ATTACHMENT D
CALC NO 50.01IPEEEHCLPF01
REVISION 00
PAGE NO B1

Client: NMPC

Calculation No. 95C2873-C001

Title: Block Wall Screening Spreadsheet

Project: NMP1 IPEEE

Method: Elastic Analysis and Limiting Drift Analysis

Acceptance Criteria: EPRI NP-6041

Remarks:

REVISIONS

No.	Description	By	Date	Chk.	Date	App.	Date
0	Initial Issue	TMT	7/26/95	MSLi	8/23/95	WD	9/5/95

S&A Stevenson & Associates

CALCULATION COVER SHEET

FIGURE 1.3

CONTRACT NO.

95C2783

S&A	JOB NO. 95C2873-C001 SUBJECT NMP1 IPEEE	SHEET # 2 OF 9
STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	Block Wall Screening Spreadsheet	Revision By TMT 7/26/95 Chk. MSL 8/23/95

Background

This calculation documents the seismic screening spreadsheet for the block walls in the Nine Mile Point 1 stationas part of the IPEEE evaluation. Page 1 of the spreadsheet provides the basis for preliminary screening. If the block walls do not pass the preliminary screening, page 2 can be used which allows the wall to drift during an earthquake.

The block walls in NMP1 are typically made of 8" and 12" hollow blocks reinforced by #4 bars @32" [4]. The reinforced cell is filled with concrete. Wall bottom is reinforced with existing dowels @ 16" spacing. The walls are reinforced horizontally by Dur-O-Wall, or 3/16" deformed side rods at 16" spacing [4]. The sides of the walls are tied in to precast concrete with two 1/4" threaded rods into inserts.

The walls are considered well anchored at the ends. In the pre-screening, only the out-of-plane bending moment at the center of the wall is checked. The in-plane loading is neglected. The slight beneficial effect due to the gravity is also ignored.

Solution Methodology

The solution is mainly based on EPRI NP-6041 [1] Appendix R without taking advantage of the permissible drift. In addition to the methodology of [1], two-way plate action is considered in both the frequency estimation and the maximum moment estimation.

<u>Elastic Frequency</u>

Instead using the formula in [1], the two-way rectangular plate frequency formular from [3], p. 258 will be used. The wall is assumed to be simply-supported on all four sides,

$$f = \frac{\lambda^2}{2\pi W^2}\sqrt{\frac{E_m I_e g}{q(1-\nu^2)}}$$

where

$$\lambda^2 = \pi^2\left[1+\left(\frac{W}{H}\right)^2\right]$$

W = Width of the wall
H = Height of the wall
q = Weight per unit wall area
ν = Poisson's ratio
E_m = elastic modulus of masonry $\approx 750\ f'_m$ (psi)
I_e = Effective moment of inertia

$$= I_T + \left(\frac{M_{CR}}{M_{CDFM}}\right)^3 (I_g - I_T) \le I_g$$

I_g = Gross moment of inertia
I_T = Cracked section transformed moment of inertia

M_{CR} = Cracking moment = $f_T S_g$
f_T = Cracking tension in flexure $\approx 2.5\sqrt{f_m'}$ (psi)
S_g = Gross section modulus = $2I_g / D$

Since the walls are hollow, it is grouted only at the reinforcement, the moment of inertia will calculated using the concrete block cover only.

$$I_g = bt(D-t)^2 / 2$$

where b = unt width of the wall, and t = thickness of cover. For the cracked section, the location of the neutral axis from the compression face can be estimated by solving

$$x\left(\frac{x}{2}\right) - nA_s(d-x) = 0$$

where

$$n = \frac{E_s}{E_m}$$

E_s = elastic modulus for rebars

assuming x does not exceed t, the cracked section moment of inertia

$$I_T = \frac{bx^3}{3} + nA_s(d-x)^2$$

<u>Vertical Moment Capacity</u>

$$M_V = 0.9M_U = 0.9A_s f_y\left[d - \frac{a}{2}\right]$$

where

A_s = steel area per unit width
f_y = yield strength of rebar
d = depth from the compressive face to the center of steel = $D/2$
D = Depth of wall

$$a = \frac{A_s f_y}{0.85 f_m'}$$

f_m' = specified compressive strength of masonry (psi)

The vertical moment capacity is defined as the larger of the M_V or the cracking moment M_{CR} defined in the previous section.

Horizontal Moment Capacity

Since the Dur-O-Wall horizontal reinforcement has only 0.028 in^2 every 16", in addition the splice is only 6", which will not be able to sustain the yield strength of the bars, the bending in the horizontal direction will be governed by the cracking moment of the blocks.

According to [7], Table 6.3.1.1, the allowable flexural tension parallel to bed joint is at least 133% of the tensile strength when stressed normal to bed joints.

$$M_H = 1.33 M_{CR}$$

Maximum Moment

The maximum moment in the wall will be determined by the close form solutions presented in [2], Section 30, pp. 113-119 assuming all edges of the wall are simply-supported. The maximum moment occurs at the center of the wall

$$(M_x)_{y=0} = \frac{qx(W-x)}{2} - qW^2\pi^2 \sum_{m=1,3,5...}^{\infty} m^2\left[2\nu B_m - (1-\nu)A_m\right]\sin\frac{m\pi x}{W}$$

$$(M_y)_{y=0} = \nu\frac{qx(W-x)}{2} - qW^2\pi^2 \sum_{m=1,3,5...}^{\infty} m^2\left[2B_m + (1-\nu)A_m\right]\sin\frac{m\pi x}{W}$$

$$(M_x)_{max} = (M_x)_{y=0,x=W/2} = \frac{qW^2}{8} - qW^2\pi^2 \sum_{m=1,3,5...}^{\infty} m^2\left[2\nu B_m - (1-\nu)A_m\right]\sin\frac{m\pi}{2}$$

$$= \left(\frac{1}{8} - \pi^2 \sum_{m=1,3,5...}^{\infty} m^2\left[2\nu B_m - (1-\nu)A_m\right]\sin\frac{m\pi}{2}\right)qW^2$$

$$= \beta qW^2$$

$$(M_y)_{max} = (M_y)_{y=0,x=W/2} = \nu\frac{qW^2}{8} - qW^2\pi^2 \sum_{m=1,3,5...}^{\infty} m^2\left[2B_m + (1-\nu)A_m\right]\sin\frac{m\pi}{2}$$

$$= \left(\frac{\nu}{8} - \pi^2 \sum_{m=1,3,5...}^{\infty} m^2\left[2B_m + (1-\nu)A_m\right]\sin\frac{m\pi}{2}\right)qW^2$$

$$= \beta_1 qW^2$$

where

S&A	JOB NO. 95C2873-C001	SHEET # 5
	SUBJECT NMP1 IPEEE	OF 9
STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	Block Wall Screening Spreadsheet	Revision
		By TMT 7/26/95
		Chk. MSL 8/23/95

$$A_m = -\frac{2(\alpha_m \tanh\alpha_m + 2)}{\pi^5 m^5 \cosh\alpha_m}$$

$$B_m = \frac{2}{\pi^5 m^5 \cosh\alpha_m}$$

Spectral Acceleration

The spectral acceleration will be extracted from the corresponding Floor Response Spectrum at the bottom and the top of the block wall. The average of the top and bottom acceleration will be used in the spreadsheet.

HCLPF

The *HCLPF* will be estimated by the minimum of

$$HCLPF_V = \frac{(M_y)_{max}}{M_V}(PGA)$$

and

$$HCLPF_H = \frac{(M_x)_{max}}{M_H}(PGA)$$

Pre-Screening Implementation

The above procedure is implemented in an Excel spreadsheet, BWSCREEN.XLS, sheet BLOCK.

Block Wall Compression Strength f_m'

Based on test results in Ref. [5] and [6], the average compressive strength is 2,920 psi with a standard deviation of 400 psi. Following the guideline of [1], the SMA strength capacity for non-ductile materials should be set the 99% level, therefore, it is recommended that

$$f_m' = 2{,}920 - 2.3 * 400 = 2{,}000 \text{ psi}$$

Weight

Lacking detailed information, the following weight may be used [8] for hollow walls

Wall thickness	Unit Weight
6"	43 lb/ft^2
8"	55
12"	80

Any attached weight on the wall, including electrical boxes, conduits, etc. should be added to the total weight.

Response Spectra Damping
When retrieving spectral values, 7% damping similar to reinforced concrete structures may be used for the preliminary screening.

HCLPF Based on NP-6041, Appendix R

Alternative to the above elastic solution, the following calculation allowing the block wall to drift based on Appendix R of [1] is presented in a spreadsheet.

Based on the above parameters, the CDFM permissible drift limit is determined by

$$\left(\frac{\Delta_u}{H}\right)_{CDFM} = \frac{0.005}{c/d} F_c \leq 0.04$$

where

$$F_c = \frac{H/d}{30} \leq 1.0$$

Seismic Capacity
Based on Ref. [1], for a simply supported uniformly loaded non-load bearing masonry wall, the seismic spectral acceleration capacity is

$$\frac{S_{Ac}}{g} = \left\{\frac{8M_{CDFM}}{qH^2} - 4\left(\frac{\Delta_u}{H}\right)\right\}.$$

Secant Frequency
In determining the seismic demand using the equivalent linear elastic procedure, an effective frequency is required. According to Ref. [1], the secant frequency corresponding to an ultimate nonlinear displacement Δ_u is

$$f_s = \frac{1}{2\pi}\sqrt{\frac{1.5S_{Ac}}{\Delta_u}}$$

The effective nonlinear seismic demand can be approximated by treating the walls as pseudo-elastic with an effective frequency equals f_s and effective damping β_e at about 6% [1]. Therefore

$$S_{A_D} = S_A(f_s,\ 6\%)$$

The scale factor to be applied to a reference input spectrum is

$$F_{S_I} = \frac{S_{A_C}}{S_{A_{DR}}}$$

The HCLPF can then be obtained by

$$\text{HCLPF} = F_{S_I}\,(\text{PGA})$$

The computation has been implemented in the spreadsheet file BWSCREEN.XLS, sheet DRIFT.

Note that the elastic frequency is lower than that of the pre-screening spreadsheet, because Appendix R of NP-6041 assumes the wall to span one way vertically while in the pre-screening, two-way action is used. The final HCLPF is the maximum within the drift limits in the sheet. In some cases with large drift, the seismic capacity may turn negative. These limiting cases should be ignored.

References

1. EPRI NP-6041, "A Methodology for Assessment of Nuclear Power Plant Seismic Margin," Revision 1, Final Report, August 1991.

2. Tomoshenko and Woinowsky-Krieger, "Theory of Plate and Shells," 2nd Edition, McGraw-Hill, 1959.

3. Blevins, "Formulas for Natural Frequency and Mode Shape," Van Nostrand Reinhold, 1979.

4. NMP1 Drawing C-18801-C, Rev. 6, Turbine Building Battery Board Room at El. 261'-1", Plane Sections and Details.

5. NMP1 Calculation S6-IE8011-MWR1, Masonry Wall Ref. 1. 1987.

6. NMP1 Calculation S6-IE8011-MW, Masonry Walls, 1987.

7. ACI 530-92/ASCE 5-92/TMS 402-92, Building Code Requirements for Masonry Structures, 1992.

8. AISC, Steel Construction Manual, 8th Edition.

S&A	JOB NO. 95C2873-C001 SUBJECT NMP1 IPEEE	SHEET # 8 OF 9
STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	Block Wall Screening Spreadsheet	Revision By TMT 7/26/95 Chk. MSL 8/23/95

Block Wall Preliminary Screnning Based on S&A Calculation 95C2873-C001:			
Wall Name:	Diesel Generator Area Block Wall #29 (Example)		
User Input:			Remark
Height (H)	36.8	ft	Total unsupported height of block wall
Span (W)	40	ft	Unsupported horizontal span
Weight (q)	79	lb/ft^2	Weight per unit area
Nominal Depth	12	in	
Sa Top	0.41	g	Top spectral acceleration
Sa Bottom	0.36	g	Bottom spectral acceleration
Sa	0.385	g	Average spectral acceleration (7% damping)
Constant Fields:			
Cover Thickness	1.25	in	
Poisson's Ratio	0.15		
f'm	2000	psi	Mortar compressive strength
fy	40000	psi	Steel yield strength
Steel Area (As)	0.00625	in^2/in	#4 bar @ 32"
PGA	0.13	g	Peak Ground Accleration for FRS
Em	1500000	psi	750 * f'm
Es	29000000	psi	
n	19.33		
Calculated Fields:			
Actual Depth (D)	11.625	in	3/8" less than nominal
d	5.8125	in	
Ig	67.28	in^4/in	Section moment of inertia
Sg	11.57	in^3/in	Section modulus
fT	111.80	psi	Flexural strength
Mcr	1.29	k-in/in	Cracking coment
x	1.07	in	
It	3.13	in^4/in	
Ie	67.28	in^4/in	
Frequency (f)	4.01	Hz	Fundamental frequency
a	0.147	in	
Mv	1.29	k-in/in	
Mh	1.72	k-in/in	
Beta1	0.0416		Moment coefficient
My	2.02	k-in/in	Maximum horizontal moment
Beta	0.0361		Moment coefficient
Mx	1.76	k-in/in	Maximum vertical moment
HCLPF	0.083	g	

S&A	JOB NO. 95C2873-C001 SUBJECT NMP1 IPEEE	SHEET # 9 OF 9
STEVENSON & ASSOCIATES a structural-mechanical consulting engineering firm	Block Wall Screening Spreadsheet	Revision By TMT 7/26/95 Chk. MSL 8/23/95

Drift Calculation Based on EPRI NP-6041, Appendix R						
Cotinuation on Wall:	Diesel Generator Area Block Wall #29 (Example)					
As	0.00625	in^2				
d	5.81	in				
ρ	0.00108					
a	0.147	in				
c	0.173	in				
c/d	0.030					
L	441.6	in				
Fc	1		NP-6041 Eq. R-14			
Δu / L	0.040		NP-6041 Eq. R-15			
Δu	17.66	in	CDFM Permissible Drift Limit			
W	0.549	lb/in^2				
MPΔ	2.14	k-in/in				
MCDFM	1.29	k-in/in				
Drift Ratio	Drift	Frequency	Reference Demand	Capacity	Scale Factor	HCPLF
Δu / L	Δu (in)	f (Hz)	SADR (g)	SAC (g)	FSI	g
Elastic	0.00	2.158	0.281	0.097	0.34	0.045
0.005	2.21	0.713	0.092	0.077	0.84	0.109
0.01	4.42	0.434	0.057	0.057	0.99	0.129
0.02	8.83	0.166	0.025	0.017	0.68	0.088
0.03	13.25	#NUM!		-0.023	#DIV/0!	
0.04	17.66	#NUM!		-0.063	#DIV/0!	
HCLPF	0.129	g				

Client: Niagara Mohawk Power Corporation
Calculation No. C-004

Title: Fragility Analysis of Selected Block Walls in Nine Mile Point Unit I

Project: Nine Mile Point I IPEEE

Method:

Acceptance Criteria: EPRI NP-6041, Appendix R

Remarks:

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0	Original Issue	MSLi	8/25/95	TMT	8/25/95	WD	10/17/95

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CALCULATION COVER SHEET

FIGURE 1.3

CONTRACT NO.

95C2873

S&A Stevenson & Associates a structural-mechanical consulting engineering firm	PROJECT NO. 95C2873 CAL. NO. C-004 SUBJECT: NMPI IPEEE	SHEET #1 2 of 16 17 Revision 0
	Fragility Analysis of Selected Block Walls in Nine Mile Point Unit I	By MSL 8/25/95 Chk. TMT 8/25/95

This calculation documents the HCLPF evaluation for selected block walls in Nine Mile Point Unit I (NMPI). The list is based the walls that are not screened in NMPC's report, "Nine Mile Point 1 - IPEEE, Seismic Analysis - Masonry Wall Screening & Evaluation," Rev. 0, August 1995, spreadsheet on page 3, except for walls 32, 33, 35, and 104, which were screened on page 8 of the NMPC report, and wall 48 which has a HCLPF value greater than 0.3g in the preliminary screening.

The calculation is based on the following material properties used,

$f'_m = 2{,}000$ psi
$f_y = 40{,}000$ psi

Some of the earlier NMPI block wall calculations use $f'_m = 700$ psi but most recent calculations use higher f'_m value than the value used in this calculation.

Wall #	Location	Thick	Reinforcement	Size	HCLPF	Comments
22	RX261	16" Solid	#4 bar @ 16" EF	18.5' H x 20' W	0.53 g	Two-way slab
34	SH256	12" Hollow	unreinforced	16' H x 33' W	0.31 g	Two-way slab
23-1	TB261	8" Hollow	#4 bar @ 16"	14' H x 20' W	> 0.3 g	See Wall #24 and need to verify the reinforcement
23-2	TB261	12" Hollow	#4 bar @ 16"	14' H x 20' W	> 0.3 g	See Wall #24 and need to verify the reinforcement
24	TB261	8" Hollow	#4 bar @ 48"	14' H x 20' W	0.39 g	Two-way slab
27	TB261	12" Hollow	#4 bar @ 32"	13.5' H x 60' W	0.41 g	One-way slab with drift
29	TB261	12" Hollow	#4 bar @ 32"	38.8' H x 40' W	0.13 g	One-way slab with drift
53	TB277	12" Hollow	#4 bar @ 32"	20' H x 49.5' W	0.39 g	One-way slab with drift
47-1	TB277	8" Hollow	#4 bar @ 32"	12' H x 40' W	0.47 g	One-way slab with drift
47-2	TB277	12" Hollow	#4 bar @ 32"	21.4' H x 30' W	0.34 g	One-way slab with drift
49	TB277	8" Hollow	#5 bar @ 24"	21' H x 25' W	0.33 g	Two-way slab
52	TB277	12" Hollow	#4 bar @ 32"	20.25' H x 40' W	0.37 g	One-way slab with drift

Block Wall Preliminary Scrcredits Based on S&A Calculation 95C2873-C001:			
Wall Name:	Stairwell Enclosure Area Block Wall #24 with horizontal span of 20'		
User Input:			Remark
Height (H)	14	ft	NMPI Calc. No. S6-TB261-MW24, Rev. 0, page 4
Span (W)	20	ft	NMPI Calc. No. S6-TB261-MW24, Rev. 1, page 9
Weight (q)	55	lb/ft^2	NMPI Calc. No. S6-TB261-MW24, Rev. 0, page 4
Nominal Depth	8	in	NMPI Calc. No. S6-TB261-MW24, Rev. 0, page 4
Sa Top	0.385	g	Average of 0.4g (5%) and 0.37g (7%) at TB 277' BD11 NS
Sa Bottom	0.245	g	Average of 0.25g (5%) and 0.24g (7%) at TB 261' BE10 NS
Sa	0.315	g	Average spectral acceleration (6% damping)
Constant Fields:			
Cover Thickness	1.25	in	
Poisson's Ratio	0.15		
f'm	2000	psi	Mortar compressive strength
fy	40000	psi	Steel yield strength
Steel Area (As)	0.0042	in^2/in	#4 bar @ 48" (NPMI Drwg. #F-45030-C)
PGA	0.13	g	Peak Ground Accleration for FRS
Em	1500000	psi	750 * f'm
Es	29000000	psi	
n	19.33		
Calculated Fields:			
Actual Depth (D)	7.625	in	3/8" less than nominal
d	3.8125	in	
Ig	25.40	in^4/in	Section moment of inertia
Sg	6.66	in^3/in	Section modulus
fT	111.80	psi	Flexural strength
Mcr	0.74	k-in/in	Cracking coment
x	0.71	in	
It	0.89	in^4/in	
Ie	25.40	in^4/in	
Frequency (f)	16.46	Hz	Fundamental frequency
a	0.098	in	
Mv	0.56	k-in/in	
Mh	0.99	k-in/in	
Beta1	0.0357		Moment coefficient
My	0.25	k-in/in	Maximum horizontal moment
Beta	0.0195		Moment coefficient
Mx	0.14	k-in/in	Maximum vertical moment
HCLPF	0.392	g	

NMP1 IPEEE
Project 95C2873
Calc. No. C-004

Block Wall Preliminary Screnning Based on S&A Calculation 95C2873-C001:			
Wall Name:	Auxiliary Control Room Block Wall #27 with horizontal span of 60'		
Block Wall along Column Line BB or A is checked			
since the spectra acceleration is always higher in the North/South direction.			
User Input:			Remark
Height (H)	13.5	ft	NMPI Calc. No. S6-TB261-MW27, Rev. 0, page 8
Span (W)	60	ft	NMPI Calc. No. S6-TB261-MW27, Rev. 0, page 4
Weight (q)	101.3	lb/ft^2	NMPI Calc. No. S6-TB261-MW27, Rev. 0, page 5
Nominal Depth	12	in	NMPI Calc. No. S6-TB261-MW27, Rev. 0, page 4
Sa Top	0.5	g	Average of 0.536 (5%) and 0.463g (7%) at TB 277' BD11 NS
Sa Bottom	0.302	g	Average of 0.316g (5%) and 0.288g (7%) at TB 261' BE10 NS
Sa	0.401	g	Average spectral acceleration (6% damping)
Constant Fields:			
Cover Thickness	1.25	in	
Poisson's Ratio	0.15		
f'm	2000	psi	Mortar compressive strength
fy	40000	psi	Steel yield strength
Steel Area (As)	0.00625	in^2/in	#4 bar @ 32" (NMPI DWG #F-45030-C & Calc. No. S6-TB261-MW27, Rev. 0, page 4)
PGA	0.13	g	Peak Ground Accleration for FRS
Em	1500000	psi	750 * f'm
Es	29000000	psi	
n	19.33		
Calculated Fields:			
Actual Depth (D)	11.625	in	3/8" less than nominal
d	5.8125	in	
Ig	67.28	in^4/in	Section moment of inertia
Sg	11.57	in^3/in	Section modulus
fT	111.80	psi	Flexural strength
Mcr	1.29	k-in/in	Cracking coment
x	1.07	in	
It	3.13	in^4/in	
Ie	67.28	in^4/in	
Frequency (f)	14.97	Hz	Fundamental frequency
a	0.147	in	
Mv	1.29	k-in/in	
Mh	1.72	k-in/in	
Beta1	0.0063		Moment coefficient
My	0.92	k-in/in	Maximum horizontal moment
Beta	0.0010		Moment coefficient
Mx	0.14	k-in/in	Maximum vertical moment
HCLPF	0.183	g	

Block Wall Preliminary Screnning Based on S&A Calculation 95C2873-C001:			
Wall Name:	Diesel Generator Area Block Wall #53 with horizontal span of 49.5'		
User Input:			Remark
Height (H)	20	ft	NMPI Calc. No. S6-TB277-MW53, Rev. 0, page 5
Span (W)	49.5	ft	NMPI Calc. No. S6-TB277-MW53, Rev. 0, page 5
Weight (q)	66	lb/ft^2	NMPI Calc. No. S6-TB277-MW53, Rev. 0, page 5
Nominal Depth	12	in	NMPI Calc. No. S6-TB277-MW53, Rev. 0, page 4
Sa Top	0.864	g	Average of 0.950g (5%) and 0.778g (7%) at TB 300' BC10A EW
Sa Bottom	0.5085	g	Average of 0.553g (5%) and 0.464g (7%) at TB 277' BD11 EW
Sa	0.68625	g	Average spectral acceleration (6% damping)
Constant Fields:			
Cover Thickness	1.25	in	
Poisson's Ratio	0.15		
f'm	2000	psi	Mortar compressive strength
fy	40000	psi	Steel yield strength
Steel Area (As)	0.00625	in^2/in	#4 bar @ 32" (NMPI DWG #F-45030-C)
PGA	0.13	g	Peak Ground Accleration for FRS
Em	1500000	psi	750 * f'm
Es	29000000	psi	
n	19.33		
Calculated Fields:			
Actual Depth (D)	11.625	in	3/8" less than nominal
d	5.8125	in	
Ig	67.28	in^4/in	Section moment of inertia
Sg	11.57	in^3/in	Section modulus
f'r	111.80	psi	Flexural strength
Mcr	1.29	k-in/in	Cracking coment
x	1.07	in	
It	3.13	in^4/in	
Ie	67.28	in^4/in	
Frequency (f)	9.35	Hz	Fundamental frequency
a	0.147	in	
Mv	1.29	k-in/in	
Mh	1.72	k-in/in	
Beta1	0.0181		Moment coefficient
My	2.01	k-in/in	Maximum horizontal moment
Beta	0.0044		Moment coefficient
Mx	0.48	k-in/in	Maximum vertical moment
HCLPF	0.084	g	

Drift Calculation Based on EPRI NP-6041, Appendix R											
Wall Name:	Diesel Generator Area Block Wall #53 with horizontal span of 49.5'										
			Remark								
As	0.00625	in^2									
d	5.81	in									
ρ	0.00108										
a	0.147	in									
c	0.173	in									
c/d	0.030										
L	240.0	in									
Fc	1		NP-6041 Eq. R-14								
Δu / L	0.040		NP-6041 Eq. R-15								
Δu	9.60	in	CDFM Permissible Drift Limit								
W	0.458	lb/in^2									
MPΔ	0.53	k-in/in									
MCDFM	1.29	k-in/in									
Drift Ratio	Drift	Frequency	SaBot (5%)	SaBot (7%)	SaTop (5%)	SaTop (7%)	Reference Demand	Capacity	Scale Factor	HCPLF	
Δu / L	Δu (in)	f (Hz)	g	g	g	g	SADR (g)	SAC (g)	FSI	g	
Elastic	0.00	7.993	0.506	0.439	0.752	0.620	0.579	0.391	0.68	0.09	
0.005	1.20	2.131	0.280	0.255	0.285	0.255	0.269	0.371	1.38	0.18	
0.01	2.40	1.466	0.190	0.160	0.200	0.160	0.178	0.351	1.98	0.26	
0.02	4.80	0.976	0.130	0.115	0.135	0.115	0.124	0.311	2.52	0.33	
0.03	7.20	0.744	0.097	0.084	0.097	0.085	0.091	0.271	2.99	0.39	
0.04	9.60	0.595	0.083	0.073	0.083	0.073	0.078	0.231	2.97	0.39	
Drift HCLPF	0.39	g									

TABLE 1

TABLE 1

Table -1 - Status of NMP1 IPEEE Improvement Initiatives					
Action ID	IPEEE Section	Improvement	Benefit	Significance	Status
1	Seismic	Control room panels F through N require top cross-ties	Control room panels have weak lateral support and could twist and separate in an earthquake. This would render a significant portion of the control room inoperable and would likely force evacuation and thereby significantly affect success path capabilities.	High, control room response following an earthquake is critical and should be reliable.	DER 1-95-3212 complete
2	Seismic	Power boards 16A/B and 17A/B require base plug welding	These power boards are weakly anchored and could topple in an earthquake. This would fail a significant amount of equipment, combined with the likely coincident LOSP, would fail the success path.	High, failure of these power boards, combined with LOSP, would fail the success path.	DER 1-95-3140 in process, due RFO15 per A-46 program action plan
3	Seismic	Power boards 102/103 require rear base plug welding	These power boards are weakly anchored and could topple in an earthquake. This would fail a significant amount of equipment, combined with the likely coincident LOSP, would fail the success path.	High, failure of these power boards, combined with LOSP, would fail the success path.	DER 1-95-3090, 3091 in process, due RFO15 per A-46 program action plan
4	Seismic	Aux Control room cabinets 1S34, 35, 36, 51, 52, 53, 54, 55, 56, 57, 59, 60, 62, 63, 64, 65, 69, 70, 73, 74, 75 require base fillet weld	1S34 through 36 have little impact, but could topple over on other critical cabinets with success path components. Cabinets 59, 60, 63, 64, 73 and 74 are also important based on containing success path components. The remaining cabinets are not important except to the extent they can impact other important cabinets.	High, failure of these cabinets can fail most if not all of the success path.	DER 1-95-3147, 3148, 3149, 3151, 3152, complete
5	Seismic	Aux Control room cabinets 1S37 through 39 require positive anchorage	These cabinets can topple on cabinets 1S80, 82, 84, 85, 86, 87, 88 failing all emergency AC power, Panels 1S37 and 1S38 dominate risk considerations.	High, failure of emergency AC, combined with LOSP, would fail the success path.	DER 1-95-3147, 3148, 3149, 3151, 3152, complete
6	Seismic	Aux Feed breakers require additional anchorage	Should these circuit breakers fail to transfer on demand they could align the EDGs to offsite power and effectively fail the EDGs.	High, failure of these circuit breakers, combined with LOSP, would fail the success path.	DER 1-95-3141 complete
8	Seismic	Cable tray in turbine building El261 requires rod replacement	Failure of these cable trays could cause station blackout.	High, station blackout would fail the success path.	DER 1-95-2518 complete

Table -1 - Status of NMP1 IPEEE Improvement Initiatives					
Action ID	IPEEE Section	Improvement	Benefit	Significance	Status
9	Fire, Others	Enhance operator training on procedure N1-SOP-14 to include station blackout (SBO) mitigation without DC power	Long term unrecoverable SBO was a somewhat minor contributor in the IPE. However, IPEEE scenarios where AC power cannot be recovered are more prevalent. Fire and high winds can lead to SBO scenarios where recovery is not likely for much longer than the 8 hours currently considered for SBO mitigation. It is proposed to have operator training review the procedure N1-SOP-14 "Alternate Instrumentation" in the context of a SBO with DC power unavailable. This would better enable NMP1 to cope with a long term SBO and would give NMP1 a capability unique within the nuclear industry.	High, this action item is considered to be significant such that IPEEE results will be adversely affected should it not be implemented	Training Review Request (TRR) written and approved for Training Advisory Committee review.
10	Fire	Storage of combustibles in fire area T3B should be curtailed or more tightly controlled	Cables associated with both divisions of emergency AC, DC, and various front-line systems (i.e., feedwater) are located in the south-east corner of the turbine building (el 261') near the old personnel access point. During recent IPEEE team walkdowns, a number of combustibles were noted in this immediate vicinity. These combustibles included: five drums filled with oily rags, paint cans, bags of trash, electronic equipment, and aerosol spray cans. All of these sources lead to a relatively high transient fire event probability in this area. Curtailing storage would reduce a significant fire related safety issue.	High, a relatively minor fire could result in severe plant impacts	DER 1-96-1737 complete
11	Seismic	Cast iron inserts require tightness check and possible replacement	Cast iron inserts are used widely to attach cable trays to ceilings. Failure could result in widespread cable tray failure and failure of associated cables and equipment. Reliability of these components is crucial to maintaining the capability of the success path.	High, widespread failure of these anchors could fail the success path.	The limited analytical review (LAR) performed within A-46 evaluated cable trays with cast iron inserts. The LAR determined the actual load is less than the insert allowable. Item closed.
12	Seismic	Lead cinch anchors require tightness check and possible replacement	Lead cinch anchors are used for anchorage of various success path components. Their reliability is important to earthquake mitigation.	High, widespread failure of these anchors could fail the success path.	Complete

Table -1 - Status of NMP1 IPEEE Improvement Initiatives

Action ID	IPEEE Section	Improvement	Benefit	Significance	Status
13	Seismic	Secure control room ceiling panel diffusers to T-bars in ceiling	Ceiling panels could fall during a seismic event and impact operators. Modification would improve operator safety and effectiveness.	Moderate, would not necessarily affect success path capability; would affect operator reliability.	DER 1-97-0908 complete
14	Fire	The following are potential improvements in critical areas requiring analysis: 1. Additional control of combustibles (C1, T2B) 2. Thermography or a barrier (C1, T3B) 3. Move a small transformer or use of thermography (T3B)	These areas (cable spreading room, turbine building - southeast and turbine building north wall next to elevator) and scenarios contribute to the fire analysis results. Thus, any inexpensive change to the plant can have a relatively large benefit.	Moderate	These areas have been added to the thermography program.
15a	Seismic	Relay 31D-X requires replacement or procedure change	This normally deenergized relay enables EDG field flashing. If normally open (NO) relay contact chatters, EDG breaker will close and trip EDG. If normally closed (NC) contact chatters, the field flash contactor 31D will chatter while passing field current and would likely result in catastrophic failure of the contact thus preventing EDG restart.	High, failure of this relay, combined with LOSP, would fail the success path.	DER 1-94-1077 complete
15b	Seismic	Relay 67NI requires testing, replacement, or procedure change	This relay can momentarily actuate causing 86DG-3 relay to trip the EDG and the associated circuit breaker.	Moderate, results in EDG trip but failure is recoverable; EDG will restart on undervoltage after seismic motion subsides and breaker recloses automatically.	Temporary procedure in place, due RFO15 per A-46 program action item
15c	Seismic	Relay 87DG-2 requires testing, replacement, or procedure change	This relay can momentarily actuate trip of the EDG and closure of associated circuit breaker.	Moderate, results in EDG trip but failure is recoverable; EDG will restart on undervoltage after seismic motion subsides and breaker recloses automatically.	Temporary procedure in place, long term fix via DER 1-96-1361 due RFO15

Table -1 - Status of NMP1 IPEEE Improvement Initiatives					
Action ID	IPEEE Section	Improvement	Benefit	Significance	Status
15c	Seismic	Relay 51G requires testing, replacement, or procedure change	This relay can energize a trip of offsite power and prevent EDG breaker closure until relay is reset.	Moderate, results in EDG breaker trip but failure is recoverable; EDG will restart on undervoltage after seismic motion subsides and breaker recloses automatically.	Temporary procedure in place, due RFO15 per A-46 program action item
15d	Seismic	Relay 50/51 requires testing, replacement, or procedure change	This relay can energize a trip of offsite power and prevent EDG breaker closure until relay is reset.	Moderate, results in EDG breaker trip but failure is recoverable; EDG will restart on undervoltage after seismic motion subsides and breaker recloses automatically.	Temporary procedure in place, due RFO15 per A-46 program action item
15e	Seismic	Relay 1H-9 requires replacement or procedure change	This relay in the fire actuation system could actuate in a relatively minor seismic event. This would cause isolation of the EDG room HVAC system and actuation of Cardox fire suppression in several areas. Improvement of these relays would enhance the probability that important equipment is available to mitigate the impact of earthquakes.	Moderate, these relays could trip EDG ventilation which could only affect the EDG after some duration judged to be at least 30 minutes. Cardox initiation could affect operator actions outside the control room but this is not expected to be significant, actions can still be accomplished.	DER 1-95-2987 due RFO15
15f	Seismic	Relay 1H-10 requires replacement or procedure change	This relay in the fire actuation system could actuate in a relatively minor seismic event. This would cause isolation of the EDG room HVAC system and actuation of Cardox fire suppression in several areas. Improvement of these relays would enhance the probability that important equipment is available to mitigate the impact of earthquakes.	Moderate, these relays could trip EDG ventilation which could only affect the EDG after some duration judged to be at least 30 minutes. Cardox initiation could affect operator actions outside the control room but this is not expected to be significant, actions can still be accomplished.	DER 1-95-2987 due RFO15

Table -1 - Status of NMP1 IPEEE Improvement Initiatives					
Action ID	IPEEE Section	Improvement	Benefit	Significance	Status
15g	Seismic	Relay 74A-9 requires replacement or procedure change	This relay in the fire actuation system could actuate in a relatively minor seismic event. This would cause isolation of the EDG room HVAC system and actuation of Cardox fire suppression in several areas. Improvement of these relays would enhance the probability that important equipment is available to mitigate the impact of earthquakes.	Moderate, these relays could trip EDG ventilation which could only affect the EDG after some duration judged to be at least 30 minutes. Cardox initiation could affect operator actions outside the control room but this is not expected to be significant, actions can still be accomplished.	DER 1-95-2987 due RFO15
15h	Seismic	Relay 74A-10 requires replacement or procedure change	This relay in the fire actuation system could actuate in a relatively minor seismic event. This would cause isolation of the EDG room HVAC system and actuation of Cardox fire suppression in several areas. Improvement of these relays would enhance the probability that important equipment is available to mitigate the impact of earthquakes.	Moderate, these relays could trip EDG ventilation which could only affect the EDG after some duration judged to be at least 30 minutes. Cardox initiation could affect operator actions outside of the control room but this is not expected to be significant, actions can still be accomplished.	DER 1-95-2987 due RFO15
15i	Seismic	Relay 45X-9 requires test, replacement, or procedure change	This relay in the fire detection circuitry could cause actuation of the 1H-9 relay with impact discussed above.	Moderate, see 1H-9	DER 1-96-1678 combined with DER 1-95-2987 due RFO15
15j	Seismic	Relay 45X-10 requires test, replacement, or procedure change	This relay in the fire detection circuitry could cause actuation of the 1H-10 relay with impact discussed above.	Moderate, see 1H-10	DER 1-96-1678 combined with DER 1-95-2987 due RFO15

Table -1 - Status of NMP1 IPEEE Improvement Initiatives					
Action ID	IPEEE Section	Improvement	Benefit	Significance	Status
15k	Seismic	Series 2 timer requires replacement or procedure change	This timer in the fire actuation system could actuate in a relatively minor seismic event. This would cause isolation of the EDG room HVAC system and actuation of Cardox fire suppression in several areas. Improvement of these relays would enhance the probability that important equipment is available to mitigate the impact of earthquakes.	Moderate, this timer could trip EDG ventilation which could only affect the EDG after some duration judged to be at least 30 minutes. Cardox initiation could affect ex-control room operator actions but this is not expected to be significant, actions can still be accomplished.	DER 1-95-2987 due RFO15
16	Fire	Storage of combustibles in fire area A1 should be curtailed and smoking area designation removed	Cables associated with offsite power are located east of the chemistry offices on elevation 250' of the administrative building (G Building). The cables of concern are located in cable trays behind the locked gates in this area. Storage of records, computer equipment, and other combustible material was observed immediately under these cable trays. In addition, the area just outside the gate appears to be used as a break area. It was posted as a "Designated Smoking Area" and two ashtrays with cigarette butts were present. In addition, this area is also used for storage of files and other materials. Given the importance of offsite power, we recommend that, as a minimum, the material underneath the cable trays be moved and that smoking be prohibited in this area. Measures to remove all unnecessary storage in this area may also be prudent.	Moderate, a relatively minor fire could result in significant plant impacts	DER 1-96-1737 complete
17	Seismic	Electrical cabinet doors should be checked periodically	Several electrical cabinet doors were found loose on a random sample basis during the walkdowns. In a seismic event they could rattle and lead to failure of sensitive equipment in the cabinet. This preventative maintenance activity would help to ensure operability of safety related equipment	Moderate, considered an enhancement to current preventative maintenance.	Work order 98-00653-00 complete, doors gasketed.

Table -1 - Status of NMP1 IPEEE Improvement Initiatives					
Action ID	IPEEE Section	Improvement	Benefit	Significance	Status
18	Seismic	Lube oil reservoir sight glasses of pumps should be checked periodically	Several lube oil reservoir sight glasses were found loose on a random sample basis during the walkdowns. In a seismic event they could leak and lead to seizing the pump. This preventative maintenance activity would help to ensure operability of safety related equipment.	Low, considered an enhancement to current preventative maintenance. Based on additional walkdown, only pumps on success path with these type of reservoirs are core spray topping pumps (They were confirmed loose). With seismic/SLOCA scenario, pumps are of minimal importance since core spray pumps provide adequate flow.	SQUG experience database reports no failures of this type. Based on seismic capacity engineering judgment and relatively low importance, action item closed, no additional action.
19	Fire, Seismic	Remove containment vent and torus cooling dependency on instrument air	Currently instrument air is required to align containment vent and containment spray in the torus cooling mode. Containment vent valves could be opened with handwheels. Containment spray valves 80-15, 16, 35, 36 currently fail as is (open) on loss of instrument air and have no handwheels for manual operation. It is proposed to have manual handwheels added to these valves so that operators could align torus cooling without instrument air. This would increase the reliability of torus cooling.	Low, this action item is considered to be a benefit but IPEEE results would not be adversely affected without implementation.	This action is considered cost-beneficial only if implemented along with other work that may arise in the future (i.e., perform this mod if valves are modified for any other reason). On hold for future consideration.