Docket File

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 9, 1993

Docket No. 50-220

LICENSEE: Niagara Mohawk Power Corporation

FACILITY: Nine Mile Point Nuclear Station Unit No. 1

SUBJECT: SUMMARY OF MARCH 23, 1993, MEETING TO DISCUSS DIFFERENCES IN METHODOLOGY USED FOR SUMMING CONDENSATION OSCILLATION LOADS IN NINE MILE POINT UNIT NO. 1 TORUS SHELL MATERIALS (TAC NO. M85003)

A meeting was held in the NRC One White Flint North Office in Rockville, Maryland, with Niagara Mohawk Power Corporation (NMPC) and NRC staff representatives to discuss differences in methodology used for summing condensation oscillation loads in Nine Mile Point Unit No. 1 (NMP-1) torus shell materials. The NRC staff had requested this meeting. Enclosure 1 is a list of meeting attendees. Enclosure 2 is a copy of the handout material provided by NMPC.

By letter dated May 14, 1991, NMPC submitted a report to the NRC proposing a reduction in the condensation oscillation (CO) loads in the NMP-1 torus. The NRC staff reviewed that submittal and issued its safety evaluation on August 25, 1992. In its safety evaluation, the NRC staff concluded that CO stresses in the torus walls should be combined by the absolute sum method. NMPC's position was that these stresses should be combined by the square root of the sum of the square method plus the absolute sum of the stresses for four frequency peaks.

NMPC noted this difference in methodology in a letter to the NRC dated November 23, 1992, and requested a rereview. The November 23, 1992, letter also proposed to defer implementation of possible torus modifications for one additional fuel cycle. The NRC staff responded by letter dated December 23, 1992. Our response approved continued operation provided the criteria specified in our January 22, 1985, safety evaluation continue to be satisfied and the monitoring programs specified in our August 25, 1992, safety evaluation are implemented. Our December 23, 1992, letter also suggested that a meeting be held to discuss the differences in methodology for summing the CO loads.

By letter dated March 12, 1993, NMPC reported the results of the latest wall thickness measurements of the NMP-1 torus. NMPC reported that the NMP-1 torus is still in conformance with the NRC's safety evaluation of January 22, 1985, and based on the observed corrosion rate, the torus will not corrode below the required minimum wall thickness by the next refueling outage.

NMPC and their consultants presented information (see Enclosure 2) which appeared to be supportive of NMPC's methodology position for summing the CO

DF01

MGMO-4

[illegible]

loads. The NRC staff agreed to rereview the NMPC methodology. To perform this review, we request that two reports (NEDO-24010-03, August 1979 and SMA 12101.04-R001D, March 1981) referenced in Enclosure 2 be submitted to the NRC within 30 days.

The NRC staff also requested NMPC to document, within 30 days, the assertion that the Continuum Dynamics, Inc. acoustic model, which implies a unity reduction factor (no reduction) for the case of uncorrelated downcomers within a torus bay with all bays correlated, is correct.

Sincerely,

Donald S. Brinkman

Donald S. Brinkman, Senior Project Manager
Project Directorate I-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
1. List of Attendees
2. License Handout Material

cc w/enclosures:
See next page

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Syracuse, New York 13212

ENCLOSURE 1

Attendance List

March 23, 1993 Meeting to Discuss Differences

in Methodology Used for Summing CO Loads

Name	Position	Organization
Donald S. Brinkman	Senior Project Manger	NRC/NRR/PDI-1
Robert A. Capra	Director, PDI-I	NRC/NRR/PDI-1
Robert P. Kennedy	Struct. Mech. Consulting	Consultant, NMPC
Richard H. Berks	Principal Engineer	Teledyne Engr. Serv.
Richard A. Enos	Principal Engineer	Teledyne Engr. Serv.
Lee Klosowski	Gen. Supv. Nuc. Des U1	MMPC
Mohammed F. Alvi	Supervisor Civil/Struct U1	NMPC
Philip B. George	Engineer	NMPC
Alan Bilanin	Senior Associate	Continuum Dynamics
John Lehner	Group Leader	BNL
Constantino Economos	Engineer	BNL
S. K. Chaudhary	Sr. Reactor Engr.	USNRC-RGN-I
J. Kudrick	Section Chief	NRC/NRR/SCSB
M. Snodderly	Reactor Engineer	NRC/NRR/SCSB
Tony D'Angelo	Sr. Reactor Engineer	NRC/NRR/SCSB
Jim Davis	Materials Engineer, NRR	NRC/NRR/DE
Robert B. Burtch, Jr.	Manager, Nuclear Communications	NMPC
Gary D. Wilson	Managing Counsel	NMPC
Nick Spagnoletti	Program Director-Licensing	NMPC
Robert Pollard	Nuclear Safety Engineer	Union of Concerned Scientists

ENCLOSURE 2

NIAGARA MOHAWK POWER CORPORATION

PRESENTATION

TO

NRC

MARCH 23, 1993

NINE MILE POINT UNIT 1

REDUCTION IN MARK I TORUS PROGRAM CONDENSATION OSCILLATION LOAD DEFINITION AND RESULTING EFFECT ON MINIMUM SHELL THICKNESS REQUIREMENTS

- AGENDA -

INTRODUCTION	L. KLOSOWSKI
CONDENSATION OSCILLATION LOADS	A. BILANIN
STRESS SUMMATION	R. KENNEDY
SUMMARY	L. KLOSOWSKI
Q & A	ALL

NMP1 TORUS CO LOAD REDUCTION

PURPOSE

RESOLVE INCONSISTENCY BETWEEN NRC SER DATED AUGUST 25, 1992 AND NMPC SUBMITTAL DATED MAY 14, 1991

NMPC SUBMITTAL PROVIDES BASIS FOR REDUCTION IN CONDENSATION OSCILLATION (CO) LOADS DUE TO GEOMETRY DIFFERENCES BETWEEN FSTF AND NMP1 TORUS

NRC SER APPROVES LOAD REDUCTION

NMPC SUBMITTAL COMBINES STRESS HARMONICS USING MODIFIED SRSS* (INCLUDING STRESSES FROM REDUCED CO LOADS)

MODIFIED SRSS SUMMATION ACCEPTED BY NRC IN MARK I TORUS PROGRAM

NRC SER APPROVES MODIFIED SRSS SUMMATION OF STRESS HARMONICS BUT NOT WHEN USING REDUCED CO LOADS

CO LOAD REDUCTION AND MODIFIED SRSS SUMMATION INDEPENDENT

USE OF MODIFIED SRSS (INCLUDING STRESSES FROM REDUCED CO LOADS) APPROPRIATE

THIS ADDITIONAL CLARIFICATION WAS PROVIDED IN NMPC SUBMITTAL DATED NOVEMBER 23, 1992

(* - ABSOLUTE SUM OF 4 LARGEST STRESS HARMONICS PLUS SQUARE ROOT SUM OF SQUARES REMAINING 27 STRESS HARMONICS)

MODIFIED SRSS STRESS COMBINATION

FSTF BUILT (1/16 SEGMENT, 1-BAY, 8 DOWNCOMERS, RIGID END CAPS)

TESTS RUN - LOADS, PRESSURES AND STRESSES MEASURED

ANALYTICAL MODELS DEVELOPED TO MATCH MEASURED LOADS, PRESSURES AND STRESSES

MODIFIED SRSS (ABSOLUTE SUM 4 LARGEST STRESS HARMONICS AND SRSS REMAINING 27 STRESS HARMONICS) RESULTED IN GOOD CORRELATION WITH MEASURED STRESSES

(ALL STRESSES WERE CLOSE TO OR EXCEEDED MEASURED STRESSES)

CO LOAD REDUCTION

FSTF NOT REPRESENTATIVE OF NMP1 TORUS

- RIGID END CAPS
- 8 DOWNCOMERS

NMP1 HAS 8-4-8-4.... DOWNCOMER BAYS

END CAP EFFECTS RESULT IN HIGHER CO LOADS IN ALL FREQUENCY RANGES

THEREFORE, LOADS AND PRESSURES MEASURED IN FSTF ARE CONSERVATIVE FOR NMP1 TORUS

NMP1 TORUS CO LOAD REDUCTION

<u>SUMMARY</u>

ABSOLUTE SUM OF 4 LARGEST STRESS HARMONICS AND SRSS OF REMAINING 27 STRESS HARMONICS CORRELATES MEASURED AND CALCULATED STRESSES WELL

MEASURED LOADS ARE UNREALISTICALLY HIGH DUE TO END CAP EFFECTS AND 8 DOWNCOMER BAYS

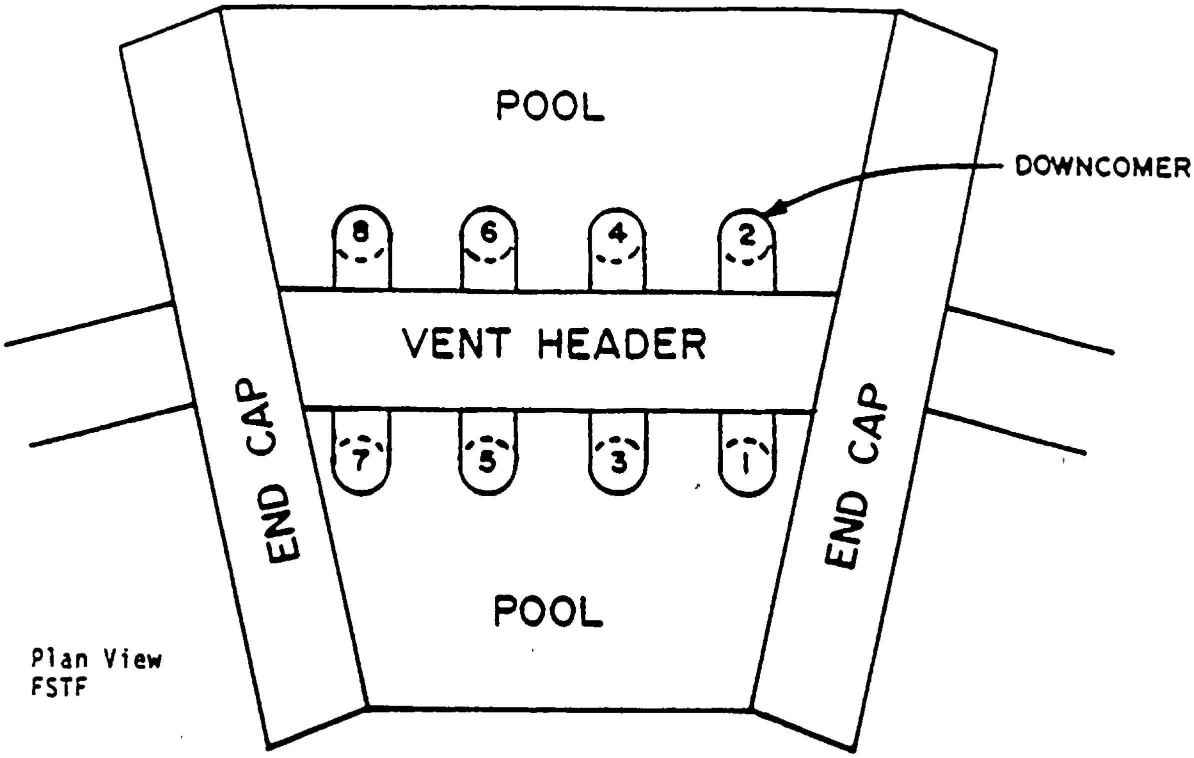
MODIFIED SRSS COMBINATION OF STRESSES FROM REDUCED CO LOADS IS APPROPRIATE

MANY OTHER CONSERVATISMS EXIST

THEREFORE, STRESS REDUCTIONS IN NMPC MAY 14, 1991 SUBMITTAL ARE APPROPRIATE

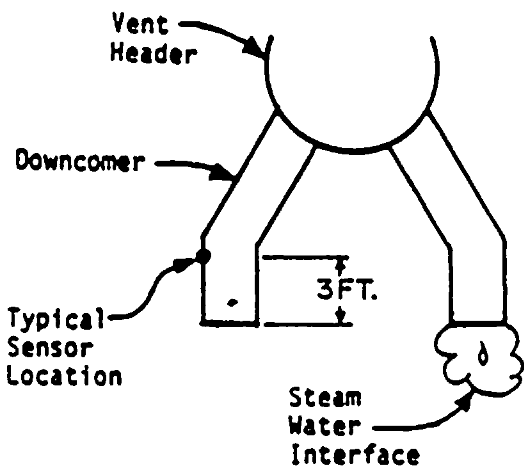
TORUS CO LOAD REDUCTION

FULL SCALE TEST FACILITY (FSTF)



Plan View
FSTF

VENT	TRANSDUCER
1	P5123
2	P5243
3	P5323
4	P5443
5	P5523
6	P5643
7	P5723
8	P5843



Downcomer exit pressure transducers in FSTF.

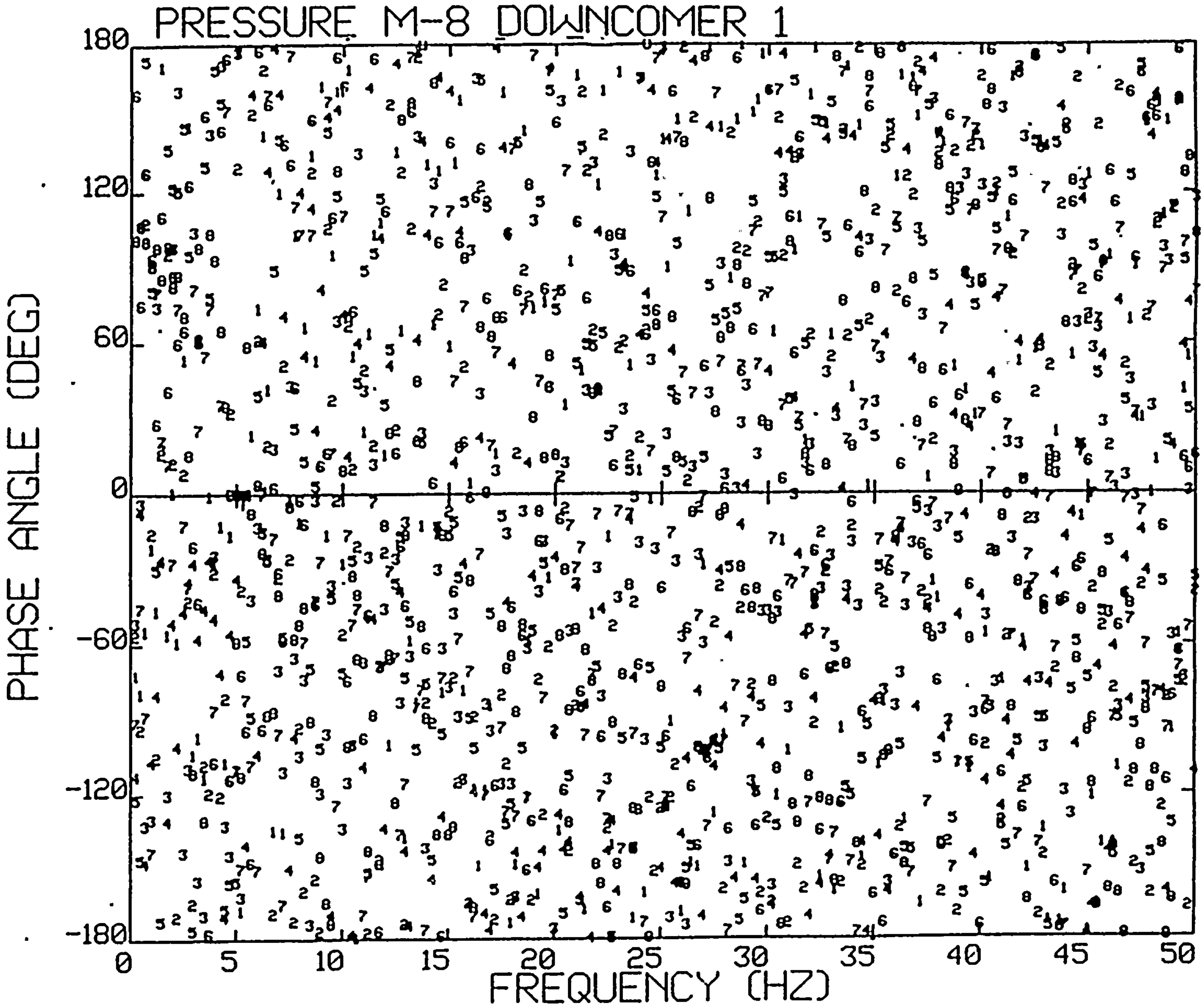


Figure 3.2. Comparison of the phase angles between harmonic components in the vent exit transducer P5123 (Run M-8)

TORUS CO LOAD REDUCTION
CORRELATION OF PRESSURE SOURCES-FSTF RESULTS

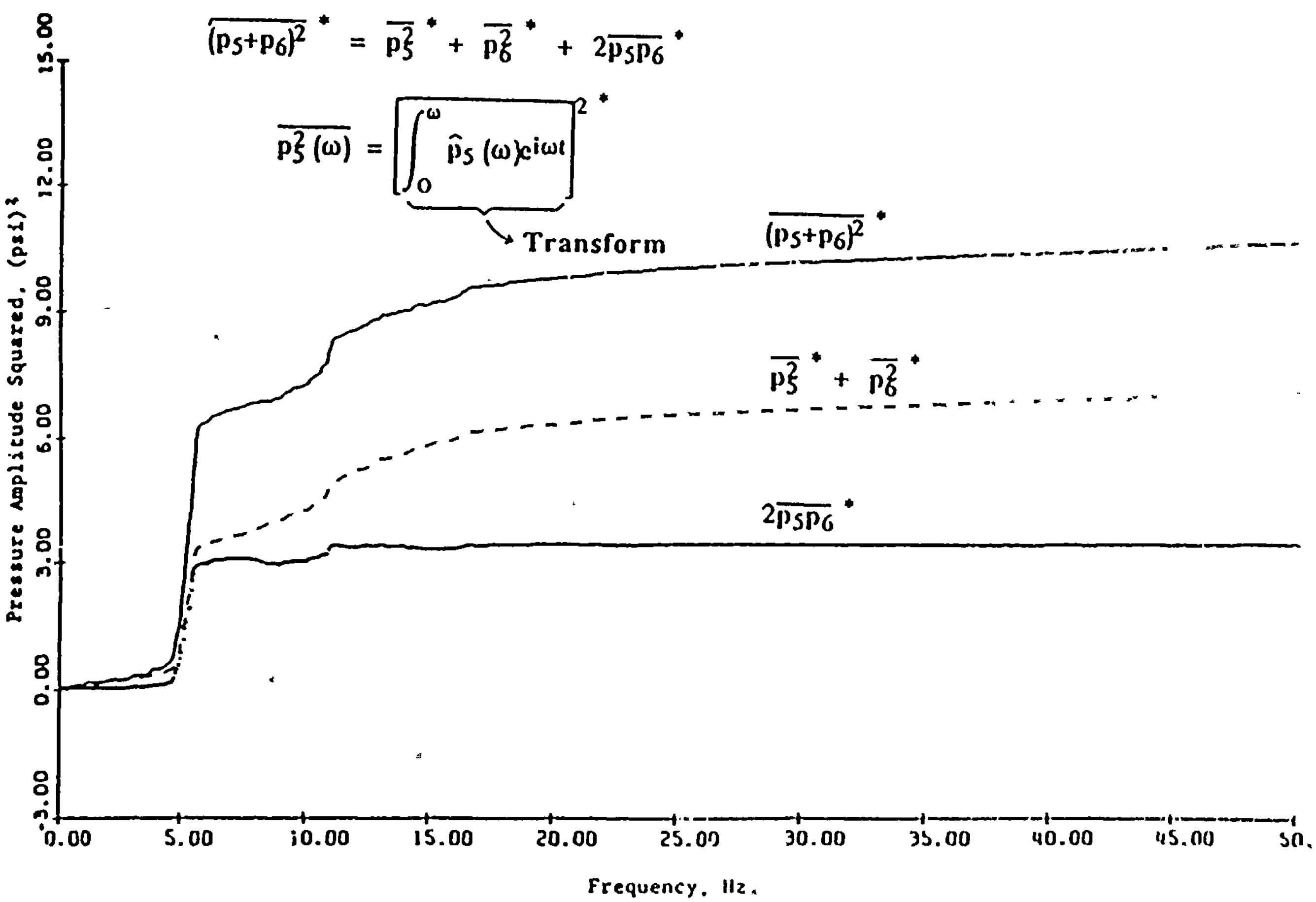


Figure 2. Mean Square pressure signals between downcomers 5 and 6, FSTF Run M8, 20 - 35 seconds during condensation oscillation as a function of frequency (measured from zero frequency).

TORUS CO LOAD REDUCTION

FSTF TEST RESULTS

- ANALYSIS RESULTS BASED ON THE FSTF TESTS HAVE SHOWN THAT DURING CONDENSATION OSCILLATION
  - THE PULSATING CONDENSATION AT EACH EXIT IS RANDOM (UNCORRELATED) IN THE FREQUENCY DOMAIN EXCEPT AT TWO FREQUENCY RANGES
  - THE PULSATING CONDENSATION AT THE DOWN-COMER EXITS ARE STRONGLY CORRELATED BETWEEN DOWNCOMERS AT 4-6 HZ AND WEAKLY CORRELATED AT 8-12 HZ.
  - THESE FINDINGS WERE PRESENTED TO THE NRC ON MARCH 4, 1981
- THE CONSEQUENCE OF THIS RANDOMNESS AND THE GEOMETRY OF THE FULL SCALE TEST FACIL-ITY IS A MEASURED CONDENSATION OSCILLATION TORUS LOAD WHICH IS VERY CONSERVATIVE.

TORUS CO LOAD REDUCTION

NMP1 TORUS PLAN VIEW

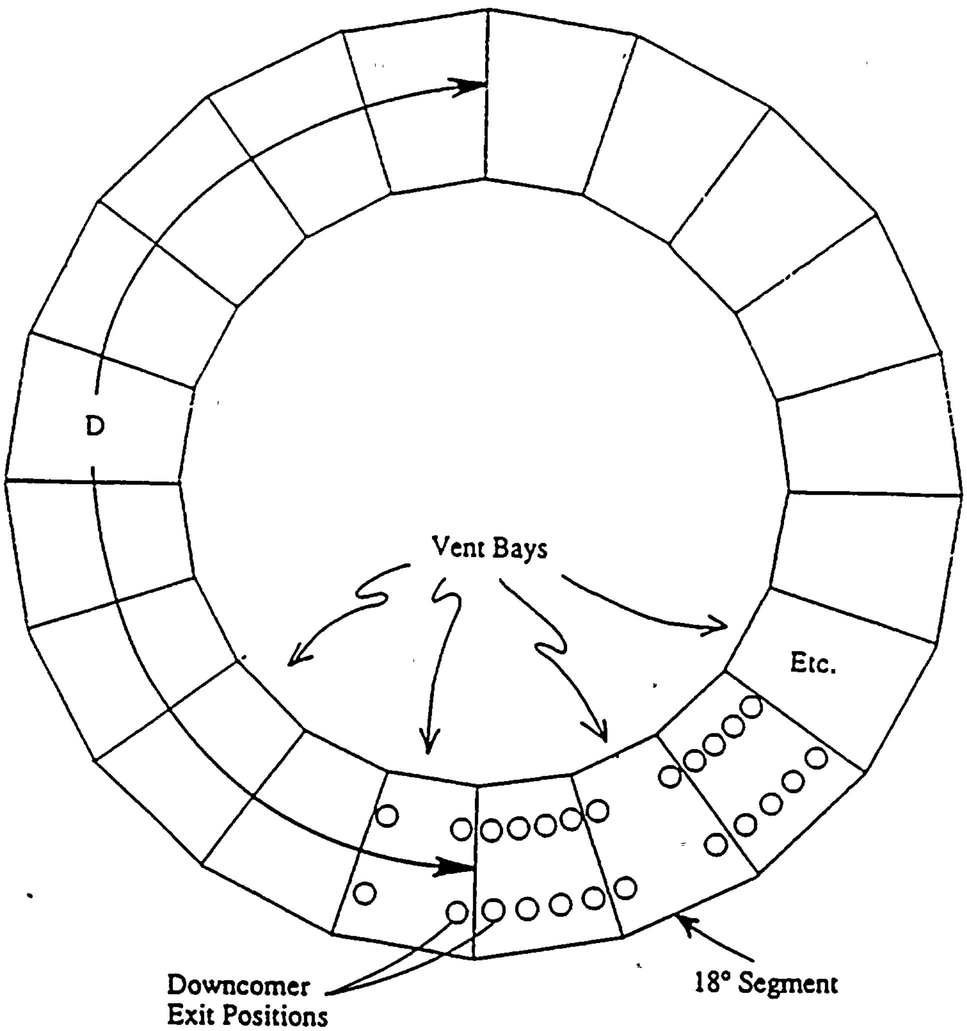


Figure 3. Plan view of Nine Mile Point suppression pool showing 8-4-8-4 downcomer/bay geometry. (Not to Scale)

TORUS CO LOAD REDUCTION

NMP1 CURRENT ANALYSIS PLAN

- UTILIZE MULTI-BAY HYDRODYNAMIC MODEL AND APPLY SPECIFICALLY TO NINE MILE POINT UNIT 1 TO PROVIDE A MORE REALISTIC CONDENSATION OSCILLATION TORUS SHELL LOAD
- THIS MULTI-BAY HYDRODYNAMIC MODEL TAKES INTO ACCOUNT
  - UNCORRELATED STEAM CONDENSATION
  - ALTERNATING 8 AND 4 DOWNCOMER BAYS

Response Combination
Background References

1.) Kennedy , R.P, and N.M. Newmark, "Bases for Criteria for Combination of Earthquake and other Transient Responses by the Square-Root-Sum-of-the Squares-Method," NEDO-24010-2, General Electric Company, San Jose, California, December 1978.

2.) Kennedy, R.P., Tong, W.H., and N.M. Newmark, "Study to Demonstrate that Approximately the SRSS Combined Response Has Greater than an 84 Percent Nonexceedance Probability When the Newmark-Kennedy Acceptance Criteria are Satisfied, NEDO-24010-03, General Electric Company, San Jose, California, August 1979.

These References State and Demonstrate That:

1. The goal of a response combination procedure should be to retain approximately the same level of conservatism (as expressed by the non-exceedance probability) as exists for each of the component responses contained in the combination.

2. It is unnecessary for the response combination procedure to add additional conservatism.

3. The desired level of conservatism should be placed at other levels in the design process such as the definition of the loading, the response calculational method, and the definition of acceptable response levels.

4. The response combination methodology cannot rationally or uniformly cover potential unconservatism inadvertently introduced elsewhere in the design process.

Response Combination Goal of Retaining Conservatism Introduced Elsewhere is Met So Long As:

$$R_C \geq R_{50\%} \qquad (1)$$

And

$$Rc \geq \frac{R_{84\%}}{1.2} \qquad (2)$$

Where:

R_c = Combined Response for Defined Loading

$R_{50\%}$ = 50% Non-Exceedance Probability (NEP) Combined Response For Defined Loading

$R_{84\%}$ = 84% NEP Combined Response For Defined Loading

C.O. Loading

- Defined By Fourier Harmonic Amplitude Coefficients Within 1-HZ Frequency Bands
- Individual Harmonic Amplitudes Are Predominantly Randomly Phases
- It is Incredibly Unlikely that More than A Few Individual Fourier Amplitude Responses Will Worst-Case Combine (Absolute Sum) When Phasing is Random
- Absolute Combination of All Individual Fourier Amplitude Responses is Excessively Conservative and Cannot Be Justified Technically When Phasing is Random.
- Issues Studied Extensively in :

1. Kennedy, R.P., S.A. Short and W.H. Tong, "Evaluation of Harmonic Phasing for Mark I Torus Shell Condensation Oscillation Loads," SMA 12101.02-R-001, Structural Mechanics Associates, Newport Beach, California, July 1980.
2. Kennedy, R.P., S.A. Short and R.B. Narver, "Evaluation of FSTF Tests M-12 and M-11B Condensation Oscillation Loads and Responses," SMA 12101.04-R001D, Structural Mechanics Associates, Newport Beach, California, March, 1981.

SMA 12101.04-R002D

RESPONSE FACTORS APPROPRIATE FOR USE WITH CO HARMONIC RESPONSE COMBINATION DESIGN RULES

by

Robert P. Kennedy

AUTHOR Robert P. Kennedy
Robert P. Kennedy
President

APPROVED Thomas R. Kipp
Thomas R. Kipp
Manager, Quality Assurance

Prepared For

GENERAL ELECTRIC COMPANY
NUCLEAR ENERGY DIVISION
San Jose, California

July, 1981

STRUCTURAL MECHANICS ASSOCIATES
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Response Combination Goal is Met So Long As:

$$R_c = \sum_{i=1}^{3} |R_i| + \sqrt{\sum_{i=4}^{N} (R_i)^2} \qquad (3)$$

where R_i represents the response of the i^{th} response harmonic with R_1, R_2, and R_3 being the largest three (3) response harmonics. By this rule the largest 3 response harmonics are combined absolutely and added absolutely to the SRSS combination of the remainder of the response harmonics. This combination is equivalent to assuming that the largest 4 response harmonics are worst-case phased (absolute sum phasing) and the remainder are random phased at the time of peak response. This combination is consistent with the assumption of nearly constant amplitude harmonics with random phasing between harmonics such that the possibility of more than 4 or 5 harmonics achieving nearly worst-case phasing at any one time is highly remote.

Conclusions

Recommended Response Combination Proceedure Depends Only On:

1. Acceptance of Response Combination Goal of Retaining Conservatism Introduced Elsewhere

2. Adequately Conservative Definition of Loading Such That Item 1 is Accepted

3. Predominately Random Phasing of Individual Harmonic Amplitudes

4. Ratio of Absolute Sum (AS) to SRSS Combined Response Being Similar to Those Obtained for GE LDR Loading (i.e., Less Than About Four)

   - The Number N1 of Harmonics Which Must be Combined Absolutely Increases As the Ratio AS/SRSS Increases.

- BASED UPON THEORETICAL CONSIDERATIONS N1 INCREASES WITH INCREASE OF AS/SRSS RATIO

SMA 12101.05-R001

DESIGN APPROACH BASED ON FSTF DATA FOR COMBINING HARMONIC AMPLITUDES FOR MARK I POST-CHUG RESPONSE CALCULATIONS

by

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Stephen A. Short
Wen-How Tong

prepared for

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May, 1982

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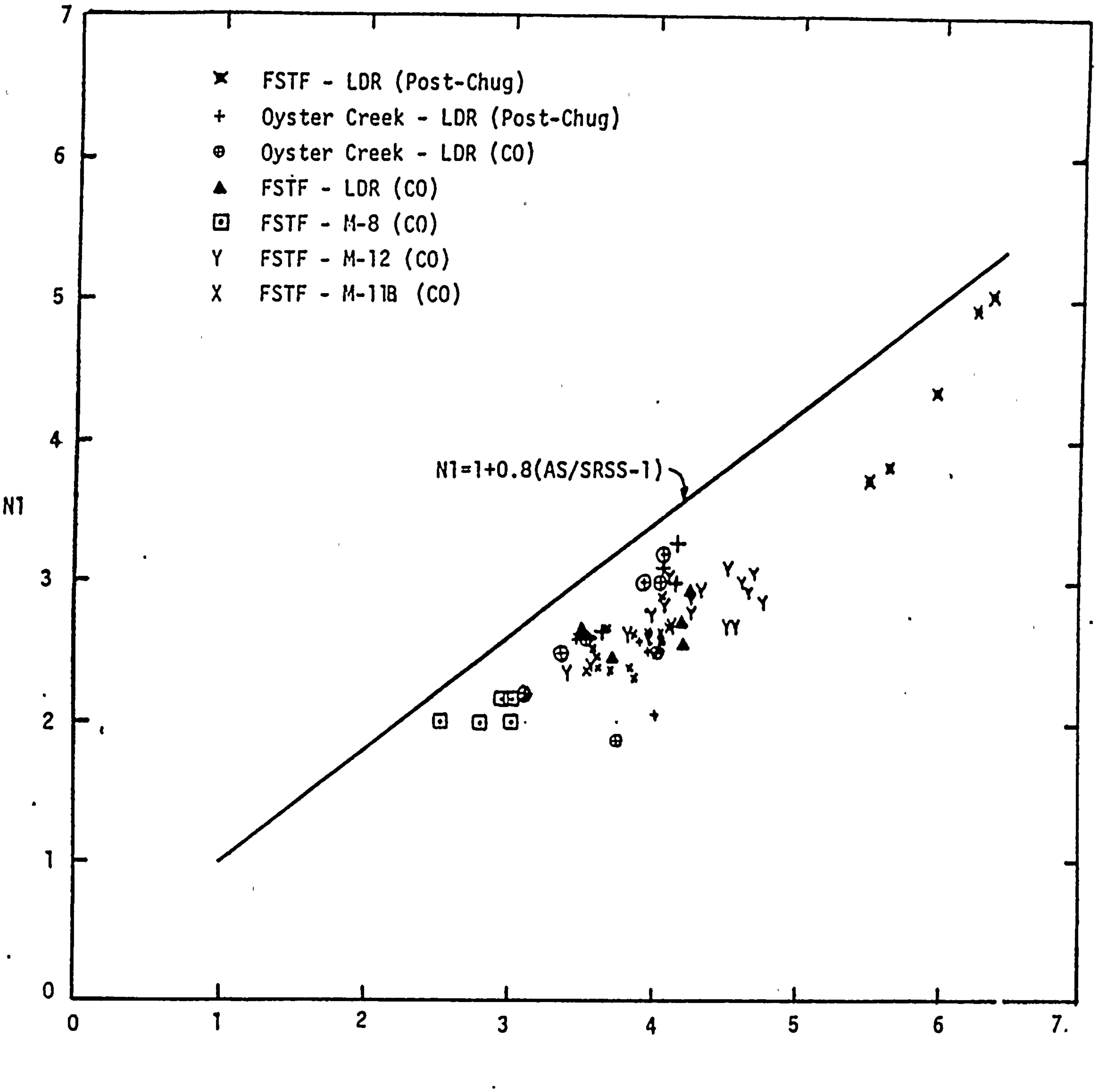

N1(50%NEP) VS. AS/SRSS PLOT USING CO AND CHUG STUDY DATA

OVERALL SUMMARY

IT IS TECHNICALLY CORRECT TO:

(1) REDUCE CO LOADS BASED ON RANDOM PHASING BETWEEN DOWNCOMERS AND GEOMETRIC DIFFERENCES BETWEEN NMP1 AND FSTF

AND

(2) COMBINE STRESSES BY MODIFIED SRSS SUM OF STRESS HARMONICS TO ACCOUNT FOR RANDOMNESS OF HARMONIC PHASING

loads. The NRC staff agreed to rereview the NMPC methodology. To perform this review, we request that two reports (NEDO-24010-03, August 1979 and SMA 12101.04-R001D, March 1981) referenced in Enclosure 2 be submitted to the NRC within 30 days.

The NRC staff also requested NMPC to document, within 30 days, the assertion that the Continuum Dynamics, Inc. acoustic model, which implies a unity reduction factor (no reduction) for the case of uncorrelated downcomers within a torus bay with all bays correlated, is correct.

Sincerely,

Original signed by:

Donald S. Brinkman, Senior Project Manager
Project Directorate I-1
Division of Reactor Projects - I/II
Office of Nuclear Reactor Regulation

Enclosures:
1. List of Attendees
2. License Handout Material

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JCalvo	RACapra
DBrinkman*	CVogan
OGC	EJordan, MNBB 3701
JKudrick, 8/D/1	TD'Angelo, 8/D/1
JDavis, 7/D/4	MSnodderly, 4/E/4
ACRS (10)	CCowgill, RGN-1*
VMcCree, RGN-1	

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