Consumers Power

POWERING MICHIGAN'S PROGRESS

Big Rock Point Nuclear Plant, 10269 US-31 North, Charlevoix, MI 49720

William L Beckman
Plant Manager

February 3, 1993

Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

DOCKET 50-155 - LICENSE DPR-6 - BIG ROCK POINT PLANT -
SYSTEMATIC EVALUATION PROGRAM TOPIC III-6, SEISMIC DESIGN CONSIDERATIONS

The Systematic Evaluation Program was initiated in February 1977 by the US Nuclear Regulatory Commission (USNRC) to review the designs of older operating nuclear reactor plants to reconfirm and document their safety. In NUREG-0828 dated May 1984, the USNRC issued the Integrated Plant Safety Assessment - Systematic Evaluation Program - Big Rock Point Plant, Final Report.

In regards to SEP Topic III-6, Seismic Design Considerations, the Staff concluded that the approach by the Licensee (i.e., to selectively upgrade the "weak links" in the systems and structures necessary to mitigate accidents that would be expected to result from seismic events) was reasonable and, if properly executed, would provide sufficient seismic resistance so that the health and safety of the public could be ensured. The Staff required that the Licensee's evaluation address the issues raised regarding the analysis methods in the topic evaluation and the potential for failure of masonry walls wherever they apply. The Staff would continue to review the Licensee's implementation of this approach and will describe the results in a supplement to this final report.

To assist the Staff in their review, a request for additional information has been made by the Office of Nuclear Reactor Regulation (NRR) Big Rock Point Project Manager. This information has been attached to this letter.

William L Beckman
Plant Manager

CC: Administrator, Region III, USNRC
NRC Resident Inspector - Big Rock Point

080072

ATTACHMENT

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PDR ADOCK 05000155
P PDR

AE01

To GCWithrow

From TSikavitsas

Date April 10, 1991

Subject CLOSEOUT OF PROJECT NO. 847
BIG ROCK POINT PLANT

CC REBarnhart
DEMoeggenberg
CMMoeggenberg
PRC Chairman
TRG Chairman
DCC: 740*22*45*04
740*50*99*01

CONSUMERS
POWER
COMPANY

Internal
Correspondence

TS 91-002

RECEIVED
APR 15 1991
DCC

Project Title: Emergency Condenser Shell and Support Evaluation

TRG Issue No.: BN-014A

Project Description:

The scope of Integrated Plan Issue BN-014A, Resolution of Seismic Weak Links, was to perform an evaluation to determine the seismic capacity of the emergency condenser shell and supports to comply with a seismic criteria/demand at the established Safe Shutdown Earthquake-SSE. The response spectra used for this SSE evaluation is the "site specific" spectra as described in the conclusion statement of the Updated FHSR, Section 2.5.2.1..

* The emergency condenser shell support failure causes the failure of the emergency condenser. This failure not only causes loss of primary heat removal source during a loss of station power, but it also could cause a loss of the RDS valves, and the loss of the fire water supply to the core spray system either through fire water make-up line to the EC, rupture or the EC shell falling off the ECS level and rupturing the surrounding enclosure spray and the core spray piping.

Project Status:

By upgrading the identified weak link to a level greater than the SSE, core damage can further be reduced. The proposed upgrade for the Emergency Condenser was submitted to a consultant for a seismic capacity analysis and a modification necessity determination.

The analysis has been completed by the consultant (ABB Impell) and has been independently reviewed in detail by CPCO ESS Engineering (IOM RBJ 27-91) for support of documented results.

The emergency condenser has been evaluated in a manner consistent with other systems and equipment at the Big Rock Point Plant. The analysis concludes that the shell meets code allowable stresses (i.e., ASME B&PV CODE NB-3200) for the faulted condition and that the supports remain elastic.

The recent analyses submitted by the consultants have essentially upgraded the emergency condenser for seismic capacity and have indicated that no modifications are required. Therefore, the evaluation of the emergency condenser is considered complete.

Alsc since no modifications are required to be performed on the emergency condenser, reserved Facility Change Number-FC-661 should be cancelled or reassigned to a different project.

Please concur with project closeout:

Approved GeHathnau Date 4/10/91

Return to CMMoeggenberg

0000 8668 0458

IC0491-0054A-BT01

To	GCWithrow	
From	TSikavitsas	CONSUMERS POWER COMPANY
Date	April 10, 1991	
Subject	CLOSEOUT OF PROJECT NO. 847 BIG ROCK POINT PLANT	Internal Correspondence
CC	REBarnhart DEMoeggenberg CMMoeggenberg PRC Chairman TRG Chairman DCC: 740*22*45*04 740*50*99*01	TS 91-002

Project Title: Emergency Condenser Shell and Support Evaluation

TRG Issue No.: BN-014A

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The emergency condenser has been evaluated in a manner consistent with other systems and equipment at the Big Rock Point Plant. The analysis concludes that the shell meets code allowable stresses (i.e., ASME B&PV CODE NB-3200) for the faulted condition and that the supports remain elastic.

The recent analyses submitted by the consultants have essentially upgraded the emergency condenser for seismic capacity and have indicated that no modifications are required. Therefore, the evaluation of the emergency condenser is considered complete.

Also, since no modifications are required to be performed on the emergency condenser, reserved Facility Change Number-FC-661 should be cancelled or reassigned to a different project.

Please concur with project closeout:

Approved GeWatthrau Date 4/10/91

Return to CMMoeggenberg

To TSikavitsas, Big Rock Point

From RBJenkins, P-13-223A

Date April 2, 1991

Subject BIG ROCK POINT
EMERGENCY CONDENSER ANALYSIS

CC

RBJ 27-91

CONSUMERS
POWER
COMPANY

Internal
Correspondence

Ref. 1 Letter from Robert D Campbell (SMA) to R B Jenkins (CPCo), transmittal of SMA Calculation No. 13703.01, "Big Rock Emergency Condenser Tank" dated December 4, 1981.

Ref. 2 Letter from Donald A Wesley (ABB Impell) to R B Jenkins (CPCo), dated October 11, 1990.

Ref. 3 Letter from David K Nakaki (ABB Impell) to R B Jenkins (CPCo), "Big Rock Point Emergency Condenser", dated November 21, 1990.

Ref. 4 Letter from David K Nakaki (ABB Impell) to R B Jenkins (CPCo), Transmittal of Big Rock Point Emergency Condenser Calculation, dated November 28, 1990.

Ref. 5 D'Appolonia Consulting Engineers, "Seismic Safety Margin Evaluation, Reactor Building Primary Coolant Loop, Big Rock Point Nuclear Power Plant", Rev. 1, prepared for Consumers Power Company, August, 1981.

Ref. 6 D'Appolonia Consulting Engineers, "Derivation of Site-Specific Seismic Floor Response Spectra, Seismic Safety Margin Evaluation, Big Rock Point Nuclear Power Plant", prepared for Consumers Power Company August, 1983.

Ref. 7 "Nuclear Reactors and Earthquakes", TID-7024, prepared by Lockheed Aircraft Corp and Holmes & Narver, 1963.

Ref. 8 Wichman, K R, ET AL, "Local Stresses in Spherical and Cylindrical Shells Due to External Loadings", Welding Research Council Bulletin 107, March, 1979.

Ref. 1 is the original analysis for the Big Rock Point emergency condenser tank. That analysis used the analysis guidelines of Ref. 8 and the response spectra of Ref. 5 to conclude that modifications would be required on the built-in emergency condenser support.

Ref. 2 consisted of a proposal to take a more detailed look at the emergency condenser. That proposal contained a brief review of the Ref. 1 calculation and indicated where conservatism could be removed. Specifically, it was suggested in Ref. 2 that the newer "site specific" spectra from Ref. 6 could be employed to reduce the spectral load input. In addition, it was suggested that employing sloshing per Ref. 7 would take a significant body of emergency condenser fluid and relegate it to a very low frequency motion where the low

spectral ordinate would result in small shell and support loads with respect to the loads computed in Ref. 1.

Ref. 3 transmits the result of the analysis. Ref. 4 provides the calculation itself which supports the results documented in Ref. 3.

The calculation of Ref. 3 has been reviewed in detail with Impell. The relationship of Ref. 3 and Ref. 1 has been reviewed with Impell as well. Ref. 3 builds on Ref. 1. It is not complete of itself. Support loads based upon spectra results determined from Ref. 1 can be scaled as can shell stresses. The spectra change in going from Ref. 5 to Ref. 6 has the most significant impact in making the shell stresses and support loads acceptable. The sloshing (hydrodynamic effect) is a lesser influence.

The analysis concludes that the shell meets ASME Code-like NB-3200 allowable stresses for the faulted condition. The support is simply calculated to remain elastic. The idea of the support simply remaining elastic is not a very precise characterization of an allowable. However, it does do two things. First, an elastic support suggests that all of the elastically computed loads and stresses are reasonably accurate. Secondly, an elastic support implies that the bolt loads and concrete loads are not limiting. The bolt/pedestal arrangement is characterized in Dwg C-114. The bolts are like dowels from the pedestal into the steam drum enclosure. The arrangement has not been analyzed explicitly in the work that has been done by SMA (Ref. 1) or Impell (Ref. 4). It is understood that an elastic support implies adequate anchorage by inspection. This would appear to be a reasonable conclusion.

The emergency condenser has now been evaluated in a manner consistent with other systems and equipment. The recent analyses have essentially upgraded the condenser. The analyses have been reviewed and are considered adequate. The conclusions imply that no modifications are required.

To	TSikavitsas, Big Rock Point	RBJ 93-90
From	RBJenkins, P-13-223A	CONSUMERS POWER COMPANY
Date	November 30, 1990	
Subject	BIG ROCK POINT EMERGENCY CONDENSER EVALUATION	Internal Correspondence
CC		

RBJenkins

Attached please find three records of correspondence from ABB Impell with regard to the analysis recently conducted on the condenser. These records consist of the; proposal, summary of the calculations and the calculations themselves.

We have not reviewed the calculations in detail at this time. However, we do know how they were performed. We will review the details shortly.

We believe that most everything which was rated for seismic fragility at Big Rock was evaluated to the site specific spectra. Therefore, it is appropriate to evaluate the need for modification of any system or component at Big Rock based upon those spectra. Anything that meets any code design standard based upon those spectra should be judged as adequate and not in need of repair. Therefore, the condenser and support are not viewed as requiring modification.

ABB

ASEA BROWN BOVERI

ABB Impell Corporation

Dr. Rolfe B. Jenkins
Senior Staff Engineer
Consumers Power Company
212 West Michigan Avenue
Jackson, Michigan 49201

October 11, 1990

Dear Rolfe:

In accordance with your request, I have conducted a very brief review of the NTS seismic analysis of the Big Rock Point emergency condenser. There appear to be several sources of conservatism in the existing analysis.

First, the computed elastic frequency in the axial (E-W) direction is a little too high since the shear deformation in the support saddle was neglected. Any recalculation in response frequency will reduce the seismic load since the elastic frequency is on the low frequency side of the floor response spectrum peak.

Second, no reduction in frequency, and hence in the response loads was included to account for the inelastic effects such as sliding of the support within the anchor plate bolt hole clearances, yielding in the support, etc.

Third, the response moment in the lateral direction is too high since the center of mass was assumed at the tank center line, while in the normal operating condition, the free surface of the water is only 15 inches above the centerline and the center of mass of the tube bundles is located 21 inches below the tank centerline. Both these effects will lower the moment arm of the lateral response load, and hence the support saddle stresses.

In order to evaluate the above effects and develop more realistic seismic loads, a simple inelastic response spectra analysis in the axial direction, using the spectral averaging approach is proposed. The response analysis will be based on SEP (NUREG/CR 0098) criteria, but the resulting seismic stresses can be compared with other criteria if desired. The cost of such and evaluation will not exceed $10,000.

If you have any questions or if I can provide any additional information, please do not hesitate to call.

Finally, use of the site specific floor response spectra (D' appolonia, August 1983) will further significantly reduce the seismic response loads.

Very truly yours,

Don

Donald A. Wesley
Staff Consultant
ABB Impell Corporation

ABB
ASEA BROWN BOVERI

November 21, 1990 0540-064-1359

Dr. Rolfe B. Jenkins
Consumers Power Company
1945 West Parnall Road
Jackson, Michigan 49201

Subject: Big Rock Point Emergency Condenser

Dear Rolfe:

The seismic evaluation of the Big Rock Point emergency condenser has been completed. The evaluation included some refinement in the previous analysis by accounting for the hydrodynamic effects of the water in the tank. The previous analysis by Structural Mechanics Associates, Inc. conservatively considered only the inertial effects of the water by treating it as a rigid mass.

The current evaluation included the convective (sloshing) and impulsive response of the fluid using Housner's method for liquid storage tanks subjected to horizontal ground acceleration. To evaluate the sloshing and impulsive responses, the emergency condenser was idealized as a rectangular tank. The dimensions of the equivalent rectangular tank were based on the dimensions of the free surface of the water and the equivalent depth of water was determined such that the total fluid volume was equal to that for the actual tank. The support conditions for the condenser are such that the vertical and transverse (NS) natural frequencies are greater than 33 Hz. Thus, for the hydrodynamic response in the transverse direction, the condenser was treated as a rigidly supported tank. However, in the longitudinal direction (EW), the condenser was treated as a flexibly supported, elevated tank due to the sliding support, shell flexibility, and the support flexibility.

The maximum base shear, overturning moment, and fluid pressure were evaluated for both the transverse and longitudinal hydrodynamic responses for the most recent site-specific SSE floor spectra developed by D'Appolonia (**Derivation of Site-Specific Seismic Floor Response Spectra, Seismic Safety Margin Evaluation, Big Rock Point Nuclear Power Plant**, Project No. 78-435, prepared for Consumers Power Company, August, 1983). The sloshing and impulsive responses were combined by the SRSS method. The vertical response was evaluated by treating the fluid as a rigid inertial mass.

ABB Impell Corporation

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A stress evaluation was performed to calculate the shell membrane stresses resulting from the combined normal and seismic loading. The critical location for the shell stresses is at the horn of the saddle of the fixed support. In addition, the stress in the saddle support gusset plate was also evaluated. These two locations were evaluated because they were found to be the most critical in the previous analysis. The results of the analysis showed that the stresses in the tank shell and the saddle support were substantially reduced from the previous analysis. This occurred for two reasons. First, by including the hydrodynamic effects, the effective base shears and overturning moments were reduced. With part of the fluid mass responding in a sloshing mode, the net effective acceleration was reduced because the sloshing mode has a very low natural frequency where the spectral accelerations are lower than at the ZPA frequency. Second, the newer floor spectra typically show smaller spectral accelerations than the earlier SSE floor spectra developed by D'Appolonia (**Seismic Safety Margin Evaluation, Reactor Building Primary Coolant Loop, Big Rock Point Nuclear Power Plant**, D'Appolonia Project No. 78-4[illegible]5, Rev. 1, August, 1981) which were used in the previous analysis.

The final results show that, with the most recent floor spectra and by including the hydrodynamic effects, both the tank shell and the saddle support remain elastic and meet the allowable stress limits. Table 1 shows the resulting stress components for the tank shell using the newer 1983 spectra and including the hydrodynamic effects. The maximum stress intensity based on the membrane stresses resulted in a margin of safety of 0.56, i.e., the maximum stress intensity was found to be 56% below the allowable in which the allowable stress was taken as 2.4S, where S = 16,300 psi. For the saddle support, the margin of safety was found to be 0.35, in which the allowable stress for the support gusset plate was taken as 2.25S, with S = 16,300 psi. For comparison, Table 2 shows the resulting stress components for the tank shell using the older 1981 spectra and including the hydrodynamic effects. By accounting for the hydrodynamic effects, the tank shell meets the allowable stress criterion with loads based on the higher 1981 spectra. In addition, if the fluid is treated as a rigid inertial mass (i.e., neglecting the hydrodynamic effects) and using the newer 1983 spectra, the tank shell and the saddle support will still remain elastic and meet the allowable stress criteria.

If you should have any questions, please don't hesitate to contact either Don Wesley or myself.

Sincerely,

ABB IMPELL CORPORATION

David K Nakaki

David K. Nakaki
Lead Senior Engineer

cc: Don Wesley

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TABLE 1. SHELL STRESS COMBINATION AT THE SADDLE HORN (1983 SPECTRA) (INCL. HYDRODYNAMIC EFFECTS)

Loading	σ_x (psi)	σ_ϕ (psi)	$\tau_{x\phi}$ (psi)
Dead Load (beam bending)	-17	0	625
Hydrostatic Pressure	219	438	0
Local Membrane at Horn	0	-2367	0
Total Normal Stress	202	-1929	625
Vertical Seismic (beam bending)	-2	0	94
Vertical Seismic (pressure stress)	33	66	0
Vertical Seismic (local membrane at horn)	0	-355	0
Total Vertical Seismic	31	-289	94
Lateral Seismic (beam bending)	±4	0	±112
Lateral Seismic (pressure stress)	±40	±80	0
Lateral Seismic (local membrane at horn)	∓5264	∓2022	0
Total Lateral Seismic	∓5220	∓1942	±112
Long. Seismic (pressure stress)	±58	±116	0
Long. Seismic (local membrane at horn)	±6176	±13473	0
Long. Seismic (shear flow)	0	0	±2932
Total Long. Seismic	±6234	±13589	±2932
SRSS of Seismic	±8131	±13730	±2936
Normal + SSE	-7929	-15659	3561

Principal Stresses: S_1 = -17,049 psi, S_2 = -6,539 psi, S_3 = 0 psi

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TABLE 2. SHELL STRESS COMBINATION AT THE SADDLE HORN (1981 SPECTRA) (INCL. HYDRODYNAMIC EFFECTS)

Loading	σ_x (psi)	σ_ϕ (psi)	$\tau_{x\phi}$ (psi)
Dead Load (beam bending)	-17	0	625
Hydrostatic Pressure	219	438	0
Local Membrane at Horn	0	-2367	0
Total Normal Stress	202	-1929	625
Vertical Seismic (beam bending)	-3	0	125
Vertical Seismic (pressure stress)	44	88	0
Vertical Seismic (local membrane at horn)	0	-473	0
Total Vertical Seismic	41	-385	125
Lateral Seismic (beam bending)	±6	0	±180
Lateral Seismic (pressure stress)	±58	±116	0
Lateral Seismic (local membrane at horn)	∓8207	∓3153	0
Total Lateral Seismic	∓8143	∓3037	±180
Long. Seismic (pressure stress)	±110	±221	0
Long. Seismic (local membrane at horn)	±12060	±26388	0
Long. Seismic (shear flow)	0	0	±5743
Total Long. Seismic	±12170	±26609	±5743
SRSS of Seismic	±14643	±26785	±5747
Normal + SSE	-14441	-28714	6372

Principal Stresses: S_1 = -31,145 psi, S_2 = -12010 psi, S_3 = 0 psi

ABB
ASEA BROWN BOVERI

November 28, 1990

0540-064-1359

Dr. Rolfe B. Jenkins
Consumers Power Company
1945 West Parnall Road
Jackson, Michigan 49201

Subject: Transmittal of Big Rock Point Emergency Condenser Calculation

Dear Rolfe:

Per your request, enclosed is a copy of the calculation for the seismic evaluation of the Big Rock Point emergency condenser. This calculation is the basis for the letter report previously transmitted to you on November 21, 1990. If you should have any questions, please don't hesitate to contact either Don Wesley or myself.

Sincerely,

ABB IMPELL CORPORATION

David K Nakaki

David K. Nakaki
Lead Senior Engineer

cc: Don Wesley

ABB Impell Corporation

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