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VASSALLO,D.B. Operating Reactors Branch 2

SUBJECT: Forwards analysis of reactor bldg wall crack,supplementing 801215 evaluation.Reactor bldg structural integrity maintained for all postulated design basis events.

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NIAGARA MOHAWK

NIAGARA MOHAWK POWER CORPORATION/300 ERIE BOULEVARD WEST, SYRACUSE, N.Y. 13202/TELEPHONE (315) 474-1511

March 25, 1983

Director of Nuclear Reactor Regulation
Attn: Mr. Domenic B. Vassallo, Chief
Operating Reactors Branch No. 2
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Nine Mile Point Unit 1
Docket No. 50-220
DPR-63

Dear Mr. Vassallo:

Our letter of December 15, 1980 provided an evaluation of the Reactor Building wall crack at Nine Mile Point Unit 1. Subsequent monitoring indicates there has been a slight increase in the size of the crack. As requested by members of your staff, find attached an additional analysis of the Reactor Building wall crack. The analysis provides sufficient justification for continued operation.

As indicated in the attached analysis, Reactor Building structural integrity and therefore Secondary Containment integrity is maintained for all postulated design basis events. However, during certain seismic events, Final Safety Analysis Report allowable stresses are exceeded as shown by our current analysis. Although these allowable stresses are exceeded, the following regulatory criteria are met:

- 10CFR50 Appendix A, Criterion 2 as it relates to the requirements that structures...shall be designed to withstand the effects of earthquakes without loss of capability to perform safety functions.

- 10CFR100, Appendix A, as it relates to certain structures...being designed to withstand the Safe Shutdown Earthquake (SSE) and remain functional.

- Regulatory Guide 1.29, Paragraph C-1 as it relates to certain structures...should be designed to withstand the effects of the SSE and remain functional.

Therefore, since the Reactor Building is shown to remain functional, (i.e. structural integrity and therefore Secondary Containment integrity) modifications at this time are not required.

A001

However, to provide additional assurance of Reactor Building integrity, a strut will be installed during the current reactor recirculation system piping replacement outage. The strut will be designed to accommodate operating loads of the Reactor Building wall. A base plate, designed to crush under seismic related deflections and allow deformation to take place, will ensure support of operating loads thereafter. The structural integrity of the Reactor Building will remain intact as discussed in the analysis and illustrated in Figure 2.

Although the attached analysis indicates that Reactor Building wall integrity is maintained, we believe the analysis methods contain overly conservative assumptions. We are implementing a program to demonstrate these conservatisms exist. Our program entails completion of an on-going Electric Power Research Institute sponsored research project on non-linear soil structure interaction of the reactor building. The project involves modeling the interaction of the Reactor Building and surrounding annulus material. This project is scheduled to be completed during the summer of 1983. The resulting analysis and modeling is expected to be completed by March 1984. Also, further studies and evaluations of the thermal movements of the Screenhouse wall will be conducted. The outcome of these efforts is expected to demonstrate the conservative nature of our current analysis.

Very truly yours,

CVMangan

C. V. Mangan
Vice President
Nuclear Engineering & Licensing

CVM/RJP:bd

ANALYSIS OF REACTOR BUILDING WALL

The Reactor Building Wall was analyzed by the Finite Element Method utilizing a Structural Analysis Program (SAP) for static and dynamic responses of linear systems computer model. The model was composed of eight noded three dimensional elements.

I. Load Cases

The three (3) load cases described below were applied to the Finite Element Model (FEM) and the corresponding stresses were calculated.

A. Case 1: Load Imposed by Screenhouse Wall

A load of 585 kips was imposed on the Finite Element Model at the nodes corresponding to the Screenhouse Wall - Reactor Building Wall contact area. This load was derived by summing the loads due to a 20°F temperature rise in the Screenhouse Wall and the counteracting frictional forces at the soil/rock - Screenhouse Wall interfaces. This load is considered to be conservative since the screenhouse wall is in contact with the ground and groundwater which would tend to reduce the assumed 20°F temperature rise of the wall.

Case 2: Load Imposed By Active Earth Pressure

A load due to active earth pressure was applied to the surface of the Finite Element Model representing the north face of the Reactor Building Wall.

Case 3: Seismic Related Deflections

A relative deflection of 0.034" was introduced to the Finite Element Model at the nodes corresponding to the contact area of the Screenhouse and Reactor Building walls. This deflection was extracted from the original seismic analysis of the buildings and is considered conservative for the following reasons:

a) In the original analyses, the reactor building was modeled as a free standing structure. The model did not reflect the restraining effects contributed by the back-filled annulus around the lower one-third of the Reactor Building. It is anticipated that the annulus will lower seismic induced displacements and the damping ratios of the building (See Figure 1).

b) The Finite Element Model perimeter was constrained against rotation resulting in a stiffer than actual wall structure, thus increasing calculated stresses. In reality, some rotation around the perimeter does take place.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

c) The deflection of 0.034" at the contact area is the absolute sum of the maximum deflections of the Screenhouse Wall and the Reactor Building Wall at the appropriate elevation. This implies that the improbable situation of the maximum deflection of both buildings occurs at the same time and in opposite directions (See Figure 3).

B. Method of Stress Calculation

The stress output from the Finite Element Model was resolved into equivalent forces. Utilizing these forces, bending moments were calculated about the center of the Reactor Building Wall at the contact area. The cracked section properties of the wall were determined. Using the bending moments derived from the analysis, the stresses in the concrete, compression reinforcing steel (rebar), and the tension rebar were calculated based on Working Stress analysis methods.

C. Results of Stress Calculations

Under the constant loading conditions (operating loads) of active earth pressure and thermally induced load from the Screenhouse Wall, the concrete and compression rebar stresses are below allowables and the tensile rebar stress is within 5.5% of the Working Stress allowables. Section 1 of the Second Supplement Final Safety Analysis Report include allowable stresses for Class I structures. Allowable working stress for concrete is 45% of ultimate compressive strength. For steel, the allowable working stress is 50% of yield strength.

Superimposing the operating loads with the seismic related deflection, the concrete and compression rebar stresses are within 4.0% of the working stress allowables. The tensile rebar stress is over the yield stress.

II. Structural Integrity of the Reactor Building Wall

A. Punching Shear

The Working Stress capacity of the Reactor Building Wall at the contact area is 2,300 kips. The load applied over this area due to the three load cases was calculated to be less than 2,300 kips. The possibility of punching shear failure is remote.

B. Bending

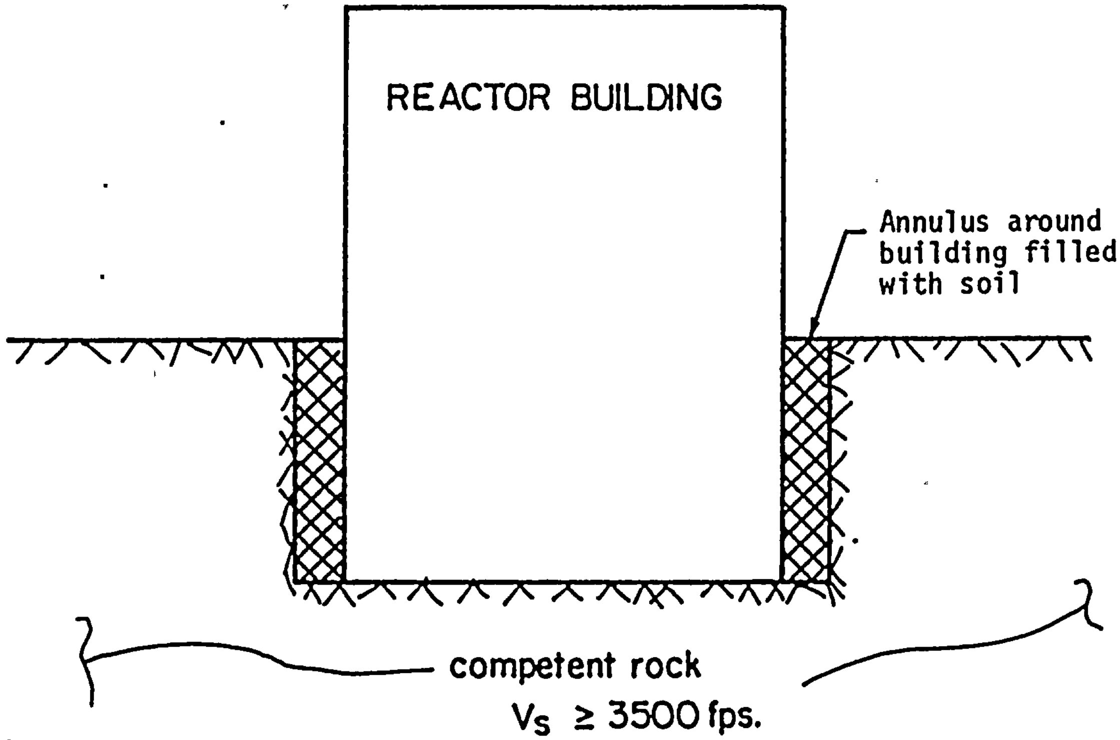
Application of all three load cases simultaneously stresses the tensile rebar above the yield stress. The wall would develop a very localized plastic hinge at the contact area. This localized effect does not constitute a structural failure.

III. Maintenance of the Boundary Between the Reactor Building Interior and the Environment

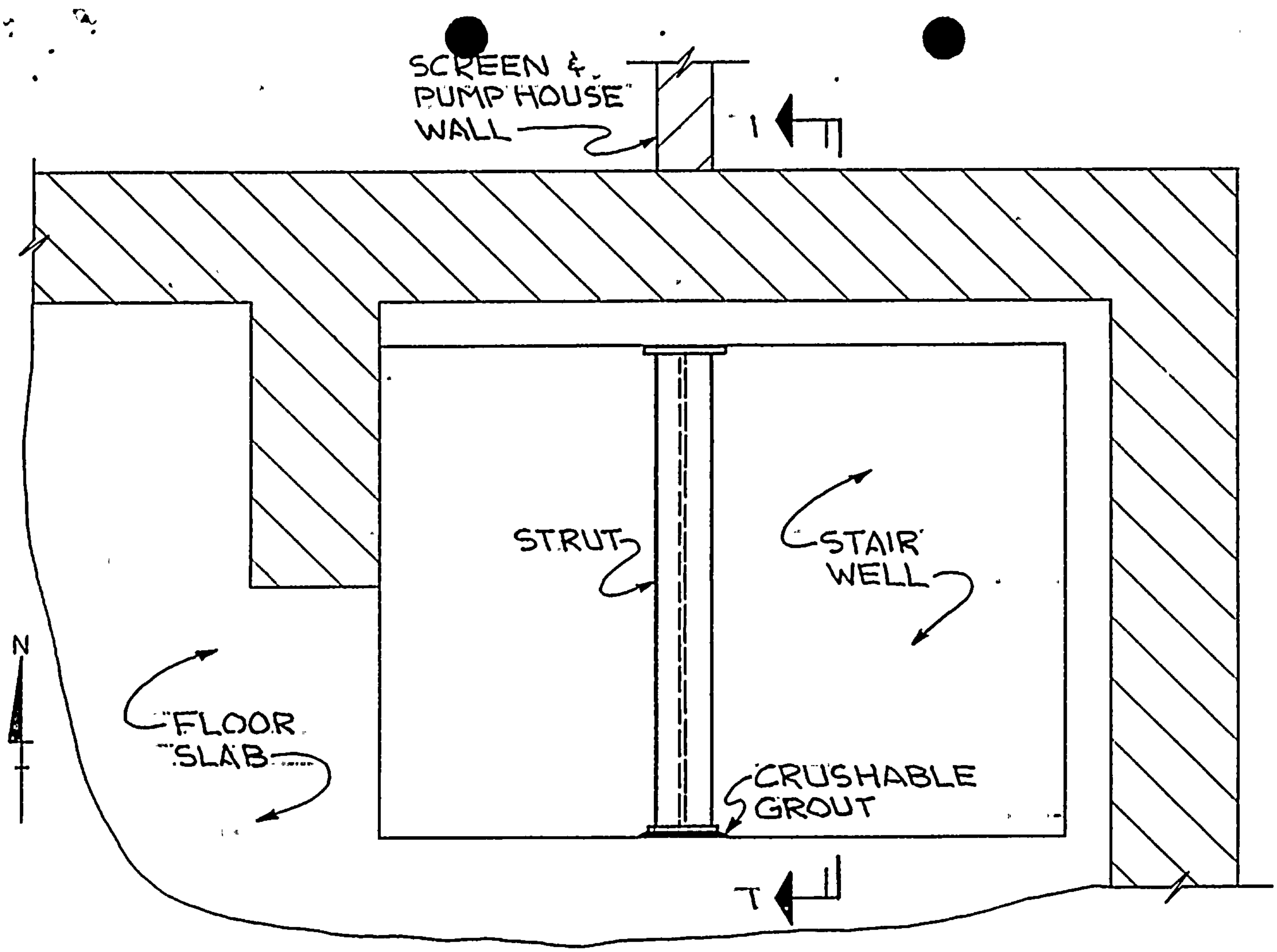
Regardless of whether the tension rebar is in an elastic state or plastic state, when there is bending in the wall, a tensile force is produced in the tension rebar. This must be balanced by a compression force in the concrete. A compressed area within the wall creates the compression force. It is this area that constitutes the boundary of the building interior from the environment. This compression block is calculated to be a minimum of 3.6 inches deep by ultimate strength analysis (See Figure 4).

IV. Proposed Modification to Enhance Reactor Building Integrity

Although the analysis shows the Reactor Building remaining functional, a compression strut supporting the Reactor Building Wall at the location of the crack will be installed to support the operating loads. It will include a base plate designed to crush under seismic related deflections. This will allow plastic action to take place during a seismic event and assure support of operating loads afterwards.



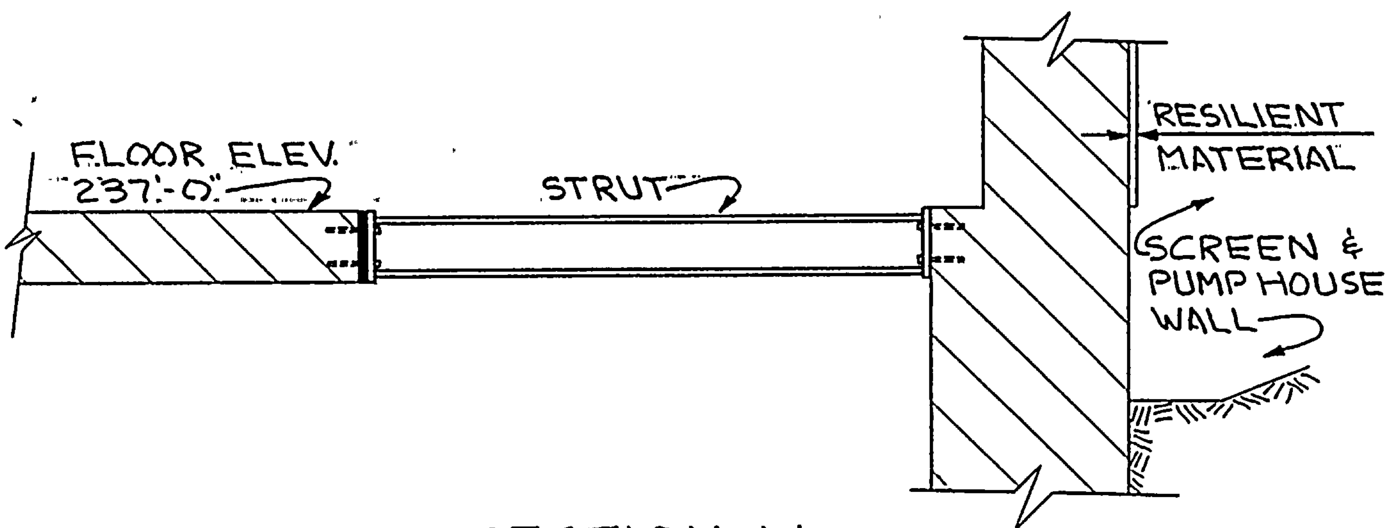
Typical Problem
FIGURE 1



PLAN

ABOVE ELEV. 237'-0"

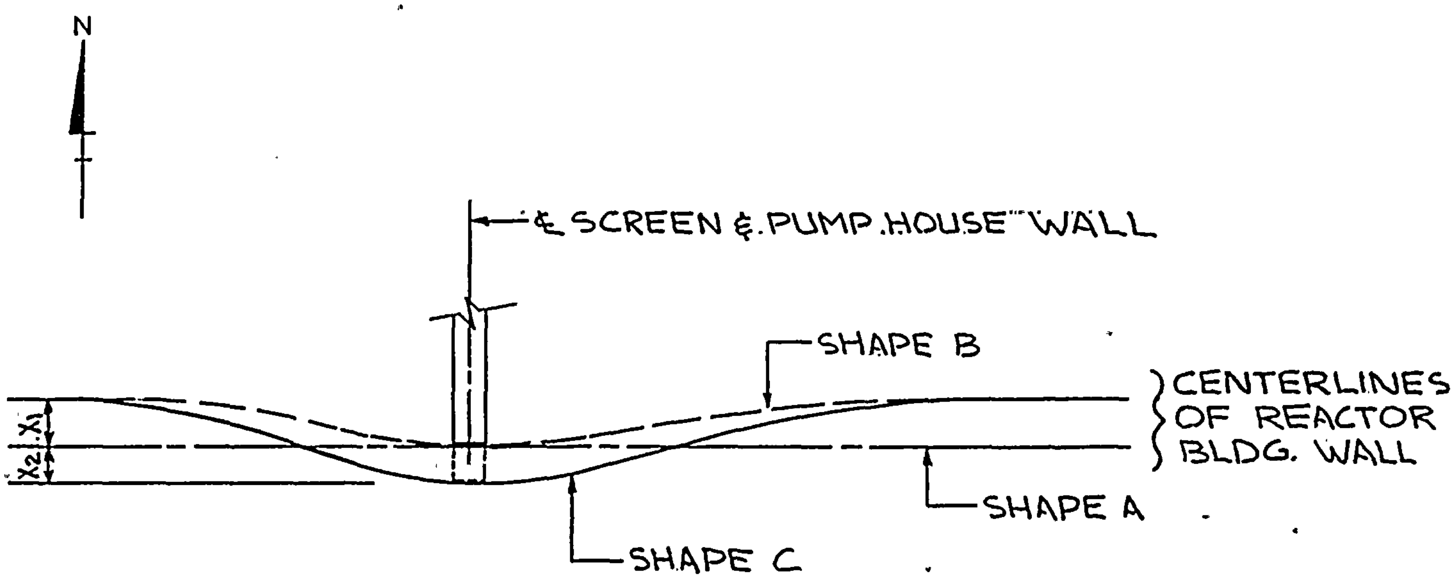
SCALE: 1/4"=1'-0"



SECTION 1-1

SCALE: 1/4"=1'-0"

FIGURE 2



PLAN VIEW

X_1 = 0.019" = NORTHERLY SEISMIC DEFLECTION OF REACTOR BUILDING AT ELEVATION 237'-0"

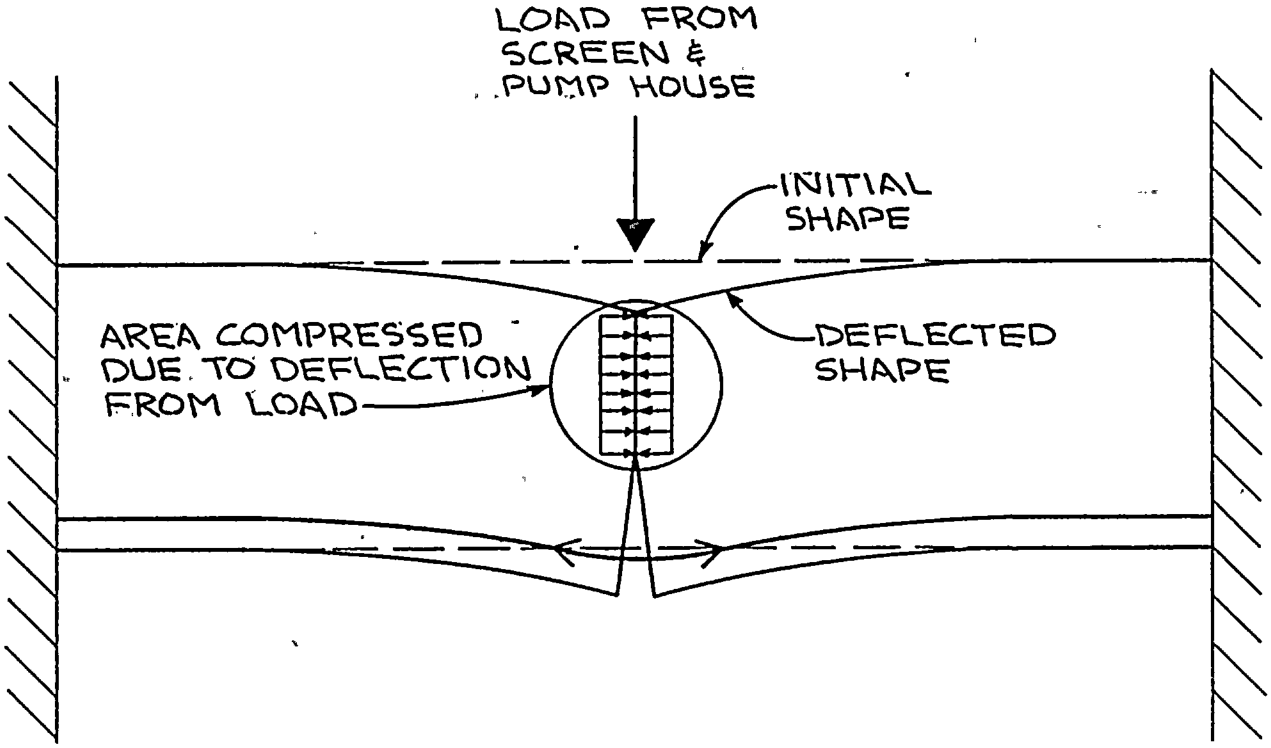
X_2 = 0.015" = SOUTHERLY SEISMIC DEFLECTION OF SCREEN & PUMP HOUSE WALL AT ELEVATION 237'-0"

SHAPE A = INITIAL POSITION OF REACTOR BUILDING WALL.

SHAPE B = REACTOR BUILDING WALL CONFIGURATION WITH NORTHERLY SEISMIC DEFLECTION OF X_1 AT BOUNDARIES AND ZERO DEFLECTION NEAR CENTER DUE TO RESTRAINING BY SCREEN & PUMP HOUSE WALL.

SHAPE C = REACTOR BUILDING WALL CONFIGURATION WITH NORTHERLY SEISMIC DEFLECTION OF X_1 AT BOUNDARIES AND SOUTHERLY DEFLECTION OF X_2 NEAR CENTER DUE TO SOUTHERLY SEISMIC DEFLECTION OF SCREEN & PUMP HOUSE WALL. THIS WAS THE SHAPE ANALYZED.

FIGURE 3



EXAGGERATED DEFLECTED SHAPE
OF REACTOR BUILDING WALL
SHOWING CONCRETE/REINFORCING
STRESS CONFIGARATIONS

FIGURE 4