DUKE POWER COMPANY
P.O. BOX 33189
CHARLOTTE, N.C. 28242

HAL B. TUCKER
VICE PRESIDENT
NUCLEAR PRODUCTION

TELEPHONE
(704) 373-4531

February 24, 1988

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Subject: Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413 and 50-414
Snubber Reduction Program

Gentlemen:

Please be advised that Duke Power is planning to use response spectra generated by the Direct Generation method in the snubber reduction program at Catawba Nuclear Station pursuant to provisions in 10 CFR 50.59.

Catawba FSAR Section 3.7 describes the Design Response Spectra and Design Time History. As shown in FSAR Figure 2.5.2-5, there is some margin between the Design Response Spectra (smooth curve) and the response spectra produced from the average of the four synthetic earthquake time histories chosen to envelope the Design Response Spectra. The traditional method of generating response spectra requires the time history input of the synthetic earthquakes and modal analysis results for the structure for which response spectra are desired. A time history analysis of the structure must then be performed to produce time histories and response spectra at various elevations.

The Direct Generation method bypasses the time history input of the ground response and the time history analysis of the structure under consideration. The modal analysis results of the structure can be utilized directly with the Design Response Spectra (smooth curve figure 2.5.2-5) as input to produce response spectra at desired elevations. Duke Power Company has performed a detailed technical description and acceptability determination. Direct Generation has been proven an accurate method of generating response spectra at desired elevations in a structure allowing precise input of the "Design Response Spectra" and eliminating the previously described margin. By increasing the accuracy of calculations and eliminating discrepancies, peak accelerations can be lowered in some frequency ranges. This allows for removal of some seismic supports (snubbers) and reduces analytical costs in producing response spectra by bypassing expensive time-history analyses. It should be noted that usage of Direct Generation to develop floor response spectra has no effect on the piping analysis method, including the structural overlaping methods.

Removing excessive conservatism from the Design Response Spectra is possible because of advancements in seismic methodology. The time-history method used for original design of the plants was a poor approximation to the actual Design Response Spectra, although the time-history method was state-of-the-art at the time. Usage of Direct Generation is intended to correct original over design due to lack of appropriate analytical techniques.

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Duke Power has determined that the Direct Generation method results in more accurate Design Response Spectra and that therefore the probability of accidents previously evaluated are not increased during an earthquake. Other design basis events, tornado, fire, flood etc. are not relevant to seismic methodology. The operability of accident mitigation equipment, systems and instrumentation is not affected by seismic methodology. Therefore, the consequences of previously evaluated accidents are not increased. No new accidents or malfunctions of equipment are created by using a different seismic methodology. The design criteria in Chapter 3 of the FSAR have not been changed, particularly Section 3.9.3, ASME Code Class 1, 2 and 3 components in the case of snubber removal as a benefit of Direct Generation.

All piping systems that are modified will be reanalyzed with the reduced spectra and the same code equations and allowable stresses will be satisfied for all components. Therefore, the probability of malfunctions of equipment important to safety is not increased during or following an earthquake. As stated earlier, other design basis events are not relevant to seismic methodology. No new failure modes are created by using a different seismic methodology and all accident mitigation equipment has been designed for certain assumed failures. Therefore, the consequences of malfunctions of equipment are not increased. Since no safety limits, setpoints, or parameters associated with the reactor or any safety systems have been affected, there is no reduction in the margin of safety defined in the bases of the Technical Specifications.

Based upon the above discussion, Duke Power has determined that there are no unreviewed safety questions resulting from the use of Direct Generation seismic design methodology. Therefore, this method was determined to be acceptable for implementation under 10 CFR 50.59. Direct Generation has been specifically recommended by the NRC in NUREG/CR 116.1, "Recommended Revisions to Nuclear Regulatory Commission Seismic Design Criteria", and it has been used at other nuclear power plants including San Onofre, South Texas Project, and Limerick.

The Catawba FSAR has been reviewed and appropriate changes describing Direct Generation Methodology have been identified. Proposed FSAR changes are attached for your review. These changes will be included in a future update to the FSAR.

Although Duke Power has determined that the Direct Generation method can be implemented without prior NRC approval pursuant to 10 CFR 50.59, it is recognized that this methodology represents a significant change in the design bases of Catawba. It is therefore requested that the NRC review and approve Duke's use of the subject methodology prior to March 23, 1988 in order to support current plant modification schedules.

This proposal involves one request for approval. Accordingly, pursuant to 10 CFR 170.21 a check for $150.00 is enclosed.

Very truly yours,

Hal B. Tucker

Hal B. Tucker

JGT/1438/sbn
Enclosure

xc: Dr. J. Nelson Grace, Regional Administration
U. S. Nuclear Regulatory Commission
Region II
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

Mr. P. K. Van Doorn
NRC Resident Inspector
Catawba Nuclear Station

Dr. K. Jabbour
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

All structural response spectra calculations have been based upon the step sizes given in Case III except when the direct generation method is used.

When the direct generation method is used, a minimum of 16 frequency points per octave (i.e. the range of frequencies, $f_1 \leq f \leq f_2$, where $f_2 = z\ f_1$) in addition to significant building frequencies are calculated.

3.7.1.3 Critical Damping Values

The following damping values are used for the seismic design of Category I structures, systems, and components for the OBE and SSE, unless higher damping factors can be justified.

ITEM	PERCENT CRITICAL DAMPING	
	OBE	SSE
Small-diameter piping systems, diameter equal to or less than 12 in. (see Note 1)	1.0	1.0
Primary Coolant Loop System Components	0.5	1.0
Large-diameter piping system (diameter greater than 12 in.) (see Note 1)	2.0	2.0
Equipment and Components	2.0	2.0
Containment Vessel	1.0	2.0
Welded Steel Structures	2.0	2.0
Bolted Steel Structures	5.0	5.0
Control Rod Drive Mechanisms	5.0	5.0
Concrete Structures	5.0	5.0
Fuel Assemblies	7.0	10.0

NOTE: 1.) As an option to the damping values listed above for piping, an alternative set of values may be used as follows:

5% damping for piping frequencies below 10 hz.; the % damping linearly decreasing to 2% at 20 hz. and 2% damping for frequencies above 20 hz. These values for damping apply to all pipe sizes for both Safe Shutdown Earthquake (SSE) and Operational Basis Earthquake (OBE) loadings. No combination of the two damping criteria are used for an analysis and the alternative set of damping values are not used in a time history analyses. Figure 3.7.1-4 illustrates the alternative set of damping values.

The stress levels in structural elements are not the same for all the elements of a whole structure; therefore, a single damping value cannot be accurately assigned to a total structure based upon a single stress level. The damping values listed above are average values based upon lower than average stress levels in the structure.

CNS

The damping values as tabulated are less than the referenced values in Regulatory Guide 1.61 for the higher stress conditions which correspond to the SSE. The tabulated damping values are less than or equal to the referenced lower stress values (OBE) except for concrete and bolted steel structures. An assessment was made to determine the impact should Catawba be required to conform to the

Groundwater pressure against safety related structures is relieved by an underdrain system as described in Section 2.4.13.5.

The following Category I Structures are not founded on continuous rock but are supported on earth or weathered rock. The maximum allowable bearing pressure assumed for foundation design for structures is 3000psf for earth and 15000psf for weathered rock.

NSW + SNSW Intake Structure
NSW + SNSW Discharge Structure
NSW Electrical Conduit Manholes
Pipe Trench to Reactor Make-up and Refueling Water Storage Tanks

For each of the structures listed above, it has been determined that the structure moves with the ground motion during an earthquake to account for the soil-structure interaction effect. The seismic analysis for soil structure interaction performed for these facilities considers the similar analysis of inertial and static effects as outlined for buried seismic Category I facilities in Section 3.7.3.12.

3.7.2.5 Development of Floor Response Spectra

Figures 2.5.2-5 reflect the time-history spectra and site design spectra.

The synthetic earthquakes used to generate the time-history spectra in Figures 2.5.2-5 are used to generate response spectra at elevations in structures that house systems and components which are required to be designed for seismic excitation.

The analytical technique used to generate the response spectra at specified elevations in a structure is the time-history method or the direct generation method. When using the time-history method, the acceleration time-history of each elevation is retained for the generation of response spectra reflecting the maximum acceleration of a single degree of freedom system for a range of frequencies at the respective elevation. When using the direct generation method, a power spectral density function (PSD) is generated for the site ground response spectra and then used to generate a structurally amplified PSD at the required elevation.

The PSD is then converted to a response spectrum reflecting the maximum acceleration of a single degree of freedom system for a range of frequencies at the respective elevation.

Vertical response spectra are not generated. The floor slabs in Category 1 structures were examined for flexibility and were found to be sufficiently stiff to justify the assumption of negligible amplification in the vertical direction.

Damping values for the structural model are selected from Section 3.7.1.3, "Critical Damping Values."

TIME-HISTORY ANALYSIS

The time-history of the specified mass points is determined by the modal method in which the responses in the normal modes are determined separately, then superimposed to provide the total response to a specified base input motion.

The modal relative displacement of mass point r is:

$$U_{rn}(t) = A_n(t) \quad \phi_{rn}$$

and the relative acceleration

$$\ddot{U}_{rn}(t) = \ddot{A}_n(t) \quad \phi_{rn}$$

The response of each mass for each mode at each increment of time is retained, and the total response for each increment of time is obtained by summing the responses of each mode for a particular time. The total relative displacement of mass point r is:

$$U_r(t) = \sum_{n=1}^{M} U_{rn}(t)$$

and the relative acceleration is:

$$\ddot{U}_r(t) = \sum_{n=1}^{M} \ddot{U}_{rn}(t)$$

Where M = the number of modes considered. The time-history method gives the exact combination of mode participation and therefore the time-history of each mass is defined.

Direct Generation

The computer code used to perform the direct generation is called Equipment Dynamic Analysis Package (EDASP). This computer code is based on the following method of direct generation. This method is explained in greater detail by Unruh and Kana (33).

A method of direct transformation of a power density spectrum to a response spectrum without using a time-history is presented by Singh and Chu (26) with further discussions by Singh (27). Additional development of the inverse transformation is provided by Kaul (28).

The equation of motion of a single degree of freedom system which is excited at its base by an input acceleration time-history x(t) is;

$$m\ddot{y}+c(\dot{y}-\dot{x})+k(y-x) = 0 \quad (1)$$

m = mass of the system
c = the dampling coefficient
k = the system stiffness
x = the base input motion
y = the absolute response of the mass

Dots indicate differentiation with respect to time.

In terms of the relative response $z = y-x$

$$m\ddot{z} + c\dot{z} + kz = -m\ddot{x} \quad (2)$$

When the above equations are divided by m and $w_o = k/m$ and $c = 2mw_o \beta$ the equations become;

$$\ddot{y} + 2\beta w_o (\dot{y}-\dot{x}) + w^2o (y-x) = 0 \quad (1a)$$

and

$$\ddot{z} + 2\beta w_o\dot{z} + w^2{}_o z = -\ddot{x}$$

Integration of Equation (2a) will give the response of the system to the base input time history x. A report by Nigam and Jennings (29) details the numerical procedures necessary to obtain the peak response of the system for strong-motion earthquake events.

It is assumed that the seismic event is a stationary Gaussian random process, therefore specification of its mean and standard deviation completely describe the event. The seismic event has a zero mean and its standard deviation is obtained from its power spectral density (PSD) $\phi(w)$ via the system transfer function as;

$$\psi(w,w_o) = H(W,w_o) \times H^*(w,w_o)\ \phi(w) \tag{3}$$

where $H(w,w_o)$ is obtained from Equation (1a), via a Fourier Transfer, as

$$H(w,w_o) = \frac{Y(w)}{X(w)} = \frac{w^2o + i2wo\beta w}{(w^2{}_o - w^2) + i2w_o\beta w} \tag{4}$$

and $H^*(w,w_o)$ is the complex conjugate transfer function. Thus,

$$\psi(w,w_o) = \frac{w^4{}_o + 4w^2\beta^2w^2}{(w^2{}_o - w^2)^2 + 4w^2{}_o\beta^2w^2}\ \phi w \tag{5}$$

The standard deviation of the response of the system is obtained from;

$$\sigma^2(w_o) = \int_{-\infty}^{+\infty} \Psi(w,w_o)\, dw \tag{6}$$

We define the response spectrum in terms of the standard deviation of the response of the systme as;

$$R(w_o) = F(w_o) \cdot \sigma(w_o) \tag{7}$$

F_o = Amplitude factor

The standard deviation must be multiplied by the amplitude factor to account for the peak response. When there is a small probability that the response spectrum value will be exceeded, Amin and Gunger (30) show that;

$$F_o (w_o) = [-2\ell n\{(-\pi/T)(\dot{\sigma}/\sigma)\ \ell n(1 - r)\}]^{1/2} \tag{8}$$

T = Earthquake effective time duration
$\dot{\sigma}$ = standard deviation of the time derivative of the response;

$$\sigma^2 (w_o) = \int_{-\infty}^{+\infty} w^2\Psi(w,w_o)\ dw \tag{9}$$

r = probability of expectance

The transformation of a response spectrum into a PSD uses a method developed by Kaul (28);

$$\emptyset / w_o = \frac{\frac{2\beta}{\pi wo} \qquad R^2(w_o)}{-2\ell n\ [(\frac{-\pi}{w_o T})\ \ell n(1-r)]} \tag{10}$$

and an iterative process. A flow chart of the iterative scheme is given in Figure 3.7.2-26. The results from equation 10 are accurate in the frequency range of 0.25 to 6.0 Hz. and the results are conservative for frequencies outside of this range for response spectra given in USNRC Regulatory Guide 1.60 (31).

This method produces inaccurate results in systems with low dampings, therefore corrections must be made to generate acceptable results. Rosenblueth and Elorduy (32) have developed a formula that corrects the system dampings;

$$\beta_e = \beta + 2/(w_o\ T) \tag{11}$$

The damping correction term is applied to all of the above expressions. The approximate solution given in Equation (10) is used as an initial estimate in the iterative process with the exact results given in Equation (7).

A comparison of the EDASP results vs. the Time-History results will be made. Response spectra will be generation using the time history method and EDASP for several mass points and various damping characteristics. The resulting response spectra will then be compared. As a basis for this comparison, the seismic analysis of the reactor building will be used. The model has 21 mass distribution points and 20 members. The time-histories used to generate the response spectra are 4 synthetic earthquakes that envelope the OBE site ground response spectrum. The response spectra used in the design of CNS is the average of the 4 spectra computed using the synthetic time histories. The acceleration time-histories were scaled by 15/8 to provide SSE accelerations. The EDASP program was used to generate 0.5% and 5.0% critical damping curves for the following mass points:

Mass Point	Elevation
3	562+0
7	595+4
11	628+8
15	662+0
19	691+2
21	713+1

A power spectral density (PSD) was generated for the reactor building model using the site ground reactor building model using the site ground response spectrum at 0.5% damping between 1.03 and 40 hz. The site ground response spectrum are obtained by applying amplification factors to the maximum ground response at selected frequencies. Each site ground response spectrum for each damping will therefore result in a different PSD. To provide a comparison for the PSD method vs. the time-history method, the response spectrum plotted for the 0.5% damping site ground response spectrum at .08g from the artificial time-histories is digitized and input into the EDASP program. The comparison of responses found in Table 3.7.1-1 contain information as follows:

Frequency columns: The EDASP column gives the frequency at which the acceleration under the heading TH-EDAS is computed.

The T.H. column lists frequencies near those used by EDASP for which responses were computed by the original analysis.

Acceleration Columns: The T.H. column gives the acceleration for frequency from the original seismic analysis of the reactor building.

The TH-EDAS column gives the acceleration for the frequency from the EDASP program for the site ground response spectrum plotted from the time-history.

Comparison of accelerations (peak and ZPA) for spectra generated by time-histories and EDASP using the site ground response spectrum generated from the time-histories:

Elevation	% Peak Change		% Change at 20 hz	
	0.5%	5%	0.5%	5%
562+0	+1.8	NA	+4.5	NA
595+4	+5.1	+13.0	+30.0	+6.9
628+8	+7.6	+15.8	+23.8	+2.4
662+0	+9.4	+17.6	+5.7	0.0
691+2	+10.4	+17.6	+3.2	+3.2
713+1	+10.8	+17.5	+11.6	+4.3

The curves generated by EDASP show results were conservative at the peaks particularly for the 0.5% curves. There is more variation away from the peak, but EDASP produces conservative results. The EDASP program provides acceptable elevated response spectra for seismic design.

RESPONSE SPECTRA

A response spectrum can be defined as the representation of the maximum response of a single mass system for a varying frequency range to a defined base motion.

The time-history of the mass points is used as the base motion to obtain the response spectrum. The numerical average for the response of the four earthquake time-histories was used to generate the final response spectrum used in the seismic design.

A typical structural mathematical model of the Containment Interior Structure is shown in Figure 3.7.2-1.

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Table 3.7.1-1 (Sheet 1)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
0.5% Critical Damping At Elev. 562+0

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.48	0.68	5.25	5.25	1.69	1.69
1.10	1.13	0.64	0.76	5.50	5.41	1.21	1.29
1.20	1.18	0.71	0.82	5.75	5.73	0.80	0.95
1.30	1.32	0.62	0.76	6.00	6.05	0.80	0.86
1.40	1.42	0.58	0.73	6.25	6.21	0.68	0.87
1.50	1.51	0.68	0.86	6.50	6.53	0.79	0.89
1.60	1.61	0.76	0.95	6.75	6.68	0.78	0.95
1.70	1.70	0.79	0.98	7.00	7.00	0.80	0.93
1.80	1.90	0.90	1.12	7.25	7.32	0.81	0.90
1.90	1.89	1.08	1.21	7.50	7.48	0.86	0.87
2.00	2.04	1.03	1.14	7.75	7.80	0.64	0.87
2.10	2.09	0.94	1.07	8.00	7.96	0.78	0.88
2.20	2.18	0.82	1.19	8.50	8.44	0.84	0.85
2.30	2.32	1.07	1.29	9.00	9.07	0.78	0.81
2.40	2.42	1.10	1.25	9.50	9.55	0.62	0.78
2.50	2.52	1.03	1.23	10.00	9.87	0.62	0.73
2.60	2.61	1.01	1.26	10.50	10.35	0.61	0.64
2.70	2.71	1.10	1.33	11.00	10.98	0.62	0.64
2.80	2.80	1.20	1.31	11.50	11.62	0.51	0.67
2.90	2.90	1.04	1.23	12.00	11.94	0.51	0.62
3.00	2.99	0.88	1.17	12.50	12.57	0.48	0.58
3.15	3.14	1.12	1.22	13.00	12.89	0.47	0.54
3.30	3.34	1.06	1.30	13.50	13.53	0.42	0.52
3.60	3.66	1.09	1.25	14.00	13.85	0.40	0.48
3.80	3.82	0.87	1.18	14.50	14.48	0.37	0.45
4.00	3.98	0.93	1.20	15.00	15.12	0.30	0.43
4.20	4.14	1.18	1.31	16.00	16.07	0.25	0.39
4.40	4.46	1.19	1.35	17.00	17.03	0.23	0.38
4.60	4.62	1.10	1.47	17.45	17.35	0.22	0.35
4.80	4.78	1.47	1.61	18.00	17.99	0.23	0.33
5.00	4.93	1.41	1.72	20.00	19.89	0.22	0.23

Table 3.7.1-1 (~~Sheet~~ Part 2)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
5% Critical Damping At Elev. 562+0

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	N/A	0.32	5.25	5.25	N/A	0.61
1.10	1.13	N/A	0.37	5.50	5.41	N/A	0.60
1.20	1.18	N/A	0.40	5.75	5.73	N/A	0.49
1.30	1.32	N/A	0.40	6.00	6.05	N/A	0.44
1.40	1.42	N/A	0.39	6.25	6.21	N/A	0.42
1.50	1.51	N/A	0.42	6.50	6.53	N/A	0.41
1.60	1.61	N/A	0.46	6.75	6.68	N/A	0.41
1.70	1.70	N/A	0.48	7.00	7.00	N/A	0.40
1.80	1.80	N/A	0.51	7.25	7.32	N/A	0.40
1.90	1.89	N/A	0.54	7.50	7.48	N/A	0.39
2.00	2.04	N/A	0.53	7.75	7.80	N/A	0.38
2.10	2.09	N/A	0.53	8.00	7.96	N/A	0.38
2.20	2.18	N/A	0.54	8.50	8.44	N/A	0.37
2.30	2.32	N/A	0.56	9.00	9.07	N/A	0.36
2.40	2.42	N/A	0.56	9.50	9.55	N/A	0.35
2.50	2.52	N/A	0.56	10.00	9.87	N/A	0.33
2.60	2.61	N/A	0.56	10.50	10.35	N/A	0.32
2.70	2.71	N/A	0.56	11.00	10.98	N/A	0.31
2.80	2.80	N/A	0.56	11.50	11.62	N/A	0.31
2.90	2.90	N/A	0.55	12.00	11.94	N/A	0.30
3.00	2.99	N/A	0.54	12.50	12.57	N/A	0.29
3.15	3.14	N/A	0.54	13.00	12.89	N/A	0.29
3.30	3.34	N/A	0.54	13.50	13.53	N/A	0.28
3.60	3.66	N/A	0.53	14.00	13.85	N/A	0.27
3.80	3.82	N/A	0.52	14.50	14.48	N/A	0.26
4.00	3.98	N/A	0.53	15.00	15.12	N/A	0.26
4.20	4.14	N/A	0.54	16.00	16.07	N/A	0.25
4.40	4.46	N/A	0.56	17.00	17.03	N/A	0.24
4.60	4.62	N/A	0.59	17.45	17.35	N/A	0.24
4.80	4.78	N/A	0.61	18.00	17.99	N/A	0.23
5.00	4.93	N/A	0.63	20.00	19.89	N/A	0.22

Table 3.7.1-1 (~~Sheet~~ Page 3)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
0.5% Critical Damping At Elev. 595+4

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.49	0.69	5.25	5.25	3.94	4.12
1.10	1.13	0.65	0.77	5.50	5.41	2.84	4.14
1.20	1.18	0.72	0.82	5.75	5.73	1.63	2.10
1.30	1.32	0.63	0.77	6.00	6.05	1.09	1.32
1.40	1.42	0.60	0.74	6.25	6.21	0.77	0.94
1.50	1.51	0.70	0.89	6.50	6.53	0.61	0.68
1.60	1.61	0.79	0.96	6.75	6.68	0.58	0.61
1.70	1.70	0.81	1.01	7.00	7.00	0.58	0.59
1.80	1.80	0.93	1.16	7.25	7.32	0.61	0.58
1.90	1.89	1.13	1.26	7.50	7.48	0.58	0.58
2.00	2.04	1.08	1.19	7.75	7.80	0.50	0.60
2.10	2.09	0.99	1.12	8.00	7.96	0.57	0.62
2.20	2.18	0.86	1.26	8.50	8.44	0.66	0.64
2.30	2.32	1.14	1.37	9.00	9.07	0.68	0.64
2.40	2.42	1.18	1.34	9.50	9.55	0.56	0.65
2.50	2.52	1.01	1.32	10.00	9.87	0.55	0.63
2.60	2.61	1.10	1.36	10.50	10.35	0.53	0.59
2.70	2.71	1.21	1.46	11.00	10.98	0.57	0.62
2.80	2.80	1.32	1.44	11.50	11.62	0.54	0.66
2.90	2.90	1.15	1.37	12.00	11.94	0.52	0.64
3.00	2.99	0.98	1.32	12.50	12.57	0.50	0.63
3.15	3.14	1.29	1.40	13.00	12.89	0.54	0.61
3.30	3.34	1.26	1.51	13.50	13.53	0.55	0.61
3.60	3.66	1.37	1.52	14.00	13.85	0.51	0.60
3.80	3.82	1.10	1.49	14.50	14.48	0.45	0.59
4.00	3.98	1.21	1.57	15.00	15.12	0.43	0.60
4.20	4.14	1.60	1.81	16.00	16.07	0.35	0.63
4.40	4.46	1.78	1.98	17.00	17.03	0.32	0.72
4.60	4.62	1.75	2.36	17.45	17.35	0.31	0.73
4.80	4.78	2.44	2.85	18.00	17.99	0.32	0.71
5.00	4.93	2.69	3.56	20.00	19.89	0.30	0.39

Table 3.7.1-1 (~~Sheet~~ Part 4)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
5% Critical Damping At Elev. 595+4

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.30	0.32	5.25	5.25	1.15	1.30
1.10	1.13	0.37	0.38	5.50	5.41	1.10	1.27
1.20	1.18	0.38	0.41	5.75	5.73	0.90	1.01
1.30	1.32	0.35	0.40	6.00	6.05	0.75	0.81
1.40	1.42	0.40	0.40	6.25	6.21	0.67	0.66
1.50	1.51	0.43	0.44	6.50	6.53	0.56	0.57
1.60	1.61	0.45	0.47	6.75	6.68	0.52	0.51
1.70	1.70	0.44	0.50	7.00	7.00	0.49	0.48
1.80	1.80	0.48	0.53	7.25	7.32	0.46	0.45
1.90	1.89	0.55	0.56	7.50	7.48	0.44	0.43
2.00	2.04	0.59	0.56	7.75	7.80	0.41	0.42
2.10	2.09	0.58	0.55	8.00	7.96	0.40	0.41
2.20	2.18	0.54	0.57	8.50	8.44	0.38	0.40
2.30	2.32	0.62	0.59	9.00	9.07	0.39	0.39
2.40	2.42	0.64	0.60	9.50	9.55	0.37	0.38
2.50	2.52	0.60	0.60	10.00	9.87	0.35	0.37
2.60	2.61	0.61	0.61	10.50	10.35	0.35	0.36
2.70	2.71	0.66	0.62	11.00	10.98	0.34	0.36
2.80	2.80	0.65	0.62	11.50	11.62	0.34	0.36
2.90	2.90	0.60	0.61	12.00	11.94	0.33	0.36
3.00	2.99	0.58	0.61	12.50	12.57	0.33	0.35
3.15	3.14	0.59	0.62	13.00	12.89	0.35	0.35
3.30	3.34	0.59	0.63	13.50	13.53	0.36	0.35
3.60	3.66	0.67	0.65	14.00	13.85	0.35	0.34
3.80	3.82	0.64	0.66	14.50	14.48	0.33	0.34
4.00	3.98	0.66	0.70	15.00	15.12	0.33	0.34
4.20	4.14	0.70	0.76	16.00	16.07	0.32	0.35
4.40	4.46	0.82	0.84	17.00	17.03	0.30	0.35
4.60	4.62	0.91	0.95	17.45	17.35	0.30	0.35
4.80	4.78	0.98	1.08	18.00	17.99	0.30	0.34
5.00	4.93	1.05	1.21	20.00	19.89	0.29	0.31

Table 3.7.1-1 (~~Sheet~~ Part 5)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
0.5% Critical Damping At Elev. 628+8

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.49	0.69	5.25	5.25	6.71	7.14
1.10	1.13	0.66	0.78	5.50	5.41	5.07	7.22
1.20	1.18	0.74	0.84	5.75	5.73	3.21	4.19
1.30	1.32	0.64	0.79	6.00	6.05	2.29	2.87
1.40	1.42	0.61	0.76	6.25	6.21	1.61	2.14
1.50	1.51	0.72	0.91	6.50	6.53	1.34	1.52
1.60	1.61	0.81	1.01	6.75	6.68	1.12	1.21
1.70	1.70	0.84	1.05	7.00	7.00	0.85	0.97
1.80	1.80	0.97	1.20	7.25	7.32	0.81	0.84
1.90	1.89	1.18	1.31	7.50	7.48	0.76	0.74
2.00	2.04	1.14	1.24	7.75	7.80	0.62	0.66
2.10	2.09	1.05	1.18	8.00	7.96	0.63	0.62
2.20	2.18	0.92	1.33	8.50	8.44	0.57	0.57
2.30	2.32	1.32	1.45	9.00	9.07	0.60	0.55
2.40	2.42	1.27	1.43	9.50	9.55	0.54	0.54
2.50	2.52	1.13	1.42	10.00	9.87	0.52	0.54
2.60	2.61	1.20	1.48	10.50	10.35	0.50	0.53
2.70	2.71	1.32	1.59	11.00	10.98	0.50	0.54
2.80	2.80	1.46	1.58	11.50	11.62	0.51	0.57
2.90	2.90	1.26	1.51	12.00	11.94	0.52	0.57
3.00	2.99	1.09	1.47	12.50	12.57	0.49	0.57
3.15	3.14	1.46	1.58	13.00	12.89	0.55	0.57
3.30	3.34	1.47	1.73	13.50	13.53	0.58	0.57
3.60	3.66	1.67	1.81	14.00	13.85	0.53	0.58
3.80	3.82	1.37	1.81	14.50	14.48	0.50	0.59
4.00	3.98	1.54	1.98	15.00	15.12	0.57	0.60
4.20	4.14	2.05	2.35	16.00	16.07	0.46	0.66
4.40	4.46	2.43	2.68	17.00	17.03	0.44	0.78
4.60	4.62	2.53	3.36	17.45	17.35	0.44	0.81
4.80	4.78	3.52	4.27	18.00	17.99	0.43	0.80
5.00	4.93	4.13	5.73	20.00	19.89	0.42	0.52

Table 3.7.1-1 (~~Sheet~~ Page 6)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
5% Critical Damping At Elev. 628+8

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.31	0.32	5.25	5.25	1.90	2.19
1.10	1.13	0.37	0.38	5.50	5.41	1.87	2.20
1.20	1.[illegible]3	0.38	0.42	5.75	5.73	1.60	1.81
1.30	1.32	0.36	0.41	6.00	6.05	1.31	1.47
1.40	1.42	0.41	0.41	6.25	6.21	1.16	1.20
1.50	1.51	0.45	0.45	6.50	6.53	0.93	1.02
1.60	1.61	0.47	0.48	6.75	6.68	0.85	0.89
1.70	1.70	0.46	0.51	7.00	7.00	0.73	0.79
1.80	1.80	0.50	0.55	7.25	7.32	0.67	0.72
1.90	1.89	0.57	0.58	7.50	7.48	0.66	0.67
2.00	2.04	0.63	0.58	7.75	7.80	0.62	0.63
2.10	2.09	0.62	0.58	8.00	7.96	0.60	0.60
2.20	2.18	0.58	0.61	8.50	8.44	0.56	0.55
2.30	2.32	0.66	0.63	9.00	9.07	0.52	0.52
2.40	2.42	0.69	0.64	9.50	9.55	0.49	0.50
2.50	2.52	0.64	0.65	10.00	9.87	0.48	0.49
2.60	2.61	0.67	0.66	10.50	10.35	0.47	0.47
2.70	2.71	0.72	0.68	11.00	10.98	0.45	0.46
2.80	2.80	0.72	0.68	11.50	11.62	0.43	0.46
2.90	2.90	0.67	0.68	12.00	11.94	0.44	0.45
3.00	2.99	0.64	0.68	12.50	12.57	0.44	0.45
3.15	3.14	0.67	0.70	13.00	12.89	0.45	0.44
3.30	3.34	0.68	0.74	13.50	13.53	0.46	0.44
3.60	3.66	0.82	0.78	14.00	13.85	0.46	0.44
3.80	3.82	0.79	0.83	14.50	14.48	0.45	0.44
4.00	3.98	0.80	0.91	15.00	15.12	0.44	0.44
4.20	4.14	0.92	1.03	16.00	16.07	0.43	0.44
4.40	4.46	1.16	1.19	17.00	17.03	0.43	0.45
4.60	4.62	1.32	1.40	17.45	17.35	0.42	0.45
4.80	4.78	1.46	1.66	18.00	17.99	0.42	0.45
5.00	4.93	1.64	1.95	20.00	19.89	0.41	0.42

Table 3.7.1-1 (~~Sheet~~ Part 7)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
0.5% Critical Damping At Elev. 662+0

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.50	0.70	5.25	5.25	9.46	10.18
1.10	1.13	0.67	0.79	5.50	5.41	7.33	10.35
1.20	1.18	0.75	0.85	5.75	5.73	4.85	6.37
1.30	1.32	0.66	0.80	6.00	6.05	3.57	4.54
1.40	1.42	0.62	0.78	6.25	6.21	2.56	3.52
1.50	1.51	0.73	0.93	6.50	6.53	2.22	2.61
1.60	1.61	0.84	1.03	6.75	6.68	1.97	2.17
1.70	1.70	0.87	1.05	7.00	7.00	1.43	1.76
1.80	1.80	1.00	1.24	7.25	7.32	1.42	1.54
1.90	1.89	1.22	1.36	7.50	7.48	1.33	1.33
2.00	2.04	1.20	1.29	7.75	7.80	1.01	1.17
2.10	2.09	1.10	1.23	8.00	7.96	1.09	1.08
2.20	2.18	0.96	1.40	8.50	8.44	0.89	0.92
2.30	2.32	1.30	1.53	9.00	9.07	0.80	0.82
2.40	2.42	1.35	1.51	9.50	9.55	0.76	0.75
2.50	2.52	1.26	1.51	10.00	9.87	0.69	0.70
2.60	2.61	1.29	1.58	10.50	10.35	0.65	0.66
2.70	2.71	1.42	1.71	11.00	10.98	0.63	0.63
2.80	2.80	1.59	1.71	11.50	11.62	0.60	0.61
2.90	2.90	1.37	1.65	12.00	11.94	0.59	0.60
3.00	2.99	1.20	1.61	12.50	12.57	0.58	0.59
3.15	3.14	1.63	1.75	13.00	12.89	0.58	0.58
3.30	3.34	1.67	1.94	13.50	13.53	0.58	0.57
3.60	3.66	1.95	2.08	14.00	13.85	0.57	0.57
3.80	3.82	1.62	2.12	14.50	14.48	0.55	0.57
4.00	3.98	1.85	2.38	15.00	15.12	0.56	0.57
4.20	4.14	2.48	2.88	16.00	16.07	0.56	0.58
4.40	4.46	3.07	3.37	17.00	17.03	0.54	0.61
4.60	4.62	3.31	4.35	17.45	17.35	0.54	0.63
4.80	4.78	4.60	5.67	18.00	17.99	0.54	0.63
5.00	4.93	5.64	7.89	20.00	19.89	0.53	0.56

Table 3.7.1-1 (~~Sheet~~ Page 8)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
5% Critical Damping At Elev. 662+0

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.31	0.33	5.25	5.25	2.66	3.09
1.10	1.13	0.38	0.39	5.50	5.41	2.67	3.14
1.20	1.18	0.39	0.42	5.75	5.73	2.34	2.65
1.30	1.32	0.36	0.42	6.00	6.05	1.93	2.17
1.40	1.42	0.41	0.42	6.25	6.21	1.70	1.80
1.50	1.51	0.46	0.46	6.50	6.53	1.37	1.52
1.60	1.61	0.48	0.50	6.75	6.68	1.20	1.33
1.70	1.70	0.48	0.53	7.00	7.00	1.05	1.19
1.80	1.80	0.53	0.57	7.25	7.32	1.01	1.08
1.90	1.89	0.60	0.60	7.50	7.48	0.97	0.99
2.00	2.04	0.66	0.61	7.75	7.80	0.90	0.92
2.10	2.09	0.66	0.61	8.00	7.96	0.87	0.87
2.20	2.18	0.61	0.64	8.50	8.44	0.78	0.79
2.30	2.32	0.71	0.67	9.00	9.07	0.73	0.74
2.40	2.42	0.74	0.68	9.50	9.55	0.70	0.70
2.50	2.52	0.69	0.69	10.00	9.87	0.67	0.67
2.60	2.61	0.73	0.71	10.50	10.35	0.64	0.64
2.70	2.71	0.79	0.73	11.00	10.98	0.62	0.62
2.80	2.80	0.78	0.74	11.50	11.62	0.60	0.61
2.90	2.90	0.73	0.75	12.00	11.94	0.59	0.60
3.00	2.99	0.71	0.76	12.50	12.57	0.58	0.59
3.15	3.14	0.75	0.79	13.00	12.89	0.57	0.58
3.30	3.34	0.79	0.84	13.50	13.53	0.57	0.57
3.60	3.66	0.96	0.92	14.00	13.85	0.56	0.56
3.80	3.82	0.93	1.00	14.50	14.48	0.56	0.56
4.00	3.98	0.97	1.12	15.00	15.12	0.56	0.55
4.20	4.14	1.16	1.30	16.00	16.07	0.55	0.55
4.40	4.46	1.50	1.54	17.00	17.03	0.54	0.54
4.60	4.62	1.73	1.85	17.45	17.35	0.54	0.54
4.80	4.78	1.95	2.25	18.00	17.99	0.54	0.54
5.00	4.93	2.23	2.67	20.00	19.89	0.53	0.53

Table 3.7.1-1 (~~Sheet~~ Page 9)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
0.5% Critical Damping At Elev. 691+2

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.50	0.71	5.25	5.25	11.62	12.60
1.10	1.13	0.67	0.80	5.50	5.41	9.12	12.83
1.20	1.18	0.76	0.86	5.75	5.73	6.14	8.12
1.30	1.32	0.67	0.81	6.00	6.05	4.59	5.89
1.40	1.42	0.63	0.79	6.25	6.21	3.35	4.63
1.50	1.51	0.75	0.94	6.50	6.53	2.93	3.50
1.60	1.61	0.85	1.05	6.75	6.68	2.68	2.97
1.70	1.70	0.89	1.10	7.00	7.00	1.99	2.45
1.80	1.80	1.03	1.27	7.25	7.32	1.96	2.15
1.90	1.89	1.26	1.40	7.50	7.48	1.88	1.88
2.00	2.04	1.24	1.33	7.75	7.80	1.39	1.66
2.10	2.09	1.14	1.27	8.00	7.96	1.54	1.55
2.20	2.18	1.00	1.45	8.50	8.44	1.28	1.33
2.30	2.32	1.36	1.59	9.00	9.07	1.24	1.18
2.40	2.42	1.41	1.57	9.50	9.55	1.07	1.07
2.50	2.52	1.32	1.58	10.00	9.87	1.00	0.99
2.60	2.61	1.36	1.66	10.50	10.35	0.91	0.91
2.70	2.71	1.51	1.80	11.00	10.98	0.87	0.87
2.80	2.80	1.69	1.81	11.50	11.62	0.83	0.85
2.90	2.90	1.45	1.75	12.00	11.94	0.77	0.82
3.00	2.99	1.28	1.72	12.50	12.57	0.80	0.79
3.15	3.14	1.76	1.89	13.00	12.89	0.75	0.77
3.30	3.34	1.83	2.10	13.50	13.53	0.74	0.75
3.60	3.66	2.18	2.29	14.00	13.85	0.72	0.74
3.80	3.82	1.82	2.37	14.50	14.48	0.70	0.72
4.00	3.98	2.10	2.69	15.00	15.12	0.66	0.71
4.20	4.14	2.82	3.30	16.00	16.07	0.64	0.70
4.40	4.46	3.56	3.91	17.00	17.03	0.64	0.71
4.60	4.62	3.92	5.12	17.45	17.35	0.63	0.70
4.80	4.78	5.45	6.78	18.00	17.99	0.63	0.70
5.00	4.93	6.79	9.60	20.00	19.89	0.62	0.64

Table 3.7.1-1 (~~Sheet~~ Page 10)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
5% Critical Damping At Elev. 691+2

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.32	0.33	5.[illegible]	5.25	3.27	3.82
1.10	1.13	0.38	0.39	5.50	5.41	3.30	3.88
1.20	1.18	0.39	0.43	5.75	5.73	2.94	3.32
1.30	1.32	0.37	0.42	6.00	6.05	2.43	2.74
1.40	1.42	0.42	0.43	6.25	6.21	2.15	2.28
1.50	1.51	0.47	0.47	6.50	6.53	1.74	1.94
1.60	1.61	0.49	0.51	6.75	6.68	1.54	1.70
1.70	1.70	0.49	0.54	7.00	7.00	1.36	1.52
1.80	1.80	0.51	0.59	7.25	7.32	1.30	1.38
1.90	1.89	0.62	0.62	7.50	7.48	1.25	1.27
2.00	2.04	0.69	0.63	7.75	7.80	1.15	1.18
2.10	2.09	0.68	0.64	8.00	7.96	1.11	1.11
2.20	2.18	0.64	0.66	8.50	8.44	1.00	1.01
2.30	2.32	0.74	0.70	9.00	9.07	0.93	0.93
2.40	2.42	0.78	0.72	9.50	9.55	0.90	0.88
2.50	2.52	0.72	0.73	10.00	9.87	0.84	0.84
2.60	2.61	0.78	0.75	10.50	10.35	0.80	0.80
2.70	2.71	0.84	0.78	11.00	10.98	0.78	0.78
2.80	2.80	0.83	0.79	11.50	11.62	0.76	0.76
2.90	2.90	0.78	0.80	12.00	11.94	0.75	0.74
3.00	2.99	0.75	0.82	12.50	12.57	0.73	0.72
3.15	3.14	0.82	0.86	13.00	12.89	0.71	0.71
3.30	3.34	0.88	0.92	13.50	13.53	0.69	0.70
3.60	3.66	1.07	1.03	14.00	13.85	0.67	0.69
3.80	3.82	1.05	1.13	14.50	14.48	0.66	0.68
4.00	3.98	1.11	1.29	15.00	15.12	0.66	0.68
4.20	4.14	1.34	1.52	16.00	16.07	0.65	0.67
4.40	4.46	1.77	1.82	17.00	17.03	0.64	0.66
4.60	4.62	2.05	2.22	17.45	17.35	0.64	0.65
4.80	4.78	2.33	2.72	18.00	17.99	0.63	0.65
5.00	4.93	2.71	3.29	20.00	19.89	0.62	0.64

Table 3.7.1-1 (~~Sheet~~ Page 11)

Comparison of Responses:
Direct Generation (FDASP) Versus Time History
0.5% Critical Damping At Elev. 713+1

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H (AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.51	0.71	5.25	5.25	13.00	14.14
1.10	1.13	0.68	0.80	5.50	5.41	10.26	14.41
1.20	1.18	0.74	0.87	5.75	5.73	6.97	9.23
1.30	1.32	0.67	0.82	6.00	6.05	5.25	6.75
1.40	1.42	0.63	0.79	6.25	6.21	3.85	5.35
1.50	1.51	0.76	0.95	6.50	6.53	3.39	4.08
1.60	1.61	0.87	1.06	6.75	6.68	3.14	3.49
1.70	1.70	0.90	1.11	7.00	7.00	2.37	2.90
1.80	1.80	1.04	1.29	7.25	7.32	2.31	2.55
1.90	1.89	1.28	1.42	7.50	7.48	2.24	2.24
2.00	2.04	1.27	1.35	7.75	7.80	1.63	1.99
2.10	2.09	1.17	1.30	8.00	7.96	1.83	1.86
2.20	2.18	1.03	1.48	8.50	8.44	1.57	1.60
2.30	2.32	1.40	1.63	9.00	9.07	1.52	1.43
2.40	2.42	1.46	1.62	9.50	9.55	1.27	1.31
2.50	2.52	1.36	1.63	10.00	9.87	1.20	1.20
2.60	2.61	1.41	1.71	10.50	10.35	1.11	1.09
2.70	2.71	1.56	1.86	11.00	10.98	1.04	1.05
2.80	2.80	1.75	1.88	11.50	11.62	0.99	1.05
2.90	2.90	1.51	1.82	12.00	11.94	0.91	1.00
3.00	2.99	1.33	1.79	12.50	12.57	0.97	0.96
3.15	3.14	1.84	1.98	13.00	12.89	0.90	0.94
3.30	3.34	1.93	2.21	13.50	13.53	0.90	0.92
3.60	3.66	2.32	2.43	14.00	13.85	0.87	0.90
3.80	3.82	1.94	2.53	14.50	14.48	0.83	0.89
4.00	3.98	2.26	2.90	15.00	15.12	0.77	0.88
4.20	4.14	3.04	3.57	16.00	16.07	0.71	0.89
4.40	4.46	3.88	4.26	17.00	17.03	0.71	0.94
4.60	4.62	4.32	5.62	17.45	17.35	0.70	0.95
4.80	4.78	6.00	7.49	18.00	17.99	0.70	0.95
5.00	4.93	7.53	10.70	20.00	19.89	0.69	0.77

Table 3.7.1-1 (~~Sheet~~ Page 12)

Comparison of Responses:
Direct Generation (EDASP) Versus Time History
5% Critical Damping At Elev. 713+1

Frequency (J)		Acceleration		Frequency (J)		Acceleration	
EDASP	T.H.	T.H.(AVE)	TH-EDAS	EDASP	T.H.	T.H.(AVE)	TH-EDAS
1.03	1.04	0.32	0.33	5.25	5.25	3.65	4.28
1.10	1.13	0.38	0.39	5.50	5.41	3.71	4.36
1.20	1.18	0.40	0.43	5.75	5.73	3.32	3.75
1.30	1.32	0.37	0.43	6.00	6.05	2.75	3.11
1.40	1.42	0.43	0.43	6.25	6.21	2.43	2.59
1.50	1.51	0.48	0.47	6.50	6.53	1.98	2.21
1.60	1.61	0.50	0.52	6.75	6.68	1.75	1.94
1.70	1.70	0.50	0.55	7.00	7.00	1.56	1.74
1.80	1.80	0.55	0.60	7.25	7.32	1.50	1.57
1.90	1.89	0.63	0.63	7.50	7.48	1.43	1.45
2.00	2.04	0.71	0.64	7.75	7.80	1.32	1.35
2.10	2.09	0.70	0.65	8.00	7.96	1.27	1.27
2.20	2.18	0.66	0.68	8.50	8.44	1.14	1.15
2.30	2.32	0.76	0.72	9.00	9.07	1.07	1.07
2.40	2.42	0.80	0.74	9.50	9.55	1.03	1.00
2.50	2.52	0.75	0.75	10.00	9.87	0.97	0.95
2.60	2.61	0.81	0.78	10.50	10.35	0.92	0.91
2.70	2.71	0.87	0.81	11.00	10.98	0.90	0.88
2.80	2.80	0.86	0.83	11.50	11.62	0.88	0.86
2.90	2.90	0.81	0.84	12.00	11.94	0.87	0.84
3.00	2.99	0.76	0.86	12.50	12.57	0.84	0.82
3.15	3.14	0.86	0.91	13.00	12.89	0.82	0.81
3.30	3.34	0.94	0.97	13.50	13.53	0.79	0.80
3.60	3.66	1.14	1.10	14.00	13.85	0.78	0.79
3.80	3.82	1.12	1.22	14.50	14.48	0.76	0.78
4.00	3.98	1.20	1.40	15.00	15.12	0.74	0.77
4.20	4.14	1.47	1.66	16.00	16.07	0.72	0.76
4.40	4.46	1.94	2.00	17.00	17.03	0.71	0.75
4.60	4.62	2.25	2.45	17.45	17.35	0.71	0.75
4.80	4.78	2.58	3.02	18.00	17.99	0.70	0.74
5.00	4.93	3.01	3.67	20.00	19.89	0.69	0.72

TABLE 3.8.2-9

ULTIMATE CONTAINMENT CAPACITY
ANALYSIS SUMMARY

Location	Ultimate Internal Pressure (PSI)	Criterion
1. Containment Shell	72	Nonlinear Axisymmetric Analysis
2. Base Anchorage	81	Concrete Shear
3. Penetrations		
a. Personnel Air Lock	79	Plastic Moment in Bulkhead
b. Equipment Hatch	80	Tensile Failure of Hatch Cover Spider
c. Spare Penetrations	1275	Yield of Pipe Cap
d. Electrical Penetrations	> 72	Connector Module Leakage
e. Bellows Assemblies	> 72	Manufacturer's Recommendation
f. Purge Penetrations	> 72	Specified to Manufacturer

TABLE 3.9.3-11 (Page 1 of 2)

Loading Conditions, Load Combination, and Allowable Stresses

for Supports, Restraints and Anchors

Duke Classes A, B, C and F(6)

CONDITION	LOAD COMBINATION	NON-NF ALLOWABLE STRESSES(3)
Normal	Thermal(2) + Pressure (as applicable) + Weight	1.0S
Upset	Thermal(2) + Thermal Transients + OBE + OBE Seismic Anchor Movement + Pressure (as applicable) + Weight + Steam Hammer + Relief Valve	1.0S
Faulted	+ 15/8 OBE + 15/8 OBE Seismic Anchor Movement + Pressure (as applicable) + Weight + Steam Hammer + Pipe Rupture (as applicable) + Relief Valve	1.5S
Hydro	Thermal(1) + Pressure (as applicable) + Weight	1.0S

NOTES:

(1) Thermal load for hydro conditions will be zero except for cold pulled systems.

(2) Use greater of hot load or 1/3 cold load for cold pulled systems hot condition. Use cold load for cold pulled system cold condition.

(3) Stress limits for those portions within the NF jurisdictional boundaries are in accordance with the applicable paragraphs of Subsection NF as described in Subsection 3.9.3.1.5.

(4) For faulted and upset load conditions, a case which replaces seismic and seismic anchor movement with design bases Tornado, applied to outside piping, must also be considered.

(5) S = allowable stress from AISC manual

TABLE 3.9.3-11 (Page 2 of 2)

Loading Conditions, Load Combination, and Allowable Stresses

for Supports, Restraints and Anchors

Duke Classes A, B, C and F(6)

Notes:

(6) Stresses for Supports, Restraints, and Anchors on Duke Classes E, G, and H piping identified as necessary to prevent interaction with Classes A, B, C and F piping are limited to the value of this table.

TABLE 3.9.3-12

Loading Conditions and Load Combination

Requirements for Snubbers

Duke Classes A, B, C, F[3]

CONDITION	LOAD COMBINATION
Normal and Upset	OBE OBE Seismic Anchor Movement + Steam Hammer + Relief Valve
Faulted	15/8 OBE 15/8 OBE Seismic Anchor Movement + Steam Hammer + Relief Valve

NOTES:

(1) For the Normal and Upset Conditions the total of applied piping loads to be less than manufacturer's Normal load rating.

(2) For the Faulted Condition, the total of applied piping loads to be less than manufacturer's Faulted load rating.

(3) For Duke Classes E, G, and H piping identified as necessary to prevent interaction with Classes A, B, C, and F piping are limited to the valves of this Table.