NES report 81A0276). In addition, referring again to Detail G of NES drawing 80E6267, Revision 5, and relative motion of the rack components will subject the roots of the fillet welds, which attach pieces 16 and 17 to the rack cells, to bending tension. This is not good practice. How was this accounted for? Provide a complete explanation and justification.

Answer:

Attachment 2 contains the induced stresses in various parts of the rack.

The stresses listed for "Rack-Leg" in Reference 1 occur in the adjustable jack-screw assembly in the rack feet. The material used for this component is 17-4 ph stainless steel which has higher allowable stresses (as indicated in Table 8.2 of Reference 1).

Visualization of the relative motions of rack components can be seen more clearly from section A-A of NES drawing 80E6267. In the overall sense, pieces 16 and 17 shown in Detail G, along with the appropriate walls of connected cells, combine to form continuous panels in both orthogonal directions. These panels intersect with one another at the junctions of pieces 16 and 17. Referring to section A-A, it can be seen that the bending stress in the root of the fillet welds joining pieces 16 and 17 is limited by the relative motion of two adjacent and parallel panels. Because of the "egg-crate" nature of the honeycomb design, this relative motion is negligible. The significant stresses in the welds result from shear forces.

1f. Question A.2: g.

The information requested is not provided in the sections of NES Report 81A0876 referred to by the licensee. The licensee is requested to provide a complete discussion of the design criteria (including reference to pertinent design specification sections) used for determining allowable buckling stresses in the rack components. Load data, acceptance criteria, and a tabulation of actual vs. allowable stresses are to be included.

Answer:

For the buckling and shear analysis of cells, the design was performed as per the requirements of ASME Boiler and Pressure Vessel Code, Appendix XVII, Section 2200. This is in accordance with the requirements of ASME Code Section NF 3230, Design of Linear Type Component Supports by Analysis, and 0800 SRP 3.8.4 Appendix D.

For buckling considerations, ASME Appendix XVII, Section 2220 was used to determine the effective width, and corresponding stresses. Compliance with the AISI Stainless Steel Cold Formed Structural Design Manual was also established. NES believes that this latter approach, although more conservative, is appropriate for the design of thin gauge stainless steel structures. Table 8.2 of Reference 1 contains a summary of actual vs. allowable stresses.

2. Question:

Referring to NES Report 81A0877; how does the non-linear model account for tipping of the racks. Provide a discussion.

Answer:

The non-linear analysis of the North Anna racks does not provide the tipping of the racks directly. Tipping analysis is performed using energy balance principles based on the results of the linear dynamic analysis. However, the results of the non-linear analysis are used to cross-check the validity of the response spectrum analysis results, as described in the response to item 4 above.

Subsequent to the analysis of the North Anna racks, NES has performed more detailed, three-dimensional analyses of various other racks. A comparison of the results obtained from these more refined analyses with those obtained from the North Anna racks indicates that the approach used for North Anna is conservative.

It should also be noted that the NES approach used for establishing the maximum responses is very conservative. The maximum horizontal sliding and the maximum tipping of the racks are all assumed to occur simultaneously. In view of the above, NES believes that the approach used for the tipping analysis of the North Anna racks is conservative.

3. Question:

Referring to NES Report 81A0876; how does the finite element model account for torsional forces due to twisting of the racks about a vertical axis. Provide a discussion.

Answer:

It has been NES' experience that a fully loaded rack results in greater stresses than a partially loaded rack. The torsional stresses that would occur in a partially loaded rack are bound by the flexural and shear stresses corresponding to a fully loaded rack. For this reason, analysis of a partially loaded rack was not required.

4. Question:

What partial loading conditions, if any, of fuel in the racks have been considered in order to determine worst case loading conditions for sliding and tipping? How were these conditions determined to be "worst case"? Provide discussion.

Answer:

When using the two-dimensional model approach to determine seismic rack displacements, NES employs a rather conservative methodology which serves to bound the displacements determined by other methods. In the case of the North Anna racks, it was assumed that two adjacent racks will simultaneously move toward one another; both experiencing maximum sliding and tilting. The resulting minimum required gap between racks to prevent contact is less than one inch (minimum gap = 2 x (max. sliding + max. tilting)). NES is providing a gap between installed racks (2 3/8 inches at top of rack) which is more than twice that required by analysis, thereby introducing additional conservatism.

ATTACHMENT 1

Material	Ult. Stress (ksi)	Yield Stress (ksi)
304 ss (ASTM-A240)	75	30
17-4 ph sst (ASTM-A564, gr. 630)	135	105

ATTACHMENT 2

Results of Worst Case Weld Stresses in the Rack

	Weld Stress (Ksi)		Allowable Stress (Ksi)	
	Level A	Level D	Level A	Level D
Weld Location	Service Limits	Service Limits	Service Limits	Service Limits
Cell Weld	11.19	14.41	18.0	28.8
Rack Base Plate	10.47	13.48	18.0	28.8
Rack Leg	11.70	21.31	18.0	28.8