NIAGARA MOHAWK POWER CORPORATION

DESIGN CRITERIA FOR REANALYSIS OF SAFETY RELATED MASONRY WALLS

NINE MILE POINT UNIT 1

JUNE 1983

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1.0 SCOPE

In May 1980, the NRC issued IE Bulletin 80-11 which required an analysis be performed on the integrity of masonry walls. Niagara Mohawk presented the results of the analysis for Nine Mile Point Unit 1 by letters dated July 8, 1980 and November 10, 1980. Additional information was submitted by letter dated June 14, 1982. The original analysis concentrated on the effects of seismic loads and identified seventy-five safety-related masonry wall systems. Modifications required as a result of this analysis were completed during the 1981 refueling and maintenance outage.

Subsequent to the original analysis, Niagara Mohawk has determined that a reanalysis of masonry walls is required. This study is prompted by the lack of consideration of high energy line break effects in the initial analysis, and a revised technical position on Durowall. Analyses performed for unrelated projects indicate that pressure loads in excess of seismic loads are possible on certain masonry walls. These results prompted a review of our I.E. Bulletin 80-11 submittal. It was subsequently determined that these loads should be considered. Also, recently the NRC has developed a technical position on the use of Durowall as a horizontal reinforcement. Therefore, this position will be reviewed. In addition, those masonry wall systems identified as non-safety related in the original analysis will be reviewed to determine if plant modifications have resulted in a need for reclassification.

The reanalysis of masonry walls at Nine Mile Point Unit 1 will follow the same criteria and methodology as the original analysis and will incorporate the new topics. The applicable codes, loads, analysis methods/assumptions, and allowable stresses are as stated in Sections 3.0, 4.0, 5.0 and 6.0 of this document, respectively. The treatment of high energy line break effects is described in Section 4.4, 'Load Combinations', and Appendix A, 'Evaluation of Effects of High Energy Line Breaks (HELBs) on Masonry Walls'. In general, a leak-before-break program is proposed. The treatment of Durowall is presented in Section 5.3, 'Horizontal Joint Reinforcement'. Also, as stated above, those walls previously identified as non-safety related will be reviewed.

The above topics were discussed with the NRC in an April 27, 1983 meeting. The minutes of this meeting, dated May 13, 1983, identified six areas where additional information was requested. This document provides the additional information.

2.0 PURPOSE

The purpose of this document is to provide technical clarification as to the criteria and methodology to be used in the reanalysis of masonry walls at Nine Mile Point Unit 1. In particular, this document addresses the treatment of Durowall as a horizontal reinforcement element and the utilization of-a-leak-before-break program to resolve the high energy line break issue.

3.0 APPLICABLE CODES

The masonry walls will be reanalyzed in accordance with the building code requirements for concrete masonry structures (ACI531-79). This is consistent with the original I.E. Bulletin 80-11 analysis. Structural steel will be reanalyzed (where necessary) in accordance with the American Institute of Steel Construction (AISC) specification for the design, fabrication and erection of structural steel for buildings (1978 Edition). Concrete will be reanalyzed (where necessary) in accordance with the building code requirements for reinforced concrete (ACI318-77). These codes meet or exceed the intent of the original codes used in the design of Nine Mile Point Unit 1.

4.0 LOADS

4.1 Seismic Loads

The horizontal seismic acceleration values to be used in the reanalysis will be those listed in the Final Safety Analysis Report (FSAR) or those obtained from the actual dynamic analysis of Nine Mile Point Unit 1. For the Reactor Building, FSAR Section VI will be used, as shown in the attached Figure 1. For the Turbine Building, the values listed in the attached Figures 2 and 3 will be used. However, the Control Room Complex will use those values listed in FSAR Section III. Acceleration values to be used for the Screenhouse, Waste Building and Offgas Building will be those listed in FSAR Section III.

4.2 Tornado Loads

The design of Nine Mile Point Unit 1 does not incorporate exterior safety-related masonry walls. Therefore, the effects of tornado loadings on safety-related masonry walls will not be considered in the reanalysis.

4.3 Accident Loads

Loads due to postulated accidents, with the exception of high energy line break pressure loads, were considered in the original analysis of safety-related masonry walls. This analysis concluded that safety-related masonry walls were not affected by jet impingement, missiles or pipe whip, as stated in a Niagara Mohawk letter from T. E. Lempges to B. H. Grier, dated July 8, 1980.

However, Niagara Mohawk has determined that the pressurization effects of a high energy line break should be considered. Our initial approach will encompass a leak-before-break methodology to demonstrate that an instantaneous open ended break of high energy lines will not occur. Details of the approach are contained in Appendix A to this document.

In the event that this initial approach does not prove to be feasible, the pressure loads due to high energy line breaks will be included in the reanalysis of safety-related masonry walls. The

effects of pressure loads resulting from a high energy line break may be mitigated by the use of building modifications which would provide additional pressure relieving capability, reinforcement of safety-related masonry walls, or combinations thereof.

4.4 Load Combinations

The load combination to be used in the reanalysis will combine normal and seismic loads. Normal loads include deadweight of the masonry walls, deadweight of any attached equipment, and any operational loads associated with attached equipment - as defined in Sections III and XVI of the FSAR.

As indicated above, the leak-before-break program will demonstrate that an instantaneous open ended break of a high energy line will not occur. Therefore, the reanalysis will not include these loads. However, if the leak-before-break program proves unfeasible, a separate analysis addressing the pressurization effects of a high energy line break on safety-related masonry walls will be performed. The loads resulting from this separate analysis will not be combined with seismic loads. The basis for not combining these loads is the seismic design of the high energy lines at Nine Mile Point Unit 1, as indicated in Table XVI-29 of the FSAR. Class I piping systems were designed to withstand seismic loads. Analyses were performed to verify that stresses due to seismic loads were within code allowables. Since the piping is adequately designed to withstand seismic loads, a seismic event will not result in an open ended high energy line break. Therefore, the combination of these loads implies the simultaneous occurrence of two independent extreme accidents and is not justified.

Table XVI-29 indicates that the main steam line outside containment is a Class II system. However, a preliminary review of the main steam line design indicates that the portion located in the Turbine Building meets Class 1 seismic requirements. An analysis will be performed to verify main steam line integrity under seismic loading.

Therefore, the reanalysis of safety-related masonry walls will not combine high energy line break loads, if addressed, with seismic loads.

5.0 ANALYSIS METHODS/ASSUMPTIONS

5.1 Application of Seismic Loads

The seismic acceleration values to be used in the reanalysis of the safety related masonry walls will be those noted in Section 4.1 of this document. These values will be multiplied by the mass of the structure to obtain an equivalent static force acting on the structure. This method of analysis conforms to the intent of the FSAR for Nine Mile Point Unit 1 as indicated in Sections III & XVI.

5.2 Horizontal In-plane and Vertical Seismic Loads

Effects due to horizontal in-plane seismic loads and vertical seismic loads have been demonstrated to be small compared to out-of-plane effects; therefore, they are not included in the reanalysis. Appendix B contains a sample calculation. These conclusions are based upon one horizontal seismic direction load in combination with the vertical seismic load.

5.3 Horizontal Joint Reinforcement

The safety-related masonry walls will be reanalyzed utilizing both vertical and horizontal reinforcement when reinforced per ACI 531-79. When a masonry wall is not reinforced per ACI 531-79, the use of horizontal reinforcement as a structural resisting element will be determined on a case-by-case basis. For those walls without vertical and horizontal reinforcement, the resisting strength of the wall will be based on the allowable tension stress in the mortar. In all cases, however, when horizontal reinforcement is used in the reanalysis, a field survey will be performed to determine the exact quantity and location of the horizontal reinforcement for that particular masonry wall.

5.4 Other Analysis Methods

The safety-related masonry walls will be reanalyzed using vertical spans, horizontal spans, or a combination of the two. When a wall is spanned vertically, a compressive force based on the weight of the wall may be incorporated to resist applied loads.

6.0 ALLOWABLE STRESSES

6.1 The allowable stresses provided in ACI 531-79 will apply. Full allowable stresses will be used since the code inspection requirements have been met as described below. Typical construction specifications for Nine Mile Point Unit 1 state that all material and work by the contractor shall be subject to approval of the purchaser, as well as any inspection authority, bureau, department or agency having jurisdiction. Any material or work or part of work that was found unacceptable by any of the above was to be removed from the premises by the contractor. There were no provisions in the contract which relieved the contractor of the responsibility or obligation for faulty or inadequate workmanship or materials. Also, if any of the materials or work or any part of the material or work was proved to be defective or inadequate in design, workmanship or materials within one year after the work was completed, the contractor was required to replace the defective or inadequate material. In summary, the general construction practices used at Nine Mile Point Unit 1 were intended to be of the highest standards. As a confirmation of this, during the plant walkdown to determine which walls were to be classified as safety-related, no major deficiencies were noted. Therefore, the inspection practices used during construction of the

masonry walls were sufficient to allow use of the full allowable stress values of ACI 531-79. In addition, to confirm these conclusions, Niagara Mohawk will perform a sample test program to determine the actual mortar and prism strengths. Results of this program will be used, as appropriate, in the reanalysis of safety-related masonry walls. Appendix C provides details of the test program.

7.0 SCHEDULE

1/2/84	Completion of Masonry Wall Test Program and Reanalysis
1984 Refueling Outage	Structural Modifications, if necessary, and Details of the Leak Before Break Program

REFERENCES

1. U.S. Nuclear Regulatory Commission, Office of Inspection and Enforcement, I&E Bulletin No. 80-11, dated May 8, 1980.

2. Final Safety Analysis Report (including supplements), Nine Mile Point Nuclear Station (Unit 1).

3. NMPC Letter, T. E. Lempges to B. H. Grier, dated July 8, 1980.

4. NMPC Letter, T. E. Lempges to B. H. Grier, dated November 10, 1980.

5. NMPC Letter, T. E. Lempges to D. B. Vassallo, dated June 14, 1982.

6. Franklin Research Center, Technical Report on the Use of Joint Reinforcement in Block Masonry Walls, March 1983.

FIGURE 1

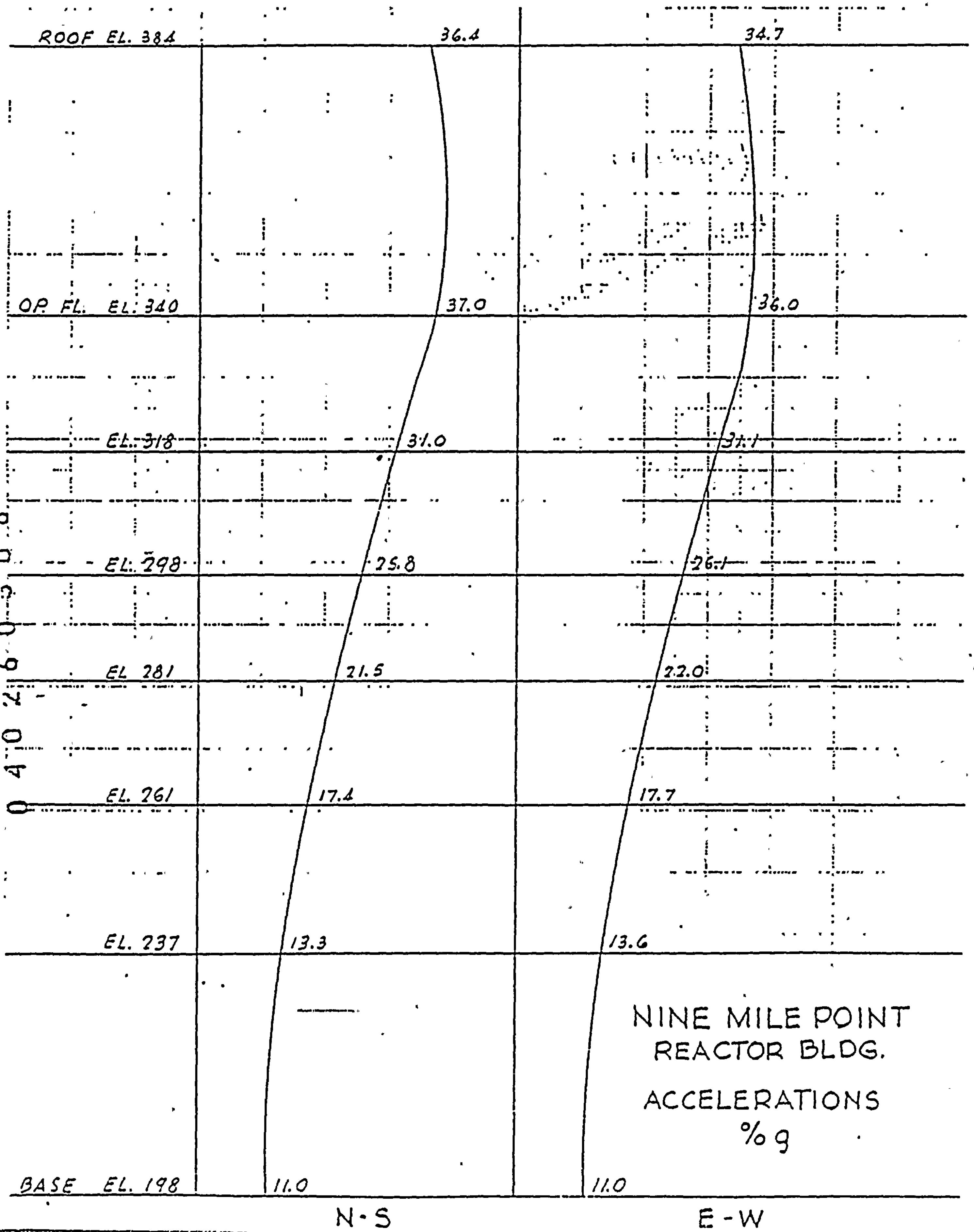
ROOF EL. 384
36.4
34.7
OP FL. EL. 340
37.0
36.0
EL. 318
31.0
31.1
EL. 298
25.8
26.1
EL 281
21.5
22.0
EL. 261
17.4
17.7
EL. 237
13.3
13.6
BASE EL. 198
11.0
11.0
N-S
E-W
NINE MILE POINT
REACTOR BLDG.
ACCELERATIONS
% g

FIGURE 2

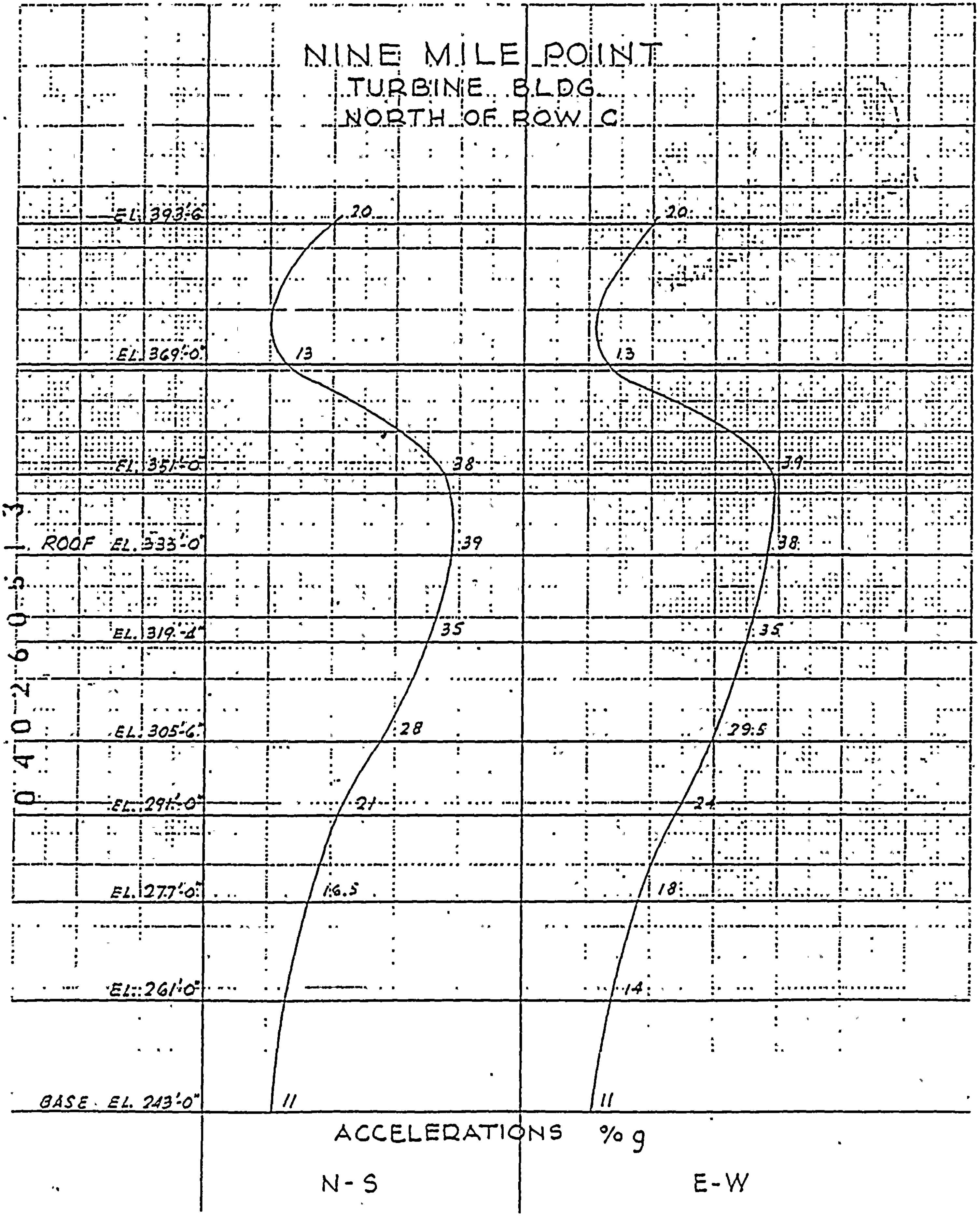

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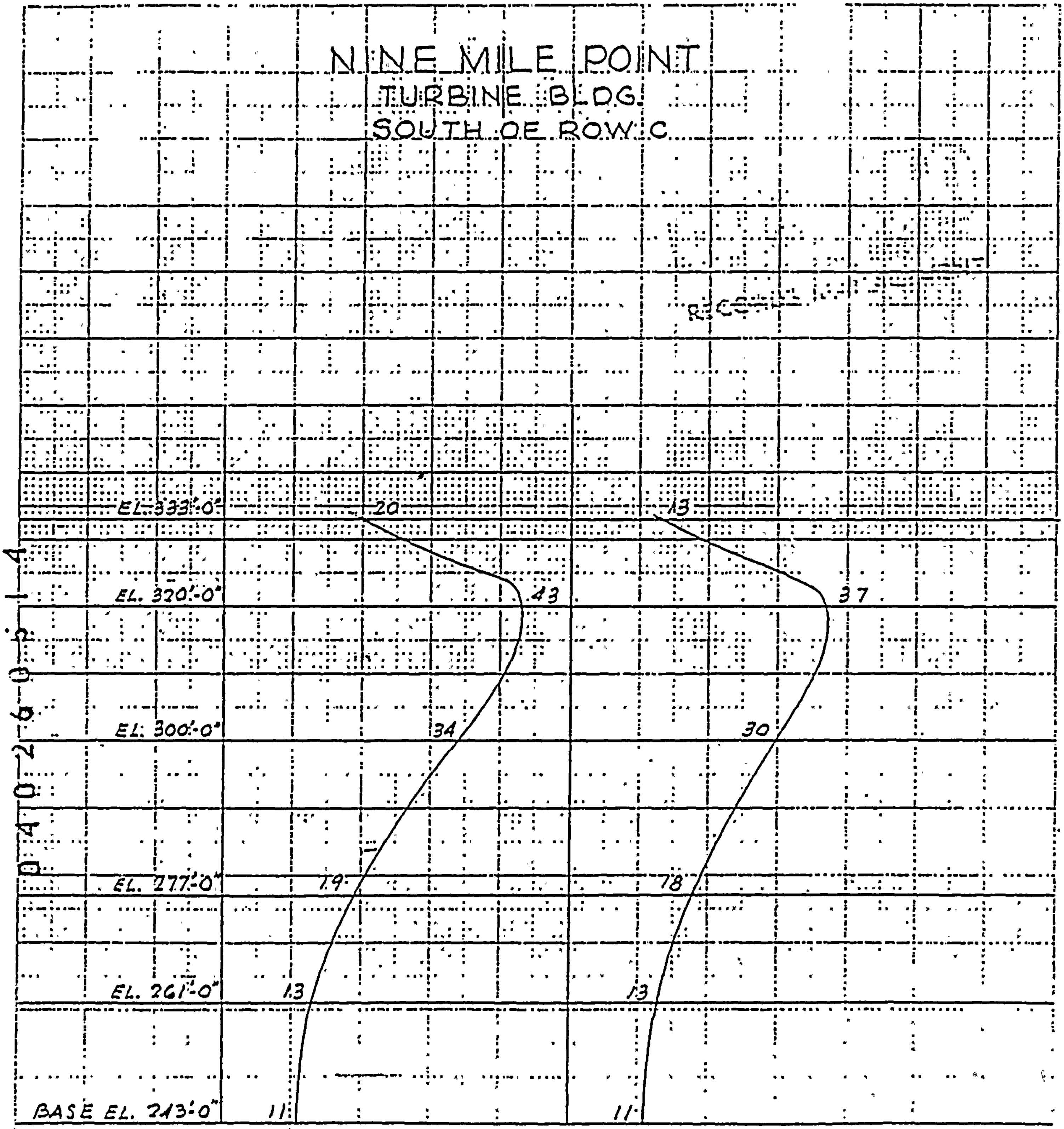
FIGURE 3



ACCELERATIONS %g

N-S E-W

APPENDIX A

EVALUATION OF EFFECTS OF
HIGH ENERGY LINE BREAKS (HELBs)
ON MASONRY WALLS

Introduction

Preliminary analyses have been performed to evaluate the effect of postulated high energy line breaks on the structural adequacy of masonry walls in the Nine Mile Point Unit 1 turbine building. Specifically, scoping analyses have been performed to: (1) determine the maximum subcompartment time-dependent pressures in the turbine building (instantaneous failure of an 24-inch main steam line), (2) evaluate the effect of the maximum resulting pressure differential on the structural integrity of masonry walls, and (3) develop and evaluate alternative actions to mitigate any unacceptable consequences. The results of these scoping analyses and the course of action planned by Niagara Mohawk Power Corporation are described below.

Turbine Building Pressurization Analyses

Analyses have been performed using the dynamic containment analysis program COMPARE* to determine the subcompartment time dependent pressures in the turbine building for postulated guillotine breaks of a main steam line. Breaks were assumed at various locations between the drywell and the turbine stop valves. The results of the analyses show that peak differential pressures approaching 75 pounds per square foot (psf) could occur across safety-related masonry walls within the first few seconds of the assumed event. The turbine building blow-out panels, which are designed to relieve at 45 psf, are opened in the process. These results are relatively insensitive to the assumed break location.

Detailed structural analyses of masonry walls have not been performed for a postulated instantaneous break in the main steam line. However, conservative analyses indicate that the allowable stresses for the masonry walls may be exceeded. Accordingly, alternative actions have been investigated.

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* R. G. Gido, et al, "Compare, Mod I, A Code for the Transient Analysis of Volumes with Heat Sinks, Flowing Vents and Doors," Los Alamos Scientific Report LA-7199-MS dated March, 1978, and Compare II, B&W version of Compare, Mod I, revised March 1980.

Alternative Actions to Mitigate Consequences of Postulated HELBs

Several courses of action have the potential to eliminate or mitigate the consequences of postulated high energy line breaks such as an instantaneous open ended main steam line break in the turbine building. These alternatives range from the strengthening of affected masonry walls to evaluations of a leak-before-break program. In the latter case, action would be taken before a postulated defect in a high energy line could propagate to an unstable size.

A description of the alternative actions considered and an evaluation of each is given below. In these evaluations, it has been conservatively assumed that other high energy lines in the turbine and the reactor buildings could fail instantaneously resulting in calculated subcompartment pressures sufficiently high to adversely affect masonry walls.

1. Strengthening of Masonry Walls

   On the basis of conservative analyses, it is estimated that as many as thirty masonry walls in the reactor and turbine buildings could require substantial modifications. Considering the large number of walls involved, interferences imposed by adjacent equipment and structures, the extensive amount of equipment mounted on these walls, and the cost and down-time associated with such backfits, it is concluded that this alternative may not be physically possible, and clearly impractical from a cost-effective basis. Experience at other facilities with similar situations has confirmed this conclusion.

2. Installation of Additional Building Blow-Out Panels

   Installation of additional building blow-out panels has been evaluated. Parametric analyses of turbine building subcompartment pressures have been performed to determine the effectiveness and practicality of adding blow-out panels to supplement the present 1800 square feet of panels. The results of these analyses indicate that this is a relatively ineffective method. The analyses show, for example, that adding blow-out panels, with a design relieving pressure of 45 psf (the blow-out pressure of the existing panels) does not substantially reduce the peak building pressure. Even if the additional panel rupture pressure was lowered to 5 psf (which may not be desirable for other reasons such as wind and tornado loads) installation of about 2000 square feet of additional vent area would be required. A similar result is expected for the reactor building.

   Considering the inefficiency of this approach due to the low rupture pressure required and the concerns associated with large portions of the building siding having a low pressure capability, this alternative fix is not considered desirable or practical.

3. Demonstration of Leak-Before-Break Performance

An alternative which has been used in a number of similar applications in the past several years is a leak-before-break program. This concept demonstrates that a postulated circumferential or axial flaw in a high energy pipe will propagate slowly to a size which results in a detectable leak rate well before it becomes unstable and ruptures. This approach has been developed by nuclear steam system suppliers, utilities, the NRC and NRC consultants, and has been used in numerous operating plant applications. The method is outlined with appropriate analysis guidelines and acceptance criteria in the enclosures to NRC letter L505-81-12-015 dated December 4, 1981 to Consumers Power Corporation. The leak-before-break assessment method was developed "as an alternative to other system modifications or alterations for locations where the mitigation of the consequences of high energy pipe break (or leakage) have been shown to be impractical". The approach is aimed at showing that conditions which could lead to a double ended pipe rupture do not exist, thereby making it unnecessary to consider the effects of a guillotine pipe rupture. This is accomplished using a defense in depth approach that includes the following main elements:

- Demonstration by suitable fracture mechanics analyses for a postulated circumferential or longitudinal through-wall crack of four times the piping wall thickness, subjected to maximum ASME Code overloads (Service Level D loads), that substantial crack growth does not occur, that local or general plastic collapse (instability) of the piping does not occur and that flow through the crack does not impair safe system shutdown.

- Demonstration that the leak rate which would result from a postulated crack is detectable by available, or additional leakage detection instruments.

- Implementation of an adequate inservice inspection program to assure that conditions which could lead to the postulated crack are detected well before a leak occurs.

This leak-before-break analysis approach has been used and accepted in numerous applications including the following:

- Evaluation of asymmetric loads due to postulated breaks in the reactor coolant system of certain Pressurized Water Reactors.

- Evaluation of high energy line breaks inside and outside containment in operating Pressurized and Boiling Water Reactors in the Systematic Evaluation Program (Topics III-5.A and III-5.B).

- Evaluation of the effect of intergranular stress corrosion cracks on the integrity of BWR recirculation system piping.

Since the piping systems involved, the plant age and the circumstances of the high energy line break evaluation are virtually the same as in those applications at other operating nuclear plants, this program is considered directly applicable to Nine Mile Point Unit 1.

Planned Course of Action

Based on the evaluations summarized above, Niagara Mohawk Power Corporation plans to undertake the following actions to resolve questions regarding the structural capability of the masonry walls at Nine Mile Point Unit 1.

1. Identification of Critical High Energy Systems

   The analysis of postulated main steam line breaks in the turbine building indicate that stresses higher than design pressure loads on safety-related masonry walls may occur. The same situation may exist when analyzing other high energy lines in the reactor and turbine buildings. Accordingly, as a first step in the planned evaluation program, analyses will be performed to identify those high energy piping systems which are of most concern from a building pressurization standpoint. The systems to be evaluated and which are considered to have the highest potential for unacceptable consequences are the following:

System	Location
Main Steam	Turbine Building
Feedwater	Turbine Building
Emergency Condenser	Reactor Building
Reactor Cleanup	Reactor Building

2. Fracture Mechanics Analyses

   - For the systems which are determined to be important from a high energy line break standpoint, specific piping runs will be selected to represent worst-case combinations of pipe size, configuration, loadings, and materials. The worst case piping runs will necessarily include both carbon steel and stainless steel and the largest and smallest size piping.

   Each of the selected piping runs will be analyzed in accordance with the NRC guidance given in Appendix 1 to NRC letter L505-81-12-015 dated December 4, 1981. The objective of these analyses will be to show by elastic-plastic fracture mechanics methods that circumferential or longitudinal through-wall cracks of length equal to four times the piping wall thickness, when subjected to maximum ASME Code Service Level D loads, do not exhibit substantial monotonic loading crack growth (i.e., unstable growth) and that local or general plastic instability will not occur. In addition, the analysis will attempt to show that circumferential through-wall cracks will remain stable for specified local, large deflection bending conditions. As part of these analyses, calculations will be made to estimate the maximum crack opening areas and leak rates for both circumferential and longitudinal cracks.

3. Leak Detection Capability

An evaluation will be made to determine the requirements for a leak detection system with the capability to detect the leak rates mentioned in paragraph 2 above, for the critical high energy piping systems. This evaluation will consider currently available leak detection systems and, if necessary, supplemental systems. The objective of this evaluation is to determine the feasibility of, and system requirements for, a leak detection system with sufficient sensitivity to detect leakage expected from the postulated worst case circumferential and axial through-wall cracks.

4. Inservice Inspection Program

As a final measure to further reduce the probability that a through-wall crack could develop in the critical high energy piping, the current Nine Mile Point Unit 1 inservice inspection program for this piping will be reviewed and revised, if necessary.

The program outlined above is considered to provide a number of significant advantages over the other alternatives considered. The most significant advantage is that the approach is directed at preventing an unacceptable pipe rupture rather than adding massive and for the most part unnecessary, structural backfits. In many similar applications, such backfits actually interfere with the performance of essential operations and inspections. Second, the approach aimed at detecting a flaw before a break addresses the undesirable consequences of a pipe break (e.g., pipe whip, personnel safety, environmental qualification of equipment, etc.), not just internal pressure effects. Third, because similar analyses have been successfully performed for large carbon steel systems (main steam and feedwater) and stainless steel sytems (reactor coolant and emergency condenser), there is reasonable assurance that this approach will demonstrate that with adequate inservice inspection and leak detection capability the occurrence of an unstable, high energy line break at Nine Mile Point Unit 1 is not credible. Finally, because of successful leak-before-break analyses for similar piping systems at other operating nuclear plants and the leakage detection capability at Nine Mile Point Unit 1 (area radiation monitors, local temperature detectors and regular operator walk-thru inspections), there is little risk of a high energy line break at Nine Mile Point Unit during the operating period while this evaluation is being performed.

APPENDIX B

SHEET NO. 1 OF 4

SUBJECT: NINE MILE POINT UNIT #1
MASONRY WALL RE-EVALUATION - BULLETIN 80-11
HORIZONTAL IN-PLANE AND VERTICAL SEISMIC LOADS

DATE: 5/26/83
INDEX OR FILE NO. 3-N2.1-S6
PREPARED BY: P.B. GEORGE
CHECKED BY: H. Gyzwood (6/3/83)

PURPOSE: TO DETERMINE THE EFFECTS OF HORIZONTAL IN-PLANE AND VERTICAL SEISMIC LOADS ON MASONRY WALLS.

GIVEN:
WALL HEIGHT = 20'-0"
WALL THICKNESS = 8"
UNIT WEIGHT ≈ 105#/FT³ (LT. WT. BLOCK)
PERCENT SOLID ≈ 55
ACCELERATION: .34g HORIZ. (EL. 300'-0" TURBINE BLDG), VERT g = ½ g HORIZ.
RELATIVE Δ = 33 MILS ($^{\Delta}$EL. 300'-0" − $^{\Delta}$EL. 277'-0")
WALL LENGTH = 15'-0"
NOTE: WALL HEIGHT, THICKNESS AND LENGTH ARE AN ESTIMATE OF TYPICAL WALLS.

ANALYSIS:

VERTICAL LOADING

1) POSITIVE VERTICAL ACCELERATION = .17g < 1g ∴ NO TENSION IN WALL

2) NEGATIVE VERTICAL ACCELERATION = .17g

$$\text{WT. WALL}/\text{LN. FT} = 105\,\#/\text{FT}^3\,(8/12)(20\text{FT})(.55) = 770.0\,\#/\text{FT}$$ ✓

LOAD DUE TO VERTICAL SEISMIC AT MIDHEIGHT = $\frac{770.0\,\#/\text{FT}}{2}(.17)$ ✓
= 65.5#/FT.

$$f_a = P/A = \frac{65.5\,\#/\text{FT}}{30\,\text{IN}^2/\text{FT}} = 2.18\,\#/\text{IN}^2$$

$$F_a = .225\,f'_m\left[1-\left(\frac{h}{40t}\right)^3\right] = .225\,(700\,\#/\text{IN}^2)\left[1-\left(\frac{20'\times 12''/'}{40\times 8''}\right)^3\right] = 91.1\,\#/\text{IN}^2$$ ✓

$$\frac{f_a}{F_a} = \frac{2.18\,\#/\text{IN}^2}{91.1\,\#/\text{IN}^2} = 0.024 = 2.4\,\%$$ OF ALLOWABLE STRESS AT MIDHEIGHT. THIS PERCENTAGE IS VERY SMALL ∴ NEGLIGIBLE.

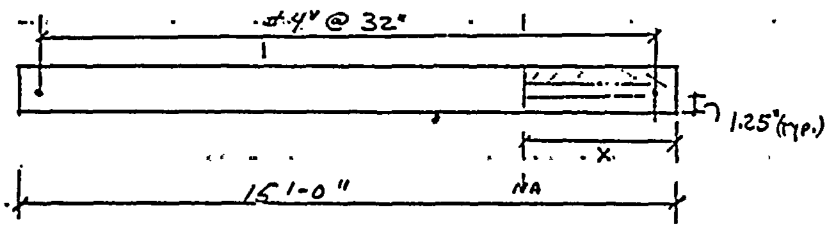
SHEET NO. 2 OF 4

SUBJECT NINE MILE POINT UNIT #1
MASONRY WALL RE-EVALUATION - BULLETIN 80-11
HORIZONTAL IN-PLANE AND VERTICAL SEISMIC LOADS

DATE 5/26/83
INDEX OR FILE NO. 3-N2.1-S6
PREPARED BY PB GEORGE
CHECKED BY H. Cogwood (6/3/83)

HORIZONTAL IN-PLANE LOADING

DETERMINE MOMENT OF INERTIA



$$m = \frac{E_s}{E_m} = \frac{29 \times 10^6 \ \#/in^2}{7 \times 10^5 \ \#/in^2} = 41.4$$

$A_s = .2 \, in^2 (2) = .4 \, in^2$

$A_{s_T} = .4(41.4) = 16.56 \, in^2$

$d \approx 144"$ ✓

ASSUME ONLY FIRST TWO VERT. BARS RESIST TENSION ; THIS IS A CONSERVATIVE ASSUMPTION.

$$\Sigma M_{NA} \quad x(2.5)\left(\frac{x}{2}\right) = 16.56(d - x)$$ ✓

$$1.25x^2 + 16.56x - 2384.6$$ ✓

$$x = 37.5 \, in$$ ✓

$$I = \frac{bh^3}{3} + Ad^2$$ ✓

$$I = \frac{2.5(37.5)^3}{3} + 16.56(106.5)^2$$ ✓

$$I = 231772.9 \, in^4$$ ✓

SHEET NO. 3 OF 4

SUBJECT NINE MILE POINT UNIT #1

MASONRY WALL RE-EVALUATION - BULLETIN 80-11

HORIZONTAL IN-PLANE AND VERTICAL SEISMIC LOADS

DATE 5/26/83

INDEX OR FILE NO. 3-N2.1-S6

PREPARED BY: PB GEORGE

CHECKED BY: H. Caywood (6/3/83)

1) STRESS BASED ON WALL INERTIA LOAD

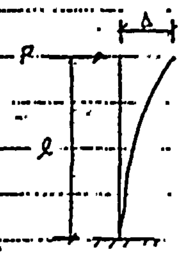
$$\omega = 105\ \#/FT^3\ (8/12)(15\ FT)(.55)(.34) = 196.4\ \#/FT\ \text{Height}$$

$$M = \frac{\omega l^2}{8} = \frac{196.4\ \#/FT\ (20\ FT)^2}{8} = 9820\ '\# = 117840\ ''\# \checkmark$$

$$f_{s_i} = i\,\frac{Mc}{I} = \frac{117840\ ''\#\ (106.5'')}{231772.9\ in^4}(41.4) = 2242\ \#/in^2 \text{ in Tensile Steel} \checkmark$$

$$f_m = \frac{117840\ \#\text{-}in\ (37.5'')}{231,772.9\ in^4} = 19.07\ \#/in^2 \text{ Compression Stress in Masonry}$$

2) STRESS BASED ON INTERSTORY DISPLACEMENT



ASSUME $E_m = 700000\ \#/in^2$ ✓

$G = 280000\ \#/in^2$

$$\Delta_T = \Delta_f + \Delta_s$$

$$\Delta_T = \frac{Pl^3}{3EI} + \frac{6Pl}{5AG} \checkmark$$

$$P = \frac{\Delta}{\frac{l^3}{3EI} + \frac{6l}{5AG}} \checkmark$$

$$P = \frac{0.033\ in}{\frac{(240\ in)^3}{3(700000\ \#/in^2)(231772.9\ in^4)} + \frac{6(240)}{5(180)(2.5)(280000\ \#/in^2)}} \checkmark$$

$$P = 1075.3\ \# \checkmark$$

N B-600

SHEET NO. 4 OF 4

SUBJECT NINE MILE POINT UNIT #1

MASONRY WALL RE-EVALUATION - BULLETIN 80-11

HORIZONTAL IN-PLANE AND VERTICAL SEISMIC LOADS

DATE 5/26/83

INDEX OR FILE NO. 3-N211-S6

PREPARED BY PB GEORGE

CHECKED BY H. Caywood (6/3/83)

$$M = Pe = 1075.3^{\#}(240'') = 258072''^{\#} \checkmark$$

$$f_{s_2} = \frac{Mc}{I} = \frac{258072''^{\#}(106.5)}{231772.9\ in^4}(41.4) = 4910\ ^{\#}/in^2 \checkmark$$

$$f_m = \frac{258072(37.5)}{231,772.9} = 41.76\ ^{\#}/in^2 \text{ Compression Stress in Masonry} \checkmark$$

$$f_{s_{TOTAL}} = f_{s_1} + f_{s_2} = 2242\ ^{\#}/in^2 + 4910\ ^{\#}/in^2 = 7152\ ^{\#}/in^2 < 20000\ ^{\#}/in^2 \text{ ok.}$$

IN THE ORIGINAL NINE MILE POINT UNIT #1 SEISMIC ANALYSIS HORIZONTAL SEISMIC LOADS IN TWO DIRECTIONS WERE NOT COMBINED. THEREFORE, HORIZONTAL IN-PLANE SEISMIC LOADS WILL BE NEGLECTED AS OUT OF PLANE SEISMIC LOADS GOVERN.

APPENDIX C

Niagara Mohawk Power Corporation

Test Program for Masonry Walls

NMPC will complete the following action items:

In order to confirm the use of inspection allowable stress category, the following will be performed:

a) Three prism samples, each 3 blocks high by 8 inches wide will be taken from selected non-safety related masonry walls (similar in construction to safety-related masonry walls).

b) Testing will be performed in accordance with ASTM E-447-74. These tests will determine the f_m value of masonry walls.

If scatter of the results is considered to be excessive, consideration will be given to conducting two additional tests. The value of f'_m shall be the average of the value of the specimens tested.

In addition, Niagara Mohawk will also determine m_o values to be used in the reanalysis.