FirstEnergy

Davis-Besse Nuclear Power Station
5501 North State Route 2
Oak Harbor, Ohio 43449-9760

Guy G. Campbell
Vice President - Nuclear

419-321-8588
Fax: 419-321-8337

License Number NPF-3

Docket Number 50-346

Serial Number 2732

September 28, 2001

United States Nuclear Regulatory Commission
Document Control Desk
Washington, D. C. 20555-0001

Subject: Supplemental Information Regarding License Amendment Application to Increase Spent Fuel Storage Capacity
(License Amendment Request No. 98-0013; TAC No. MB0688)

Ladies and Gentlemen:

On December 2, 2000, the FirstEnergy Nuclear Operating Company (FENOC) submitted an application for an amendment to the Davis-Besse Nuclear Power Station (DBNPS), Unit Number 1, Operating License Number NPF-3, Appendix A Technical Specifications, regarding a proposed increase in spent fuel storage capacity. The proposed amendment (DBNPS Serial Number 2640) would allow an increase from the current capacity of 735 fuel assemblies, to a new capacity of 1624 fuel assemblies.

On August 20, 2001, FENOC informally received a request for additional information (RAI) regarding the license amendment application. Enclosure 1 provides the response to this RAI, as discussed with the NRC staff by telephone conference call on August 29, 2001. This supplemental information does not affect the conclusion of the license amendment application that the proposed changes do not involve a significant hazards consideration and do not have an adverse effect on nuclear safety.

In order to support the planned commencement of the Spent Fuel Pool re-rack modification in October 2001, FENOC requests that the NRC staff complete its review and approval of the license amendment application as expeditiously as possible.

A001

Should you have any questions or require additional information, please contact Mr. David H. Lockwood, Manager - Regulatory Affairs, at (419) 321-8450.

Very truly yours,

MKL

Enclosures

cc: J. E. Dyer, Regional Administrator, NRC Region III
S. P. Sands, NRC/NRR Project Manager
D. J. Shipley, Executive Director, Ohio Emergency Management Agency, State of Ohio (NRC Liaison)
K. S. Zellers, NRC Region III, DB-1 Senior Resident Inspector
Utility Radiological Safety Board

Docket Number 50-346
License Number NPF-3
Serial Number 2732
Enclosure 1

SUPPLEMENTAL INFORMATION

IN SUPPORT OF THE

APPLICATION FOR AMENDMENT

TO

FACILITY OPERATING LICENSE NPF-3

DAVIS-BESSE NUCLEAR POWER STATION

UNIT NUMBER 1

Attached is supplemental information for Davis-Besse Nuclear Power Station (DBNPS), Unit Number 1 Facility Operating License Number NPF-3, License Amendment Request Number 98-0013 (DBNPS Serial Number 2640, dated December 2, 2000).

This information, submitted under cover letter Serial Number 2732, includes a response to the August 20, 2001 informal NRC Request for Additional Information.

I, Guy G. Campbell, state that (1) I am Vice President - Nuclear of the FirstEnergy Nuclear Operating Company, (2) I am duly authorized to execute and file this certification on behalf of the Toledo Edison Company and The Cleveland Electric Illuminating Company, and (3) the statements set forth herein are true and correct to the best of my knowledge, information and belief.

By: ______________________________
Guy G. Campbell, Vice President - Nuclear

Affirmed and subscribed before me this 28th day of September, 2001.

____
Notary Public, State of Ohio - Nora L. Flood
My commission expires September 4, 2002.

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

REGARDING

LICENSE AMENDMENT REQUEST (LAR) 98-0013

FOR

DAVIS-BESSE NUCLEAR POWER STATION UNIT NUMBER 1

NRC Request for Information:

1. You indicated in Reference 1 [see page 4] that the calculated stresses in a fully loaded rack will not exceed that of Standard Review Plan (SRP) Section 3.8.4 which was used as a guide. With respect to your stress calculations using the DYNARACK computer code for the dynamic fluid-structure interaction analyses, the following information is requested:

   a) Indicate whether you had any numerical convergency and/or stability problem(s) during the nonlinear, dynamic single- and multi-rack analyses using the DYNARACK code. If there were any, how did you overcome the problem?

   b) Provide the results of any existing experimental study that verifies the simulation adequacy of the fluid coupling utilized in the numerical analyses for the fuel assemblies, racks and walls. If there is no such experimental study available, provide the technical justification on how the current level of the DYNARACK code verification is adequate for engineering applications and that it should be accepted without further experimental verification work.

   c) Provide the largest magnitude of the hydrodynamic pressure distribution along the height of the rack during the fluid and rack interaction for the 3-D multi-rack analysis.

   d) Provide the deformation shape and magnitudes of the deformations of the rack from the bottom to the top for the single-rack SSE analysis when the maximum displacement at the rack top corner occurs.

DBNPS Response:

a) No convergence problems were experienced during any of the DYNARACK simulations. Stability is ensured by selecting a sufficiently small time-step (interval between successive solutions). The initial time-step is chosen based on previous experience with the solver and is adjusted during the initial runs if the solutions are not obtained. The time-step used for all simulations on this project was 0.00005 seconds. This initially chosen time-step proved to be satisfactory for convergence and no further adjustment was necessary.

b) The current version of the Holtec proprietary software code DYNARACK uses the same algorithm solvers and fluid coupling formulations as the versions used to support previous re-racking projects submitted under numerous dockets since about 1988. The DYNARACK computer software validation manual (Holtec Report HI-91700) provides a detailed description of the experimental testing performed in 1987 by Dr. Burton Paul. This manual was provided in response to an NRC Request for Additional Information (RAI) to support the 1997 re-racking license amendment submittal for Waterford 3 (Docket 50-582). Detailed discussions about the experimental data that supports the DYNARACK fluid coupling solution method were provided in the Waterford 3 RAI responses. The Waterford 3 RAIs also requested comparison with experimental work performed by Scavuzzo, et al. Holtec determined that the solver used by Scavuzzo was substantially the same algorithm as that used in DYNARACK, and comparisons performed with DYNARACK found good correlation. These comparisons were documented in the DYNARACK computer software validation manual and were also submitted to the NRC under the Waterford 3 docket (see Entergy Operations, Inc. letter to the NRC, W3F1-98-0016, dated January 29, 1998).

c) The largest magnitudes of hydrodynamic pressure adjacent to any rack are 5.3 psi positive and 5.83 psi negative pressure. These values represent differential pressures that must be added to, or subtracted from, the hydrostatic pressure (about 11 psi) at the depth of the racks. A maximum hydrodynamic pressure plot is provided in Figure 6.11.1 of Holtec Design and Licensing Report HI-992329 (included as technical supporting documentation with DBNPS License Amendment Request 98-0013). This plot represents the maximum pressures along each of the four Spent Fuel Pool walls at the seismic simulation time-step when the maximum pressure value of 5.83 psi occurs.

d) Deformations along the vertical length of the racks are computed by the DYNARACK solver for the purpose of establishing whether the fuel assembly masses come into contact with the inside of the cell wall. The computation of the rack deformations and the comparison with the five fuel mass displacements is performed internal to the program and is not reported in any of the final output files. Therefore, the requested rack deformation values are not readily obtained. However, these deformations can be obtained through hand computations using the same solution equations as those used by the DYNARACK solver.

The rack deformations are computed using beam shape functions that are based on simple beam bending theory, resulting in the third order polynomials given in the attached Figure. The inputs required to compute the deformations along the rack are the displacements and rotations at each end of the rack. The computations are performed at heights along the rack corresponding with the nodes associated with the five fuel masses (i.e., at each end of the rack and at the quarter points).

The computations of the deformations at five points along the height of the rack that experience the highest displacement during any of the single rack simulations have been performed. The results are given below. The highest displacement of 0.4296" occurred at the time-step of 11.99 seconds of simulation 7, which models a fully loaded rack module "D" under SSE excitation considering a coefficient of friction of 0.8 between the pedestal base and the top of the bearing pad. This displacement occurred for degree-of-freedom (DOF) number 8, which is assigned as one of the two horizontal translational DOFs at the top of the rack model.

Rack deformations for the worst-case condition are as follows. The deformations are all computed at the same time instant for the same rack.

For the X direction, the deformations (in inches) from the bottom to the top are:

4.98E-04	3.97E-03	1.16E-02	1.92E-02	2.27E-02

For the Y direction, the deformations (in inches) from the bottom to the top are:

-1.05E-02	-7.60E-02	-2.20E-01	-3.63E-01	-4.29E-01

These deformations are computed as relative displacements from the initial node locations. As may be seen, the displacements along the rack are primarily represented by rigid body motion of the structure, and rack bending is minimal.

NRC Request for Information:

2. With respect to the calculations for determination of Spent Fuel Pool (SFP), Transfer Pit (TP) and Cask Pit (CP) capacities per SRP Section 3.8.4 and American Concrete Institute (ACI) 349, the following information is requested:

   a) Provide physical dimensions of the reinforced concrete SFP, TP and CP.

   b) You indicated in Reference 1 that the calculated stresses in SFP, TP and CP will not exceed that of SRP Section 3.8.4 and ACI 349 which were used as guides. With respect to your stress calculations, discuss whether there are any changes in the factors of safety of the SFP, TP and CP when they are compared to the stress calculations reported in References 2 and 3. If there are any changes, provide the calculated factors of safety of the SFP, TP and CP in a tabular form for the axial, shear, bending and combined stress conditions.

   c) What is the maximum bulk pool temperature at a full core off-load during a refueling outage? If the temperature exceeds 150 °F, provide technical justifications for exceeding a gross temperature of 150 °F in accordance with the guidance in the ACI Code 349 for normal operation or any other long term period.

Reference:

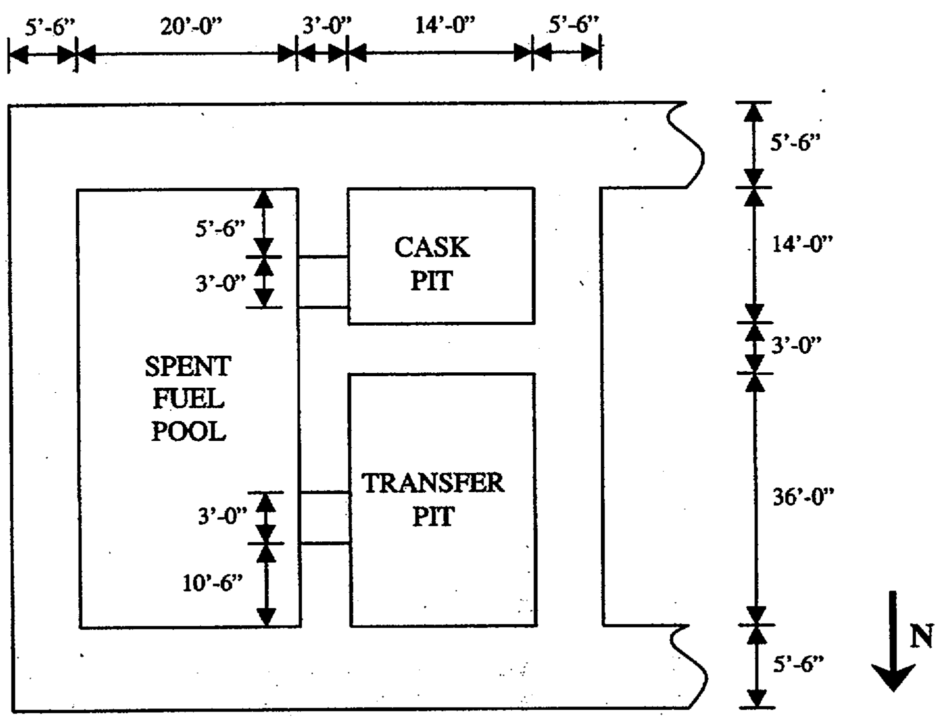
1. Letter, FirstEnergy Nuclear Operating Company to U. S. NRC, "License Amendment Application to Increase Spent Fuel Storage Capability (License Amendment Request No. 98-0013)," dated December 2, 2000.

2. Letter, FirstEnergy Nuclear Operating Company to U. S. NRC, "License Amendment Application to Allow Use of Expanded Spent Fuel Storage Capability (License Amendment Request No. 98-0007); TAC No. MA5477," dated May 21, 1999.

3. Davis-Besse Nuclear Power Station, Final Safety Analysis Report

DBNPS Response:

a) The nominal dimensions of the Spent Fuel Pool (SFP), Transfer Pit (TP), and Cask Pit (CP) are shown in Figures 8.2.1 through 8.2.5 of Holtec Design and Licensing Report HI-992329. A simplified plan sketch and a detailed description of the physical dimensions follows:



The SFP is 39'-6" deep, and measures 20'-0" x 53'-0" in plan. The operating deck is at elevation 603'-0" and the pool floor is at elevation 563'-6". The surrounding walls on three sides are 5'-6" thick. The fourth (western) wall separates the SFP from the TP and CP and is 3'-0" thick. The floor of the SFP is 5'-0" thick, with rooms located beneath that have walls that support the SFP floor.

The TP is 39'-6" deep, and measures 14'-0" x 36'-0" in plan. The TP floor is at elevation 563'-6". The north and west walls are 5'-6" thick. The south wall separates the TP from the CP and is 3'-0" thick. The east wall separates the TP from the SFP and is 3'-0" thick. The floor of the TP is 5'-0" thick, with a room located beneath it.

The CP is 46'-0" deep, and measures 14'0" x 14'-0" in plan. The CP floor is at elevation 557'-0". The north, east, south and west walls are 3'-0", 3'-0", 5'-6", 5'-6" thick, respectively. The CP floor consists of a 12'-0" thick reinforced concrete mass resting on the 3'-0" thick Auxiliary Building foundation mat.

There is a 3'-0" wide gate opening in the 3'-0" thick wall between the SFP and TP. The centerline of this gate is 12'-0" south of the SFP north wall. The gate extends from deck level (603'-0") down to the 578'-0" elevation.

There is also a 3'-0" wide gate opening in the 3'-0" thick wall between the SFP and CP. The centerline of this gate is 7'-0" north of the SFP south wall. The gate extends from deck level (603'-0") down to the 578'-0" elevation.

b) Section 3.8.1.5 of the DBNPS Updated Safety Analysis Report (USAR) addresses the results of the Auxiliary Building evaluation. The USAR does not provide a detailed listing of safety factors in the vicinity of the SFP. Therefore, a comparison between safety factors before and after re-racking is not possible using the USAR as a source document.

During the initial efforts to prepare the evaluation of the pool structure for the proposed re-racked pool and revised fuel storage conditions, the 1978 design basis calculation for the SFP structure was reviewed in an attempt to make a comparison similar to that requested here. The 1978 design basis calculation was performed using hand computations and Moody diagrams to develop the loads imposed on the structure. During the review, errors were discovered in the computations that were performed to determine the moment associated with the thermal loading condition, and in development of the horizontal seismic loads applied to the walls through the rack-to-wall bracing system. The thermal loading condition error was non-conservative. However, the rack bracing seismic condition computation error resulted in conservatively applied load. As corrective action, it was decided to perform a finite element evaluation of the Auxiliary Building areas surrounding the SFP. The evaluation was based on the proposed re-rack configuration, but also bounded the existing fuel storage rack configuration.

The primary structural differences between the existing configuration and the proposed re-rack configuration are in the additional mass of the fuel and racks, the increased thermal conditions, and the removal of the rack-to-wall seismic restraints. The fully loaded re-rack configuration contains considerably more mass than the existing configuration. Therefore, floor loadings will be higher than the fully loaded racks in the existing configuration. The pool structure was previously analyzed for thermal loadings based on bulk pool operating (T_o) and accident (T_a) temperatures of 128 °F and 162 °F, respectively. The re-racked pool structure evaluation is based on bulk pool operating and accident temperatures of 150 °F and 170 °F, respectively. Therefore, the thermal loading will be higher for the proposed re-rack configuration versus the existing rack configuration. The new free-standing racks will be much closer to the walls than the existing racks. The existing racks are seismically braced. Therefore, hydrodynamic fluid coupling between the walls and the racks must be considered for the proposed re-rack configuration. A comparison between the forces applied to the SFP walls represented by the fluid coupling over the area of the new racks and the wall loads applied by the existing seismic braces has shown that the walls experience higher horizontal loading under the re-racked configuration. In summary, the pool structure evaluation for the re-racked configuration was developed to envelope the existing configuration for all loading cases (i.e., dead weight, thermal, and seismic).

The structural safety margins for the re-racked configuration would be reduced from those of the existing configuration, since all of the loads are increased. A direct comparison cannot be made because safety margins are not reported in the USAR in detail for the existing condition, errors were detected in the design basis calculations, and the previous hand computation style evaluation did not produce the level of detail afforded by the recently performed finite element computer software solutions, which computes imposed loadings at thousands of discrete points within the structure. The closed-form solutions presented by the Moody diagrams used in the 1978 design basis calculation produced a more coarse solution by computing averaged values over large sections of the walls and floor.

A comparison can be made between the computed results from the evaluations prepared to support Reference 1 (SFP Re-rack License Amendment Request 98-0013 for the SFP Re-rack) and Reference 2 (License Amendment Request 98-0007 for the Cask Pit Rack Installation). However, this comparison can only be made for those portions that are common to both evaluations; namely the walls surrounding the 14' x 14' Cask Pit (CP). The CP structural evaluation was performed using similar methodology (Moody Diagrams) to that used in the 1978 design basis evaluation. Safety factors were computed for all four walls, as reported in the table below. Although all four of the CP walls were included in the finite element model, the SFP evaluation determined safety factors only for two (north and east) CP walls. The two remaining (south and west) walls of the CP would not be significantly affected by the proposed rack configuration. Additionally, the south and west walls are much thicker at 66", whereas, the two walls that were evaluated are only 36". The east wall of the CP separates the CP from the SFP. In other words, this is a portion of the SFP west wall, the remainder of which separates the SFP from the Transfer Pit (TP). In the SFP evaluation reported in Reference 1, the SFP west wall safety margins do not differentiate between the portion adjacent to the TP and the CP. By observation of the larger length of the portion adjacent to the TP and recognition of similar loadings, the TP portion of this wall would control. Therefore, the SFP evaluation safety factors reported for the SFP west wall occur in the portion of the wall adjacent to the TP. Therefore, the only direct comparison between the two evaluations would be for the north wall of the Cask Pit. Nevertheless, the SFP west wall safety margins are listed below for comparison with the CP east wall.

The following tables provide the lowest safety margins at any location along the walls specified for the evaluations performed to support References 1 and 2.

Cask Pit Evaluation (Reference 2 - License Amendment Request 98-0007 for the Cask Pit Rack Installation)

Cask Pit Wall	Reinforcement Orientation			
	X Direction		Y Direction	
	Axial + Bending	Shear	Axial + Bending	Shear
North	18.69	4.28	21.50	4.63
South	3.51	7.25	43.81	7.74
West	5.62	7.25	40.90	7.74
East	7.78	1.41	31.18	4.90

Spent Fuel Pool Evaluation (Reference 1 - SFP Re-rack License Amendment Request 98-0013 for the SFP Re-rack)

Scenario 1 – Seismic Restraints Installed Across Transfer Pit Walls and No Water in Transfer Pit

Cask Pit Wall	Reinforcement Orientation			
	X Direction		Y Direction	
	Axial + Bending	Shear	Axial + Bending	Shear
North	3.64	8.27	17.75	5.11
East *	2.05	1.17	2.46	2.17

Spent Fuel Pool Evaluation (Reference 1 - SFP Re-rack License Amendment Request 98-0013 for the SFP Re-rack)

Scenario 2 – Seismic Restraints Across Transfer Pit Walls Removed and Transfer Pit Partially Filled with Water

Cask Pit Wall	Reinforcement Orientation			
	X Direction		Y Direction	
	Axial + Bending	Shear	Axial + Bending	Shear
North	2.93	4.77	4.52	3.62
East *	2.06	1.15	1.60	1.78

* As stated above, the SFP evaluation results reported for the east wall of the Cask Pit also include the east wall of the Transfer Pit.

c) The bulk pool temperature beyond the 150 °F concrete acceptance limit is discussed briefly in the license amendment request in the Safety Assessment and Significant Hazards Consideration and in Chapter 5.0 of the Holtec Design and Licensing Report HI-992329. The maximum bulk pool temperature subsequent to a normal full core off-load is approximately 154 °F. However, this is not a steady-state temperature, since this bulk pool temperature is primarily driven by the decay heat load from the fuel in the full core off-load. The remaining background fuel in the SFP from previous off-loads represents a small heat load in comparison. The decay heat load from the fuel in the full core off-load diminishes rapidly, and consequently the SFP bulk temperature remains above 150 °F for a duration of less than 80 hours.

Since the ACI Code permits long-term temperatures of up to 150 °F and short-term temperature excursions in localized areas up to 350 °F, the time above 150 °F is considered acceptable.

Docket Number 50-346
License Number NPF-3
Serial Number 2732
Enclosure 1
Attachment
Figure
Page 1

GENERATION OF SHAPE FUNCTIONS FOR BEAM SPRING COUPLING COEFFICIENTS

The beam element shape functions are polynomials satisfying certain boundary conditions in the domain 0 -1. These shape functions are defined by third order polynomials each satisfying one of four possible sets of boundary conditions. The general polynomial is defined as:

$\phi = A_1 + A_2 * \xi + A_3 * \xi^2 + A_4 * \xi^3$

Case 1 - phi =1 at 0; phi=0 at 1; phi' =0 at 0,1

Guess $a1 := 1$ $a2 := 1$ $a3 := 0$ $a4 := 0$

Given $a1 = 1$ $a1 + a2 + a3 + a4 = 0$ $a2 = 0$ $a2 + 2\cdot a3 + 3\cdot a4 = 0$

$\begin{pmatrix} A1 \\ A2 \\ A3 \\ A4 \end{pmatrix} := \mathrm{Find}(a1, a2, a3, a4)$ $A1 = 1$ $A2 = 0$ $A3 = -3$ $A4 = 2$

$i := 1..5$ $x_i := \frac{i-1}{4}$ $phi_i := A1 + A2\cdot x_i + A3\cdot (x_i)^2 + A4\cdot (x_i)^3$

$phi_i =$

1
0.844
0.5
0.156
0

Case 2 - phi =0 at 0; phi=1 at 1; phi' =0 at 0,1

Guess $a1 := 1$ $a2 := 1$ $a3 := 0$ $a4 := 0$

Given $a1 = 0$ $a1 + a2 + a3 + a4 = 1$ $a2 = 0$ $a2 + 2\cdot a3 + 3\cdot a4 = 0$

$\begin{pmatrix} A1 \\ A2 \\ A3 \\ A4 \end{pmatrix} := \mathrm{Find}(a1, a2, a3, a4)$ $A1 = 0$ $A2 = 0$ $A3 = 3$ $A4 = -2$

$i := 1..5$ $x_i := \frac{i-1}{4}$ $phi_i := A1 + A2\cdot x_i + A3\cdot (x_i)^2 + A4\cdot (x_i)^3$

Docket Number 50-346
License Number NPF-3
Serial Number 2732
Enclosure 1
Attachment
Figure
Page 2

Case 3 - phi =0 at 0; phi=0 at 1; phi' =-1 at 0; phi'=0 at 1

Guess $a1 := 1 \quad a2 := 1 \quad a3 := 0 \quad a4 := 0$

Given $a1 = 0 \quad a1 + a2 + a3 + a4 = 0 \quad a2 = -1 \quad a2 + 2 \cdot a3 + 3 \cdot a4 = 0$

$$\begin{pmatrix} A1 \\ A2 \\ A3 \\ A4 \end{pmatrix} := \text{Find}(a1, a2, a3, a4) \qquad A1 = 0 \qquad A2 = -1 \qquad A3 = 2 \qquad A4 = -1$$

$i := 1..5 \qquad x_i := \frac{i-1}{4} \qquad phi_i := A1 + A2 \cdot x_i + A3 \cdot (x_i)^2 + A4 \cdot (x_i)^3$

$phi_i =$

0
0.156
0.5
0.844
1

$phi_i =$

0
-0.141
-0.125
-0.047
0

Case 4 - phi =0 at 0; phi=0 at 1; phi' =0 at 0; phi'=-1 at 1

Guess $a1 := 1 \quad a2 := 1 \quad a3 := 0 \quad a4 := 0$

Given $a1 = 0 \quad a1 + a2 + a3 + a4 = 0 \quad a2 = 0 \quad a2 + 2 \cdot a3 + 3 \cdot a4 = -1$

$$\begin{pmatrix} A1 \\ A2 \\ A3 \\ A4 \end{pmatrix} := \text{Find}(a1, a2, a3, a4) \qquad A1 = 0 \qquad A2 = 0 \qquad A3 = 1 \qquad A4 = -1$$

$i := 1..5$

$x_i := \frac{i-1}{4} \qquad phi_i := A1 + A2 \cdot x_i + A3 \cdot (x_i)^2 + A4 \cdot (x_i)^3$

$phi_i =$

0
0.047
0.125
0.141
0

With the above definitions of the functions, the resulting deflection shape is of the form

$W(x) = W_0 * phi1(x) + W_1 * phi2(x) - dW/dx)_0 * phi3(x) - dW/dx)_1 * phi4(x)$

Docket Number 50-346
License Number NPF-3
Serial Number 2732
Enclosure 2

COMMITMENT LIST

THE FOLLOWING LIST IDENTIFIES THOSE ACTIONS COMMITTED TO BY THE DAVIS-BESSE NUCLEAR POWER STATION (DBNPS) IN THIS DOCUMENT. ANY OTHER ACTIONS DISCUSSED IN THE SUBMITTAL REPRESENT INTENDED OR PLANNED ACTIONS BY THE DBNPS. THEY ARE DESCRIBED ONLY FOR INFORMATION AND ARE NOT REGULATORY COMMITMENTS. PLEASE NOTIFY THE MANAGER – REGULATORY AFFAIRS (419-321-8450) AT THE DBNPS OF ANY QUESTIONS REGARDING THIS DOCUMENT OR ANY ASSOCIATED REGULATORY COMMITMENTS.

COMMITMENTS	DUE DATE
None	N/A