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# TECHNICAL RESPONSE TO SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION RELATED TO PROPOSED DEFERMENT OF TORUS MODIFICATIONS

NIAGARA MOHAWK POWER CORPORATION

NINE MILE POINT NUCLEAR STATION UNIT 1

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SUMMARY

The NRC Safety Evaluation Report (SER) discusses two methods of obtaining relief in the evaluation for condensation oscillation (CO) loads. The first method is to combine the 31 stress harmonics by taking the absolute sum of the 4 peak responses and adding to this the square root of the sum of the squares (SRSS) of the remaining 27 harmonics. This method has been previously accepted by the NRC. The second method is to incorporate the analytically determined CO pressure reduction factors presented in Niagara Mohawk Power Corporation's recent, and subject submittal, reference 1. The SER advises that the review they have done so far supports the position that one or the other of the two approaches may be used, but not both. That is, if credit is taken for the recently developed CO pressure reduction, then all 31 stress harmonics must be combined by absolute summation, rather than using the random phasing rules previously approved for the Mark I Torus Program. The CO pressure reduction represents new and additional relief and its use should not prohibit using the already established relief gained from the random phasing of the stress harmonics since the two analyses are independent of each other.

The work presented in reference 1 uses the Continuum Dynamics, Inc. CO pressure reduction results and combines the 31 stress harmonics by absolute summing the 4 peaks and adding to this the SRSS of the remaining 27 harmonics.

The CO pressure reduction work reduces the CO stresses by approximately 17% and 36% for the eight and four downcomer bays, respectively.

Absolute summing the 4 peak stress harmonics and adding to this the SRSS of the remaining 27 stress harmonics results in an estimated 33% lower stress than absolute summing all the individual harmonics. Conversely

stated, absolute summing all the individual stress harmonics over predicts measured stresses by about 50%.

The method of combining the stress harmonics by absolute summing the 4 peaks and adding to this the SRSS of the remaining 27 stress harmonics was the result of extensive structural analysis done for the original torus program and was recognized as the appropriate way to correlate Full Scale Test Facility (FSTF) measured stresses with FSTF analytically predicted stresses. This method was available for all plants to use, not just Nine Mile Point Unit 1 (NMP-1), and it is still valid.

The CO pressure reduction accounts for the end cap effect of the FSTF in making it appear that all bays have eight downcomers and the hydrodynamics in each bay are in phase. This is a different, and independent, phenomenon than the underlying basis to the method of combining stress harmonics discussed in the preceding paragraph. The Brookhaven attachment to the SER agrees that the end cap effect is an FSTF conservatism. The attachment does not quantify the conservatism.

NRC acceptance of the reduced CO loading addressed herein gains NMP-1 a relief of 573 psi in the eight downcomer bays, and 1565 psi in the four downcomer bays. To see that this stress reduction is nominal, these values are to be compared to a total combined stress from all sources on the order of 16,025 psi.

## 1.0 BACKGROUND

The Mark I Program General Electric (GE) determined the magnitude of the Condensation Oscillation (CO) loading based on the test results from the Full Scale Test Facility (FSTF). The FSTF facility was one bay with end caps to contain the fluid, and as a result of the compromises in test facility design, these end caps caused conservative CO shell pressures to be measured. The CO load definition, based on these measured pressures, was conservative on the order of 15 to 30 percent and this was recognized at that time. The Mark I Owners' Group determined it would not be cost effective to fund the analysis and documentation effort necessary to achieve further reduction in the CO load definition since most of the Mark I plants had adequate margin on Code stress allowables for the CO frequency domain event combination loading.

However, the Nine Mile Point Unit 1 (NMP-1) torus has a thin shell (0.460 in.) compared with most of Mark I plants, and as a result, the postulated event combination which includes Design Break/Accident (DBA) pressure and CO (event combination 20) controls the margin on torus shell thickness. Teledyne Engineering Services (TES) and Niagara Mohawk Power Corporation (NMPC) recognized this problem as being critical early in the Mark I program, and jointly took the necessary steps to mitigate loads from this event combination. First, TES refined the Torus Analysis for DBA pressure and CO including the post processing of results. Then, TES and NMPC initiated a series of thin shell meetings at GE for NMP-1 and Oyster Creek. These meetings identified areas of conservatism in the load definition to be further explored by GE.

The reduction in NMP-1 DBA pressure resulting from these meetings was essential to the successful compliance of NMP-1 to the Mark I Program Structural Acceptance Criteria for the CO event combination. The DBA pressure, rather than the CO loading conservatisms, were addressed based on cost and time considerations.

## 2.0 CO LOAD DEFINITION CONSERVATISMS

The loads on which the TES structural analysis is based are presented primarily in G.E. Report NEDO-21888, Mark I Containment Program Load Definition Report (LDR), dated November 1981 (Reference 3). These loads were developed from the FSTF during the Mark I Program and have inherent conservatisms.

### 2.1 FSTF CONSERVATISMS

There are two major conservatisms inherent to the geometry of the FSTF, they are the FSTF bay end caps and the structural damping associated with the low level of stress in the FSTF shell.

#### 2.1.1 FSTF END CAPS

In 1979, Continuum Dynamics, Inc. (CDI) was asked by the Mark I owners group, through G.E., to assess the conservatism in the Condensation Oscillation torus loads measured during the FSTF blowdown tests. This effort confirmed generally accepted conservatism in the tests with regard to test initial condition thermodynamics, and identified a significant conservatism which was not identified during test design. This conservatism was introduced by the geometry of the test facility, one-sixteenth sector which is equivalently a 22-1/2° segment of the Mark I Pressure Suppression Pool Torus. The test facility, although full-scale in cross section, attempted to simulate at full-scale the condensation phenomenon in one bay only. End caps were required to contain the pool water and the airspace above the pool in the bay. The analysis, which analyzes the hydrodynamic consequences of these end caps, was presented to the Mark I owners in 1980. To expedite completion of this issue, the Mark I owners decided not to pursue reducing this conservatism at that time. This work is revisited for this effort and developed specifically for Nine Mile Point Unit 1.

The joint TES and CDI effort presented in References 1 & 10 and summarized herein consists of an analytical reduction in the Mark I Torus Program Condensation Oscillation Load Definition. The analysis shows that the eight downcomer bays have bay averaged CO loads which are conservative by at least 19% at frequencies other than 5-6 Hz and for four downcomer bays, the bay averaged CO loads are conservative by at least 38% at frequencies other than 5-6 Hz. The load conservatisms in the 5-6 Hz frequency band are 6% and 28% for the eight and four downcomer bays, respectively. Taking all frequency bands (0 to 31 Hz) into account results in a net CO load definition conservatism of 17.1% and 36.1% for the eight downcomer (non-vent) and four downcomer (vent) bays, respectively.

### 2.1.2 FSTF STRUCTURAL DAMPING

Damping equal to 2 percent was used in the evaluations performed to develop the phasing rules. The assumption of 2 percent damping, which is appropriate for design responses from combined loads near one-half yield stress, may be too high for the low level FSTF response. If the damping used were only 1.5 percent, the harmonic response amplitudes used to develop the phasing rules would be significantly larger such that the combined calculated response using the absolute sum of the 4 peak responses and adding to this the SRSS of the remainder, would be conservative compared to the measured response. In other words, using the absolute sum of less than the 4 peak responses, perhaps the 3 peak responses, plus the SRSS of the remainder, may have bounded the measured response. In our judgement, damping on the order of 1.5 percent would be more appropriate for FSTF response levels than 2 percent. It must be emphasized that damping of 2 percent is more appropriate for design analyses in which stress levels of one-half yield are allowable.

## 2.2 LDR CONSERVATISMS

There are two conservatisms associated with the development of the LDR, G.E. Report NEDO-21888 (Reference 3). The first conservatism is related to the amplification of the individual harmonic components before combining the components and the second conservatism is related to the method used to combine or sum the individual harmonic stress components.

### 2.2.1 HARMONIC COMPONENT AMPLIFICATION

For FSTF the response amplification factors at each 0.914 Hz frequency interval were used in lieu of the response amplification factors at the structural natural frequencies in each 1-Hz window (References 4, 7 & 8). The phasing rules were developed with this reduced response. Such an approach does not introduce the conservatism in response calculation which is obtained when accounting for the response amplification factors at the structural natural frequencies in each 1-Hz window. No credit is given for the latter approach.

### 2.2.2 SUMMING OF HARMONIC COMPONENTS

The LDR (Reference 3) states that the combination of individual harmonic stress components shall be summed. Three acceptable methods are available:

1. Absolute sum of all harmonic components.

2. Absolute sum of the 3 highest peaks added to the SRSS of the remaining components and apply a 1.15 factor.

3. Absolute sum of the 4 highest peaks added to the SRSS of the remaining components, provided the reported shell stresses are not within a few percent of the allowables.

The conservatisms associated with these methods are based on the bounding of the measured FSTF test shell stress results (Test No's M-8, M-11B and M-12). Methods 1 and 2 bound all three tests, while method 3 falls just short of bounding test M-12.

## 3.0 TES CO LOAD REDUCTION - STRUCTURAL MODEL/SHELL ANALYSIS

Oscillating loads on the submerged portion of the torus shell during the CO phenomenon are caused by periodic oscillations superimposed on the prevailing local static pressures.

Plant unique loads are derived from FSTF data. Flexible wall loads were measured directly in the FSTF which is prototypical of Mark I plant configurations with the exception of the rigid end caps. Pressure measurements obtained from various locations on the torus shell show that the longitudinal pressure oscillation amplitude distribution along the torus bottom center line is essentially uniform for the FSTF.

Specification of a baseline rigid wall load is given as pressure oscillation amplitude as a function of frequency. This load has been derived from the measured FSTF flexible wall load by analysis with a coupled fluid-structural dynamic model of the FSTF torus.

The derivation of the baseline rigid wall load is described below:

a. A finite element coupled fluid-structural dynamic model of the FSTF torus was excited at varying frequencies with a unit amplitude pressure source at the vent exits. The torus shell pressure amplitudes relative to the source pressure (amplification factors) were determined as a function of frequency.

b. Using these relative amplitudes (amplification factors), the FSTF vent exit source pressures were derived from the measured torus shell pressures at the various frequencies.

c. The baseline rigid wall load was derived from the computed FSTF vent exit source pressures by hydrodynamic analysis.

The CO shell load is specified as a distribution of harmonic pressure amplitudes in 1 Hz bands (Reference 3). The analysis for this load was performed by considering the effect of unit loads at each load frequency (harmonic analysis) and then scaling and combining the individual frequency effects to determine total stress at the critical element.

The three variations in the CO spectrum (Reference 3) were evaluated by rescaling the results of the unit load analysis. 100% of water mass was used for all CO analysis. The reduction factors presented in Table 1 of Reference 10 were applied to the individual harmonic pressures.

The combination of individual harmonic stresses into total element stress was done by considering frequency contributions at 31 Hz and below. The actual combination was done by adding the absolute value of the four highest harmonic contributors to the SRSS combination of the others for shell stress. This combination method and use of the 31 Hz cutoff are the result of extensive structural evaluation of full scale test data, which is reported and discussed in References 4 and 7. Including the frequency contribution out to 50 Hz would increase the CO stress by about 20 psi, or less than 1/2%.

The method of combining the stress harmonics by the absolute sum of the 4 peaks plus the SRSS of the remainder was the result of extensive structural analysis done for the original torus program and was recognized as the appropriate way to correlate FSTF measured stresses with FSTF analytically predicted stresses using the load definition. To use absolute sum of all the components would be to ignore the phasing between frequency dependent pressure components and between frequency dependent structural responses, and to assume phasing between the harmonic components to produce the highest possible stress response. The method of combining the stress harmonics by the absolute sum of the 4 peaks plus the SRSS of the remainder was available for all plants to use, not just NMP-1, and today remains valid.

The present analysis (References 1 & 10) investigates the conservatism of the hydrodynamic torus CO load definition derived from data taken in the Mark I FSTF. It is shown that during CO, the condensation events at the downcomer exits are, as a function of frequency, random in phase for most harmonic components. As a consequence of this observation, and the geometrical constraints built into the FSTF, the CO loads definition applied to NMP-1 is conservative for two reasons.

- Alternate downcomer bays in NMP-1 have four-eight-four-eight, etc., downcomers per bay. The FSTF facility, by construction, assumes that all bays have eight downcomers per bay.

- The FSTF modeled a 22 1/2° sector of a prototypical Mark I suppression chamber. The water was contained in the sector by two very rigid end caps which would not exist in a full suppression chamber. These end caps hydrodynamically act as mirrors. This results in a measured load, as if all bays in a full torus had condensation phenomenon identical in phase and amplitude, to the instrumented FSTF bay.

The analysis shows that for NMP-1:

- Eight downcomer bays have bay averaged CO loads which are conservative by at least 19% at frequencies other than 5-6 Hz.

- Four downcomer bays have bay averaged CO loads which are conservative by at least 38% at frequencies other than 5-6 Hz.

The present work (Reference 1) accounts for both the random phasing of the stress harmonics and the reduction in FSTF measured pressures, two independent phenomena.

Inclusion of the reduced CO loading addressed herein gains NMP-1 a relief of 573 psi in the eight downcomer bays, and 1565 psi in the four downcomer bays. These values are to be compared to a total combined stress from all sources on the order of 16,025 psi.

The CO load reduction accounts for the end cap effect of the FSTF in making it appear that all bays have eight downcomers and the hydrodynamics in each bay is in phase with adjoining bays. In the Brookhaven attachment to the SER (Reference 15) it is stated that the end caps introduce an FSTF conservatism.

On page 3 of the Brookhaven attachment, the following points are made:

- The FSTF data support the notion that the CO process is random over most of the frequency spectrum considered in the load methods.

- Because of the geometric differences, particularly the 4-8-4 downcomer arrangement, the pressure loads during CO blowdown will tend to be greater in the FSTF relative to the NMP torus for the same hydrodynamic flow conditions.

- The procedure used to quantify these effects represents a straight forward application of a conventional hydrodynamic method. The results are reasonable and probably conservative because of the high sound speed used in the numerics. We also consider the assumption that a correlation exists between bays to be a significant conservatism.

The attachment itself does not quantify these conservatisms. However, George Bienkowski's review of the Random Phasing Rules, dated August 25, 1983 (Reference 14), also includes some quantification of these effects. This is discussed in Section 5.0 herein.

## 4.0 ADDITIONAL CONSERVATISMS

The following is a delineation of additional conservatisms for which no credit has been taken.

1. Uniform corrosion of the shell would cause the frequencies to drop and the response to CO load to decrease. If the frequencies drop 1 Hz, then it is estimated that NMP-1 would gain about 600 psi relief in shell stress.

2. The analysis has been performed using 2% damping. It is estimated that increasing the damping to 4%, to account for water/structure damping, would gain NMP-1 more than 900 psi relief. Even 4% damping may be low for a thin shelled water filled structure.

3. The high sound speed used in the determination of the CO load reduction factors is conservative as is shown in Reference 10.

4. Curvature effects of the torus.

5. The ASME Code allows a uniform 10% reduction in wall thickness for Class MC Components, 1990 Addenda, Section XI, Paragraph IWE-3519.3. This is the same as allowing a 10% increase in the material allowables.

6. The ASME Code, Section III, Paragraph NE-3213.10, permits up to 1/16 inch local corrosion as is explained in TES Technical Report TR-6801-2 (Reference 11).

7. Class 1 allowables for this material are greater than Class MC allowables by 21%, $S_m$ = 20 ksi for Class 1 vs. $S_m$ = 16.5 ksi for Class MC.

8. Certified Material Test Reports (CMTR's) for the NMP-1 shell material indicate higher allowables than those used in the Mark I Program Analysis, 17.6 ksi vs. 16.5 ksi (see Section 6.0). If it becomes necessary to use the CMTR's, hardness tests could be performed on the torus shell to increase confidence in the material CMTR's.

9. There is inherent conservatism in the factor of safety (FS) associated with the code, FS = 1/(1.1x1/4)= 3.64 on ultimate material strength.

## 5.0 APPLICABILITY OF THE CONCLUSIONS PROVIDED IN THE REVIEW OF THE VALIDITY OF RANDOM PHASING RULES AS APPLIED TO CO TORUS LOADS

George Bienkowski issued the results of his review of the Validity of Random Phasing Rules as Applied to CO Torus Loads, on August 25, 1983 (Reference 14).

The review concluded the following:

1. A/E's could eliminate the 1.15 response factor on shell stresses if they use 4 harmonics summed absolutely added to the remaining summed SRSS (in lieu of 1.15 factor on 3 harmonics summed absolutely added to the remaining summed SRSS), provided the reported shell stresses are not within a few percent of the allowables, otherwise the issue should be revisited. The addition of 1 harmonic, to be summed absolutely, provides only about a 10% increase in the responses rather than the 15% needed to bound the FSTF measurements.

2. A/E's could neglect the harmonic components above 30 Hertz for structures with similar natural frequency content to the FSTF or Oyster Creek if specific justification in the form of torus response frequency characteristic is presented.

3. A/E's could use any variation that produces at least as high a ratio of response to that produced by absolute sum as the highest observed in the FSTF and Oyster Creek analyses (63%).

The refined shell analysis of the NMP-1 torus shell, performed by TES, using the reduced CO load definition includes the following:

1. The CO load reduction resulting from the FSTF end caps, 17.1% and 36.1% for non-vent and vent bays, respectively.

2. The combination of individual harmonic stresses into total element stress was done by considering frequency contributions at 31 Hz and below. The actual combination was done by adding the absolute value of the four highest harmonic contributors to the SRSS combination of the others for shell stress. This combination method and use of the 31 Hz cutoff are the result of extensive numerical evaluation of full scale test data. Including the frequency contribution out to 50 Hz would increase the CO stress by about 20 psi, or less than 1/2%.

George Bienkowski's review of the Random Phasing Rules also addressed the impact of the end caps on producing conservatively measured CO loads. This discussion begins at the bottom of page 3 of the review.

Here, the review refers to an unreferenced communication in Reports SMA 12101.04-R002D (Reference 7) and SMA 12101.04-R003D (Reference 8), from Dr. Alan Bilanin, that the presence of the bulkheads introduces a factor of conservatism of at least 1.33 to the measured CO loading and responses from which the LDR amplitudes were derived. This is separate from the phasing rules governing the summation of stress harmonics.

In addition, an "Appendix A" is mentioned wherein this effect is examined. This "Appendix A" is assumed to be an appendix to George Bienkowski's review and it has not been reviewed by TES or CDI.

It is stated that the Appendix concludes that for frequencies that are not correlated between bays, the FSTF should produce 32% to 35% higher loads than would exist in a real facility and that only the fundamental frequency near 6 Hz shows any correlation between downcomers. The review further states that if one assumes correlation between bays at that frequency and random phasing (this is not the random phasing of response stress harmonics) at all other frequencies, the overall conservatism for

the average pressure may be as low as 17% (note the review says "may"), while at the response level the FSTF conservatism will range from 18% for hoop stress to 38% for the axial stress.

These independent Brookhaven generated results are not unlike those that NMPC is currently presenting.

Robert Kennedy, in his report SMA 12101.04-R003D (Reference 8), uses this additional 33% conservatism, advanced by Dr. Alan Bilanin, to account for the uncertainty of using only the three peak responses from FSTF tests M-8, M-11B and M-12. On the other hand, George Bienkowski argues that this uncertainty estimate is probably excessively conservative and that 7% rather than 33% uncertainty would provide a high confidence level of non-exceedance.

Using the above numbers from George Bienkowski's work, we have as a minimum that the measured stresses are conservative by at least:

$$\{1-[(1-.18)(1+.07)]\}100 = (1-.88)100 = 12\%$$

Also, no mention has been made in George Bienkowski's review regarding the effect of the 4-8-4 downcomer configuration. The joint TES/CDI work (Reference 1) evaluates this effect as well. So we are looking for 17% relief in the 8 downcomer bays and the Brookhaven work shows at least 12% relief. The difference may be attributed to the 4 downcomer bays to either side of the 8 downcomer bay.

In addition, the 36% reduction that we have evaluated for the 4 downcomer bays also includes the fact that only half as many downcomers are present as are in the FSTF, an effect not mentioned in George Bienkowski's review.

The conservatisms related to the end cap effect discussed herein were not included in George Bienkowski's conclusions regarding the phasing rules.

Once the end cap effect is included, there is no reason why the resulting response should bound FSTF data. Indeed, by its very nature, it should not bound FSTF data.

## 6.0 NMP-1 TORUS SHELL CMTR'S

Certified Material Test Report Review for Torus Shell (Reference 11)

TES has reviewed the Torus Shell Certified Material Test Reports (A201 Gr B FBX). A statistical analysis was performed using this (large) sample data to determine the .99 confidence interval estimate of the mean yield and ultimate strength of this material.

The Code requires that the minimum yield and minimum ultimate strength of the material be used to determine the allowable stress intensity ($S_{MC}$) as follows:

$S_{MC}$ at 70°F is the lessor of

$$1.1 \left[\frac{5}{8} S_{Y_{min}}\right] \quad \text{or} \quad 1.1 \left[\frac{1}{4} S_{U_{min}}\right]$$

Therefore, TES has assumed that the minimum yield and ultimate strengths of the material are bounded by using two sample standard deviations from the statistically estimated minimum mean values.

Based on the calculations using the above stated criteria, the Code allowable stress intensity would be estimated at:

$$S_{MC} = 17600 \text{ at } 70°F$$

Use of this estimated allowable stress intensity will provide an additional 1100 psi relief as compared to the present Code allowable of 16500 psi which was used during the Mark I Containment Program analysis for

the torus shell material for the full range of anticipated event temperatures from 70 to 350°F. In terms of relief on the shell thickness requirements, the increased allowable will provide just under 1/32 inches or 6% additional margin.

## 7.0 RELEVANCE TO SAFETY

We do not view this issue as adversely affecting safety. It can be regarded as the effort undertaken to remove known conservatisms through refinement of the postulated applied CO loads. In addition, resolution of Code issues pertaining to the allowable material strength and allowable nominal corrosion, delineated in Section 4.0, "Additional Conservatisms", if introduced, would provide for added margin for the torus shell stresses. Also, the many other conservatisms discussed throughout this response, if accounted for, would further reduce the shell stress.

### Torus Corrosion Rate(1)

Niagara Mohawk undertook a new corrosion monitoring program in August, 1989. Under this program 1′ x 3′ grids on all 40 mid bay bottom plates were UT inspected. MPR Associates, Inc. Report MPR-1152 delineates the results of this inspection. These measurements did not show any significant loss due to corrosion or pitting even at the normal water level region; and there were no wall thickness measurements that would require application of the methods described in Teledyne Report TR-6801-2, reference 11. MPR quantified the shell thickness loss, over 20 years, by comparing the measured shell thickness values to the calculated original plate thickness. Thirty four shell plates, traceable to the original mil certifications, were used in this comparison. Original plate thicknesses were calculated using plate dimensions, weight and density of the steel. These thicknesses were compared to the UT thickness obtained in August, 1989, on the same 34 plates. The results indicated an average corrosion loss of 0.8 mils per year. This rate translates to a total loss of 32 mils or about 1/32" over the original projected 40 year plant life; and compares closely to the rate predicted by Radiological & Chemical Technology, Inc. (RCT), based on analysis of sludge samples in 1979. Due to variations in

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(1) This information provided by NMPC.

the original plate dimensions and weights, and measurements, one standard deviation was added to the 0.8 mils per year. This resulted in a conservative prediction of 1.26 mils per year corrosion rate. Additionally, Niagara Mohawk Power Corporation committed to perform UT measurements on a six month basis and provide the NRC with the results (Ref. November 22, 1989, letter C. Terry to NRC). Since baseline establishment of the new corrosion program of 1989, six (6) six-month measurements have been conducted, the most recent of which were just taken in September, 1992. Further analysis and trending of these measurements indicate that a conservative corrosion rate of 1 mil/yr including one standard deviation is a more realistic corrosion rate than the baseline estimate of 1.26 mils/yr. The most probable prediction of corrosion rate is still 0.8 mils/yr, but the later results have reduced the standard deviation to $\pm$ 0.2 mils/yr.

The latest (September, 1992) UT measurements, on the thinnest torus plates indicates the average thickness of the worst plate is 0.453 inches. This thickness represents an average of 63 individual measurements (calibration adjusted) on a 1′ x 3′ grid on that worst plate. Worst case individual measurements on this or other plates have been as low as 0.445 inches (calibration adjusted).

Over the next year, the projected worst case loss of thickness would be one mil or 0.001". This would theoretically reduce the worst grid to a 0.452" average thickness and the worst individual point to 0.444". The average thickness would comply with minimum thickness allowed by Teledyne Report TR-6801-2, reference 2, and theoretically provide for about another 5 years of operation before reaching the current minimum thickness allowed. However, the 0.444" individual point would have to be analyzed for compliance to TR-6801-2 by the methods outlined therein.

The analysis submitted under NMPC's May 14, 1991 cover letter (Reference 1), to the NRC supports any average thickness or individual

point down to 0.431". In addition, the many other conservatisms discussed herein, for which no credit has been requested or taken into account, would support reductions in excess of this.

Therefore, loss of thickness occurring due to projected corrosion over the next year would be within limits of supporting analyses.

## 8.0 REFERENCES

1. TES Technical Report TR-7353-1, Revision 2, "Nine Mile Point Unit 1, Reduction in Mark I Torus Program Condensation Oscillation Load Definition and Resulting Effect on Minimum Shell Thickness Requirements," dated January 14, 1992.

2. TES Report TR-5320-1, Rev. 1, "Mark I Containment Program, Plant-Unique Analysis Report of the Torus Suppression Chamber for Nine Mile Point Unit 1 Nuclear Generating Station," dated September 21, 1984.

3. G.E. Report NEDO-21888, Rev. 2, "Mark I Containment Program Load Definition Report," dated November 1981.

4. G.E. Report NEDE-24840, "Mark I Containment Program - Evaluation of Harmonic Phasing for Mark I Torus Shell Condensation Oscillation Loads," dated October 1980.

5. G.E. Report NEDO-24574, Rev. 1, "Mark I Containment Program - Plant-Unique Load Definition - Nine Mile Point 1 Nuclear Generating Plant," dated July 1981.

6. ASME B&PV Code, Section III, Division 1 through Summer 1977.

7. Structural Mechanics Associates Report SMA-12101.04-R002D, "Response Factors Appropriate for Use with CO Harmonic Response Combination Design Rules," dated March 1982.

8. Structural Mechanics Associates Report SMA-12101.04-R003D, "A Statistical Basis for Load Factors Appropriate for Use with CO Harmonic Response Combination Design Rules," dated March 1982.

## 8.0 REFERENCES (Cont'd)

9. G.E. Supplementary Support Effort (SSE) Response Number 310, dated February 8, 1982.

10. Continuum Dynamics Technical Note No. 90-11, "Reduction of Torus Shell Condensation Oscillation Hydrodynamic Loads for Nine Mile Point Unit 1," dated November 1990.

11. TES Technical Report TR-6801-2, "Mark I Torus Shell and Vent System Thickness Requirements," Nine Mile Point Unit 1 Nuclear Station, January 29, 1988, Rev. 1.

12. Mark I Containment Program, Structural Acceptance Criteria, Plant Unique Analysis Application Guide, NEDO-24583-1, October 1979.

13. TES Calculation Package 7353-1, Revision 2, "Nine Mile Point Unit 1, Reduction in Mark I Torus Program Condensation Oscillation Load Definition and Resulting Effect on Minimum Shell Thickness Requirements," dated January 14, 1992.

14. "Review of the Validity of Random Phasing Rules as Applied to CO Torus Loads," by George Bienkowski, dated August 25, 1983, Containment Systems Group, Department of Nuclear Energy, Brookhaven National Laboratory.

15. United States Nuclear Regulatory Commission, "Safety Evaluation by the Office of Nuclear Reactor Regulation Related to Proposed Deferment of Torus Modifications, Niagara Mohawk Power Corporation, Nine Mile Point Nuclear Station Unit 1, Docket No. 50-220," dated August 25, 1992.

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