WM. H. ZIMMER POWER STATIO"

INSTRUCTIONS FOR UPDATING YOUR DESIGN ASSESSMENT REPORT

Changes to the MARK II DAR are identified ɔy a vertical line in the right margin of the page. To update your copy of the ZPS-1 DAR, remove and destroy the following pages and figures and insert pages and figures as indicated.

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Page vi	Pages vi and vi (Cont'd)
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CHAPTER 10	
Pages 1.0-1 and 1.0-2	Pages 1.0-1 and 1.0-2
CHAPTER 5.0	
Pages 5.2-13 and 5 2-14	Pages 5.2-13 through 5.2-14a
After Figure 5.2-4	Figure 5.2-5
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CHAPTER 1.0 - INTRODUCTION

The purpose of this revision of the Design Assessment Report (DAR) is to demonstrate that the Wm. H. Zimmer Nuclear Power Station, Unit 1 (ZPS-1) containment can accommodate all hydrodynamic load phenomena associated with the SRV discharge and LOCA in the BWR Mark II containment, to provide evidence of conformance with the NRC Lead Plant Acceptance Criteria (NUREG-0487), and to provide a response to the formal questions posed by the Nuclear Regulatory Commission (NRC).

In the summer of 1979, the Wm. H. Zimmer Power Station (ZPS-1) design and construction status was such that additional load changes requiring plant modifications would seriously impact the construction schedule. To avoid this situation the ZPS-1 "three-pronged" approach was adopted. The three facets of this approach are:

a. Expedite construction based on conservative loads and upgrade immediately containment capability where possible.

b. Assess the plant for the Zimmer Empirical Load Design Basis which is expected to bound any future changes in pool dynamic loads.

c. Confirm adequacy of design with results of the Zimmer in-plant SRV test and the long-term Mark II program.

The Zimmer empirical loads are described in Section 2.1. This report describes the original design-basis for ZPS-1, subsequent reassessments for revised and newly identified loads, and finally the current reevaluation of the design using the Zimmer empirical loads to ensure the adequacy and conservatism of the containment structures, piping, and equipment.

This report also describes the conformance of the Zimmer design to the NRC Lead Plant Acceptance Criteria (NUREG-0487). Subsection 5.2.3 compares the design-basis T-quencher load with the criteria of NUREG-0487 and Supplement 1 of NUREG-0487. 15
Subsection 5.3.2 compares the design-basis LOCA loads with the criteria in NUREG-0487. This report provides the NRC staff with all information necessary to continue and complete the licensing of the Wm. H. Zimmer Nuclear Power Station as scheduled. All pertinent information related to loads, load specification, load combinations, acceptance criteria, plant modification, plant margins, and confirmation of loads that apply to ZPS-1 has been compiled in this document. In addition, an in-plant SRV test will be performed to confirm the adequacy of loads used for design assessment.

In this report the individual loads and load combinations that are being utilized in the reassessment are identified and described in the first four sections. Reports defining the individual loads and providing justification for application to the ZPS-1 containment are referenced rather than repeated. This is consistent with the objective of this report.

The methods used in reevaluating the structures, piping systems,
and equipment are described in Chapter 7.0. Fatigue analysis
of the downcomers and SRV lines is included in Subsection 7.3.2. 15
The plant modification and resultant changes that have been
completed are described in Chapter 9.0. The plant margins and
conservatisms are summarized in Chapter 10.0. To fulfill the
requirements of NUREG-0487, a description of the assessments 15
used to ensure functional capability of piping systems is in-
cluded in Section E.4 of Appendix E.

The long-term Mark II program is expected to confirm that the
plant, as presently designed and constructed, is completely
safe and adequate. An interim assessment using loads derived
from results of the 4TCO tests, described in Subsection 5.3.3, 15
provides additional ensurances. However, additional design
modifications and plant changes are being implemented to
utilize the full containment capability. This ensures that
the maximum possible margins are built into the plant, so that
if load definitions should change later, they can be accommo-
dated without plant hardware changes. The ZPS-1 plant startup
should, therefore, proceed as scheduled.

5.2.3 Assessment of NRC Acceptance Criteria - SRV

The original design methods and the design reassessments described in the above subsections address all the NRC concerns in the Lead Plant Acceptance Criteria (NUREG-0487). An itemized list of the Zimmer Power Station response to the NRC Acceptance Criteria is contained in Section 5.4.

In order to demonstrate the adequacy of the William H. Zimmer Station design-basis frequency range for the all valve discharge case, a comparison was made between it and the frequency range provided in NUREG-0487, Supplement 1 (September 1980). The comparison was accomplished by generating envelopes of the magnitude of the Fourier transforms of the sets of factored design traces produced by the two methods. The Zimmer Station design basis is derived from using a 1.5 amplitude multiplier on the three KWU design traces and sweeping a dominant frequency range of 2.9 to 9.9 hertz. The NRC design basis is derived from using a 1.1 amplitude multiplier on the three KWU design traces and sweeping a dominant frequency range of 3 to 11 hertz. The resulting design envelopes are compared in the attached figure. Note that the Zimmer design-basis is 35% higher than the NRC design basis except in the narrow frequency range of 11 to 13 Hz. In this narrow range, the NRC design basis is, on the average, 8% higher.

In our judgement this small increase over a narrow frequency range 15
is of no design significance. Our opinion is based on the following:

a. The total structural and piping response has contributions from several frequencies. The Zimmer design basis is 35% higher than the NRC design basis except in the 11 to 13 hertz range where it is 8% lower. In our opinion any increase in structural or piping response due to a higher 11 to 13 hertz input will be more than compensated by a lower input (and response) for all other frequencies.

b. The Zimmer design is based on the simultaneous occurrence of the SSE, LOCA, and the SRV events. As the combined design response has contribution from all three loads, the increase in the SRV response would be more than compensated for by the conservatism Zimmer has used in other portions of its Empirical Design Basis loads. This is illustrated in Subsection 5.3.3.

c. For design of the Zimmer station, those loads were
combined by the absolute sum method. A significant
reduction would result from the use of the SRSS
(Square Root of the Sum of the Squares) method 15
which has been approved for Mark II use by the NRC.

Based on the above discussion, we conclude that the Zimmer design basis is more conservative than required by NUREG-0487, Supplement 1.

5.2.4 References

1. A. J. James, "The General Electric Pressure Suppression Containment Analytical Model," General Electric Report NEDO-10320, April 1971.

2. W. J. Bilanin, "The General Electric Mark III Pressure Suppression Containment System Analytical Model," General Electric Report NEDO-20533, June 1974.

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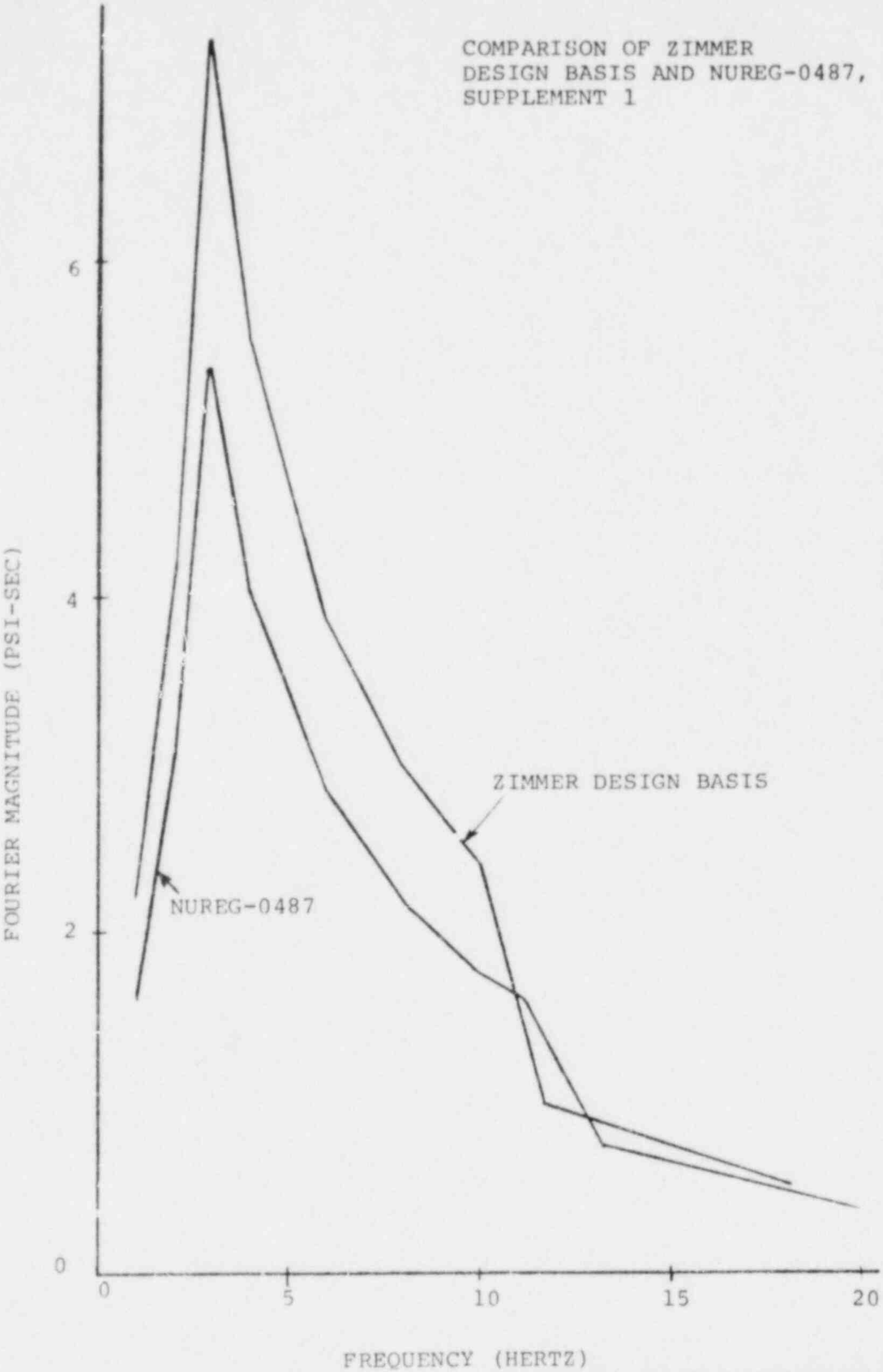

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FIGURE 5.2-5

COMPARSION OF ZIMMER DESIGN BASIS AND NUREG-0487, SUPPLEMENT 1

5.3.2.5 Condensation Oscillation Loads

The condensation oscillation (CO) load definition originally used in the ZPS-1 design is the Mark II DFFR load definition. However, to account for uncertainties in the load definition and to expedite licensing, a more conservative load definition has been used for reassessment. This method, called the Zimmer Empirical Approach, is described in Chapter 1.0. This approach is more conservative than required by NUREG-0487.

5.3.3 ZPS-1 4TCO Data Assessment

In mid-1979, the state of construction and schedule of the William H. Zimmer Power Station were such that finalization of the design loads was required to prevent costly delays in completion of the plant. These design loads are reported in the Design Assessment Report (DAR) as the Zimmer Empirical Loads. These loads were purposely defined with added conservatism to accomodate, if necessary, increased loads based on tests which were not complete at that time. A commitment was also made to confirm that the Zimmer Empirical Load was indeed adequately conservative when results of those tests became available.

The major uncertainty in the pool dynamic loads was the phenomena of LOCA steam condensation. To better define these loads, the Mark II Owners' Group performed additional tests at the 4T single-vent test facility. The results of this test became available in early 1980. To confirm the adequacy of the design load definitions for Condensation Oscillation (CO) and Chugging, new boundary loads were defined based upon the 4TCO data and applied to Zimmer structural models to allow response spectra comparisons. 15

A CO load based on the 4TCO data was submitted to the NRC in July 1980. This load was defined as two sets of pressure time histories from the 4TCO tests. The first set (called CO1) bounds all the 4TCO data taken under blowdown conditions which could be conservatively predicted to occur during a LOCA in the Zimmer station. The second set (called CO2) bounds the data taken under conditions which could be conservatively predicted to occur coincident with the actuation of the Automatic Depressurization System (ADS). In October 1980, after review of this load definition, the NRC concurred that this was an appropriate approach to demonstrate the conservatism of the design basis. After the lead plant load was reviewed, another CO load based on 4TCO data was presented to the NRC by the Mark II Owners' Group. This generic CO was essentially the same as the lead plant load except that the elimination of the small amount of non-prototypical (unrealistically high pool temperature) data was left to the individual plants as a plant unique application methodology. If the Zimmer unique selection is applied to the generic load, it becomes essentially identical to the lead plant load.

A chugging load based on 4TCO data was also defined in July 1980 and finalized in September 1980. This load is again a set of 4TCO time histories. The amplitude is a bounding average to conservatively simulate the observed variation in amplitude between chugs. The chugs were conservatively assumed to be in-phase at all vents. This load was compared with data from the JAERI (Japanese Atomic Energy Research Institute) multivent test facility and found to be conservative. After review of this lead plant chugging load, the NRC agreed that this load was adequate to proceed with construction and licensing with the provision that an assessment be made with the Mark II Generic Chugging Load Definition.

Comparison of typical response spectra envelopes are included here. The two curves represent the Zimmer design basis and a hypothetical design basis utilizing 4TCO data and the SRSS (Square Root of the Sum of the Squares) method of load combinations which has been approved by the NRC for Mark II application.

Curve 1 represents an envelope of the Zimmer Empirical Load (ZEL) Design Basis:

envelope {
OBE + SRV (Low Setpoint) + CO1 (ZEL)
SSE + SRV (Low Setpoint) + CO1 (ZEL) 15
OBE + SRV (ADS) + CO2 (ZEL)
SSE + SRV (ADS) + CO2 (ZEL)
OBE + SRV (ADS) + Chugging (ZEL)
SSE + SRV (ADS) + Chugging (ZEL)

Each load combination is combined by Absolute Sum. The loads are as defined in the Zimmer DAR.

Curve 2 represents an envelope of loads based on 4TCO data combined with seismic and SRV loads:

envelope {
OBE + SRV (Low Setpoint) + CO1 (4TCO)
SSE + SRV (Low Setpoint) + CO1 (4TCO)
OBE + SRV (ADS) + CO2 (4TCO)
SSE + SRV (ADS) + CO2 (4TCO)
OBE + SRV (ADS) + Chugging (4TCO)
SSE + SRV (ADS) + Chugging (4TCO)

Each load combination is combined by SRSS. Although a reduction in the SRV (ADS) amplitude multiplier of about 30% (1.1 in place of 1.5) has been approved by NRC, this reduction was not included in this comparison.

These comparisons show that the design basis is very conservative at frequencies below 50 hertz. The occasional exceedences above 50 hertz are not considered significant to the design.

5.3.4 References 15

1. General Electric Company and Sargent & Lundy, "Mark II Containment Dynamic Forcing Functions Information Report," NEDO-21061, September 1976 (Revision 2).

2. Final Safety Analysis Report, Wm. H. Zimmer Power Station, Chapter 6.0.

3. General Electric Company and Sargent & Lundy Engineers, "Mark II Containment Dynamic Forcing Functions Information Report," NEDE-21061-P, September 1976 (Revision 2).

4. "Analytical Model for Liquid Jet Properties for Predicting Forces on Rigid submerged Structures," NEDE-21472, September 1977.

5. S. Abramovich and A. Solan, "The Initial Development of a Submerged Laminar Round Jet," Journal of Fluid Mechanics, Vol. 59, Part 4, pp. 791-801, 1978.

6. "Mark I Containment Program 1/4 Scale Test Report Loads on Submerged Structures Due to LOCA Air Bubbles and Water Jets," NEDE-23817-P, September 1978.

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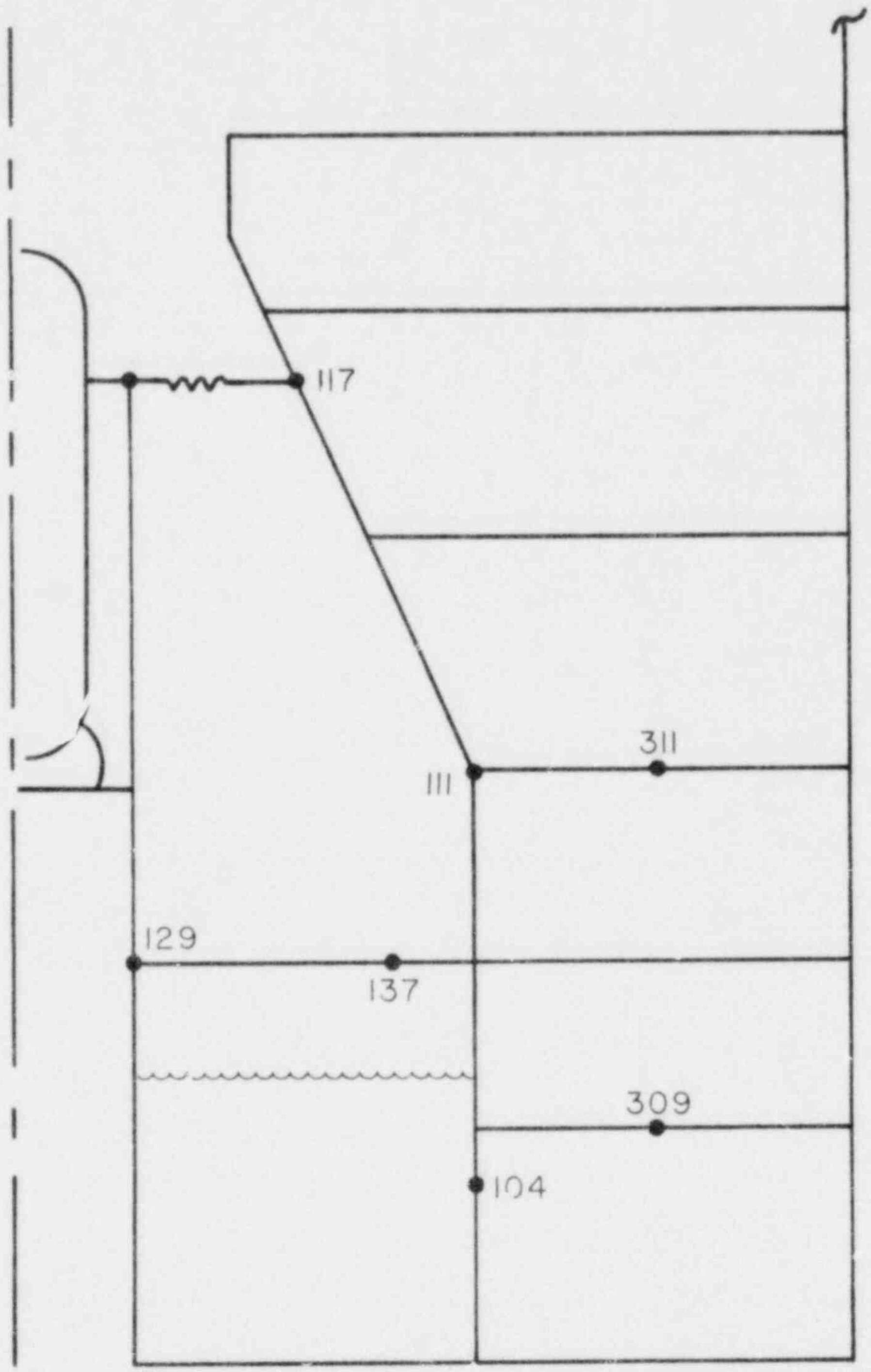

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FIGURE 5.3-27

ZIMMER PLOT LEGEND

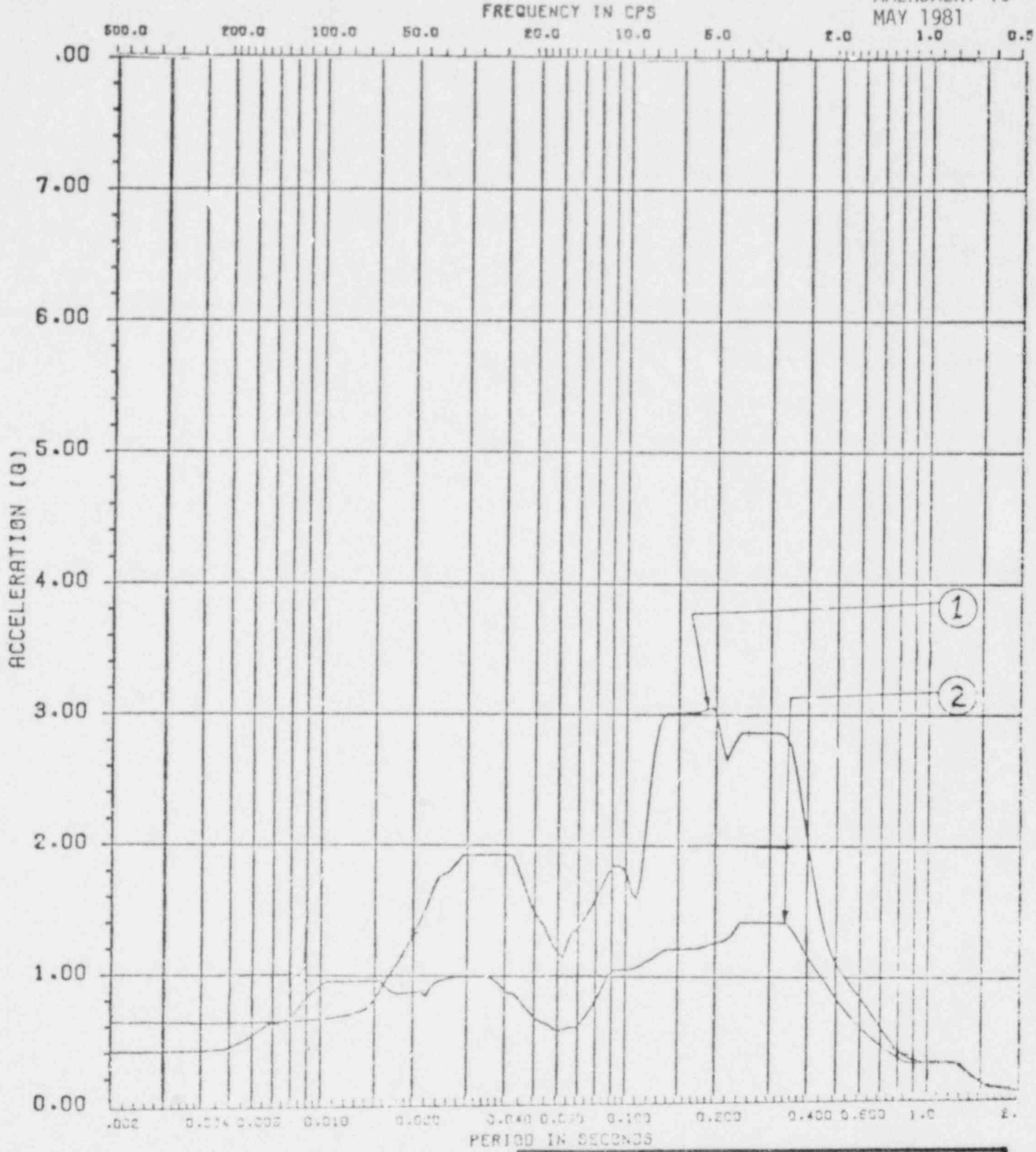

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FIGURE 5.3-28

4TCO LOADS VS. EXISTING DESIGN LOC 104 VERT

POOR ORIGINAL

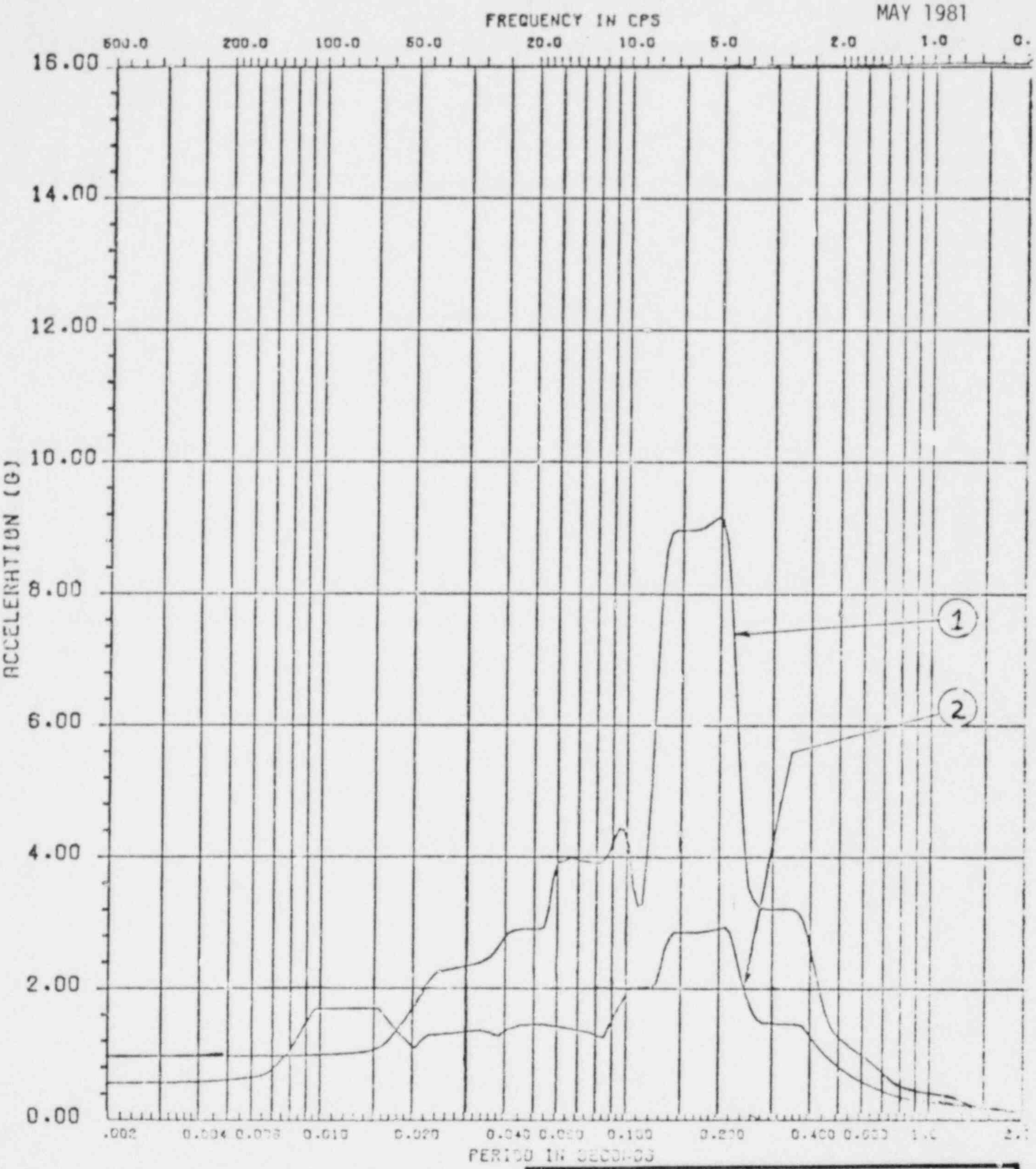

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FIGURE 5.3-29

4TCO LOADS VS. EXISTING
DESIGN LOC 129 VERT

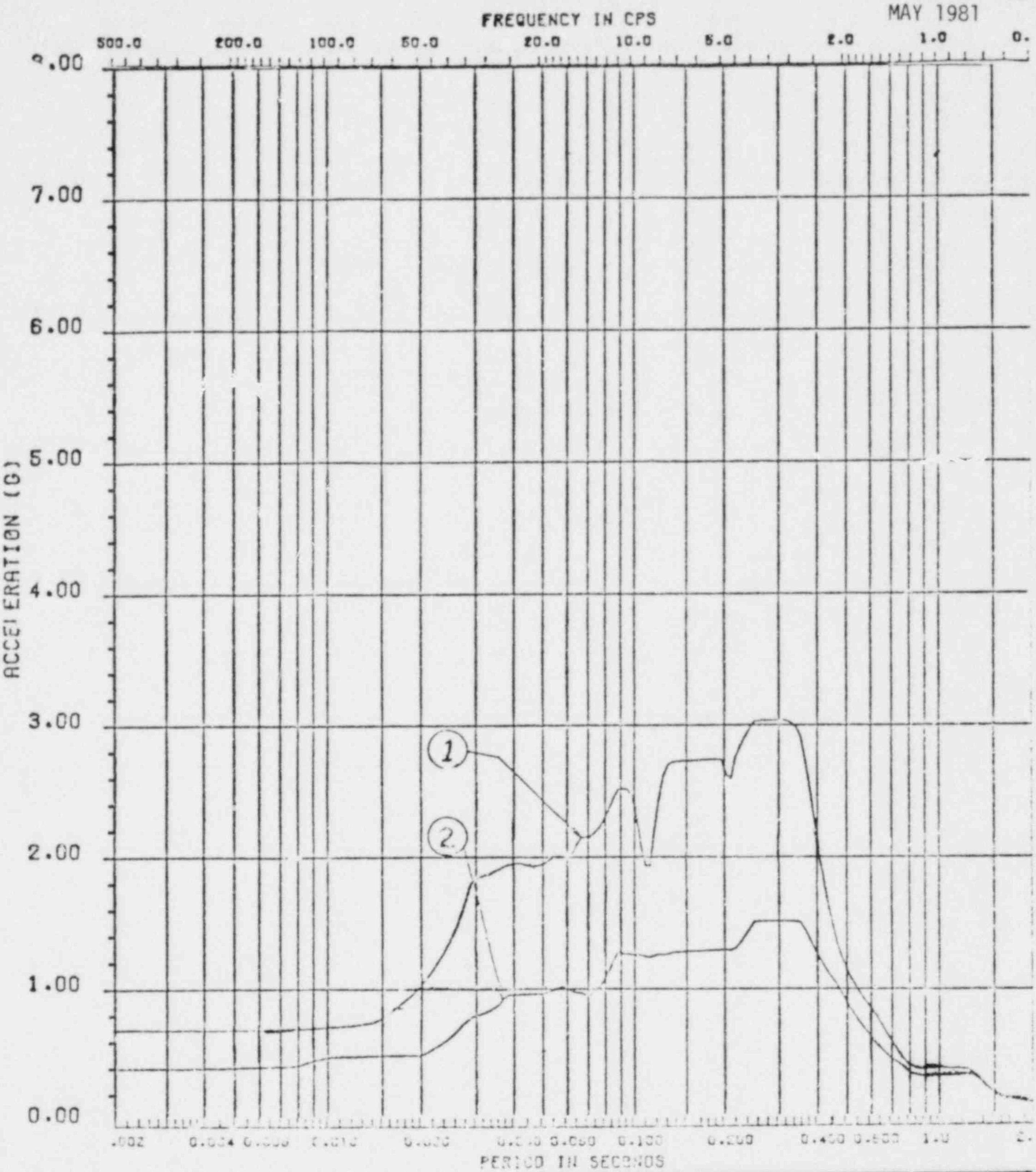

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FIGURE 5.3-30

4TCO LOADS VS. EXISTING
DESIGN LOC 117 VERT

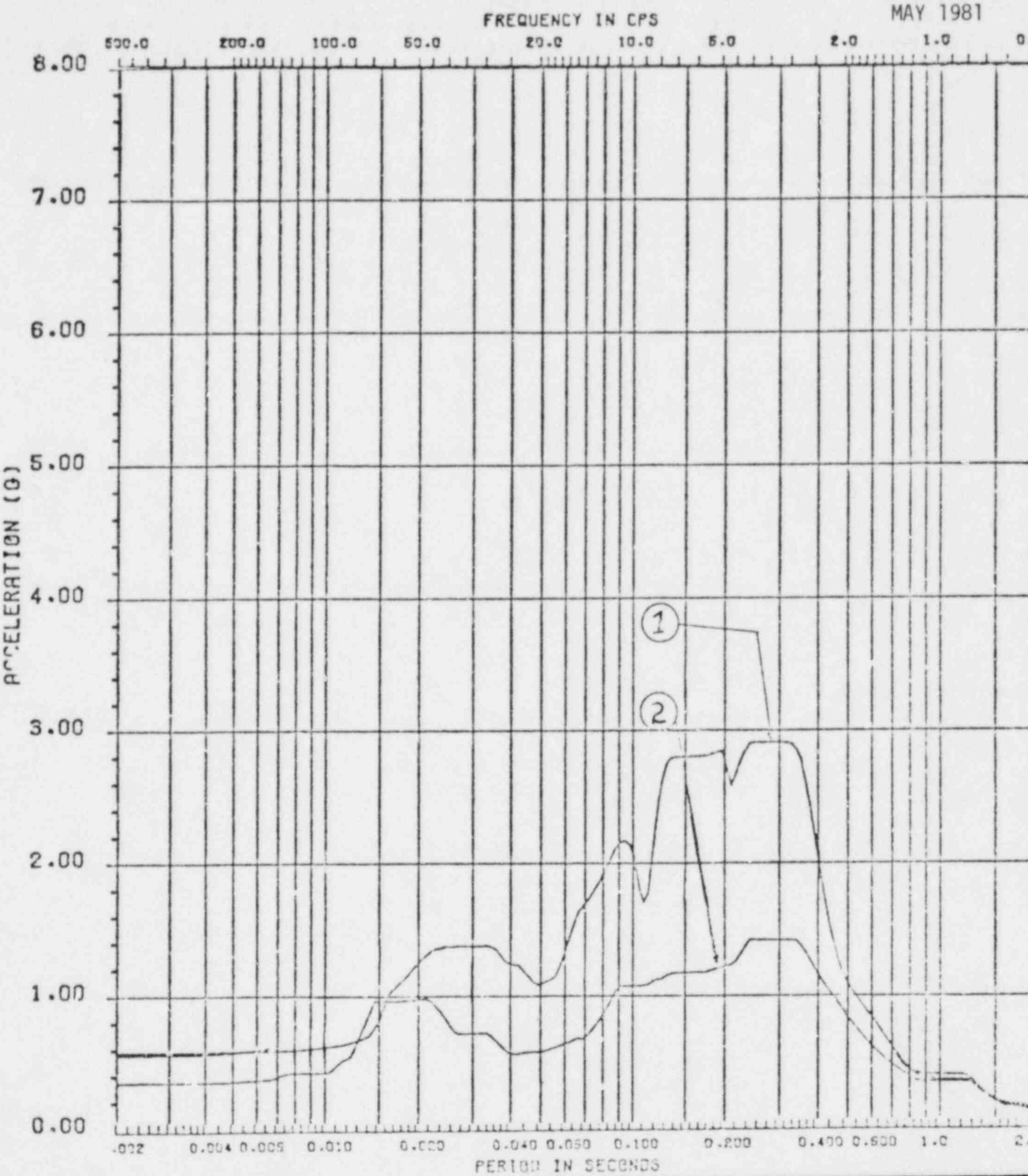

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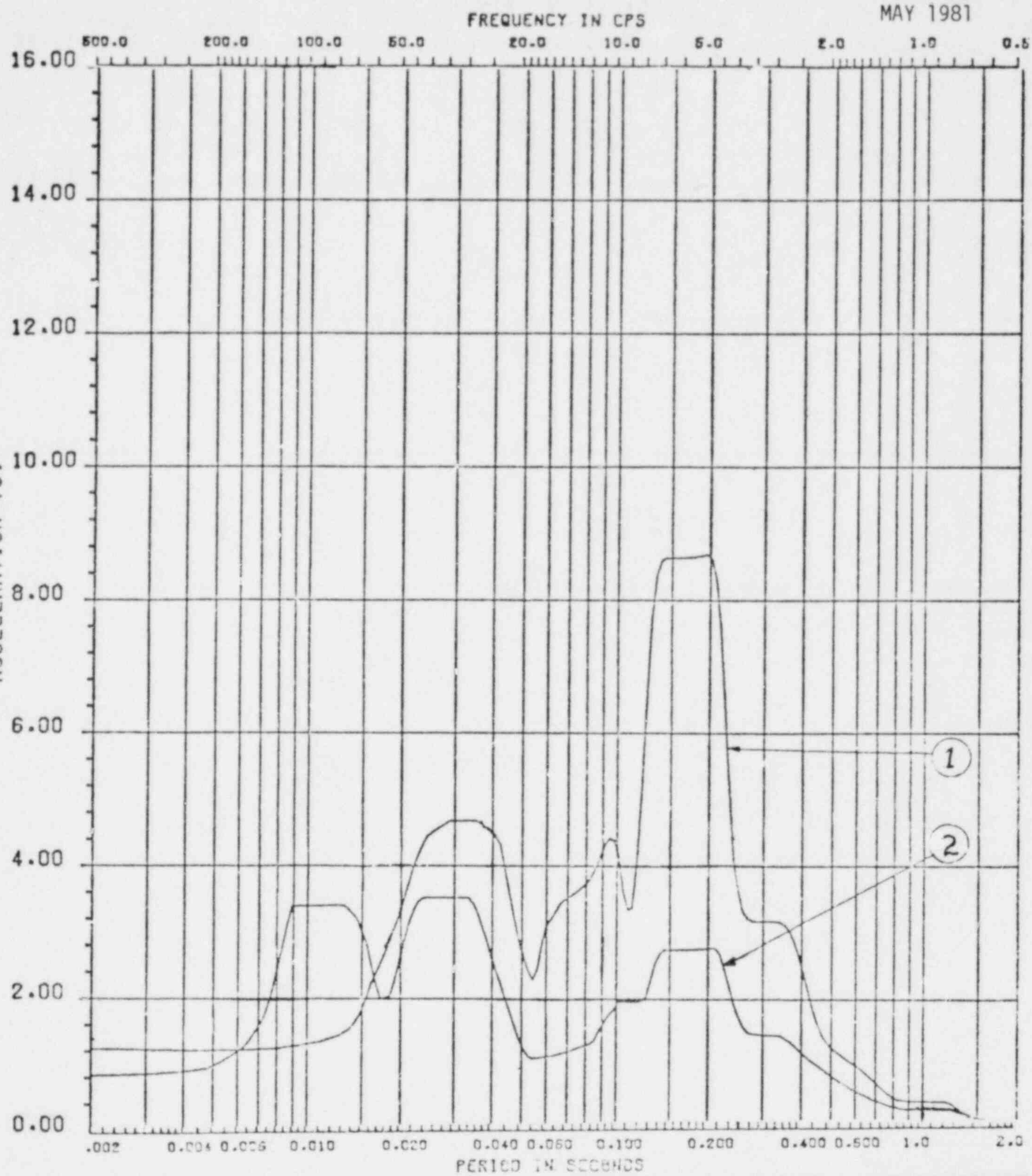
FIGURE 5.3-31

4TCO LOADS VS. EXISTING DESIGN LOC 111 VERT



POOR ORIGINAL

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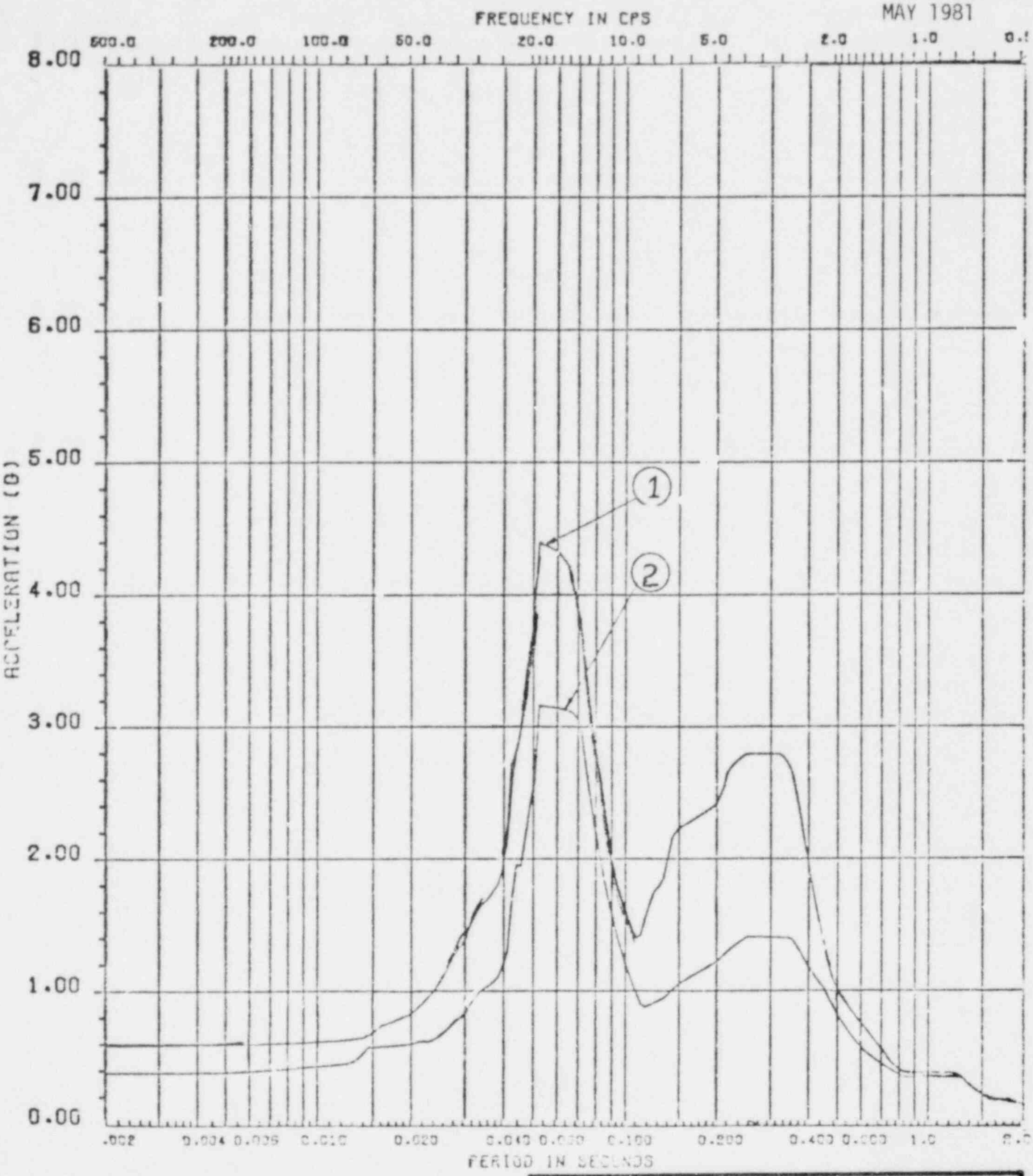
FIGURE 5.3-32

4TCO LOADS VS. EXISTING DESIGN LOC 137 VERT

AMENDMENT 15
MAY 1981



POOR ORIGINAL

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FIGURE 5.3-33

4TCO LOADS VS. EXISTING
DESIGN LOC 309 VERT

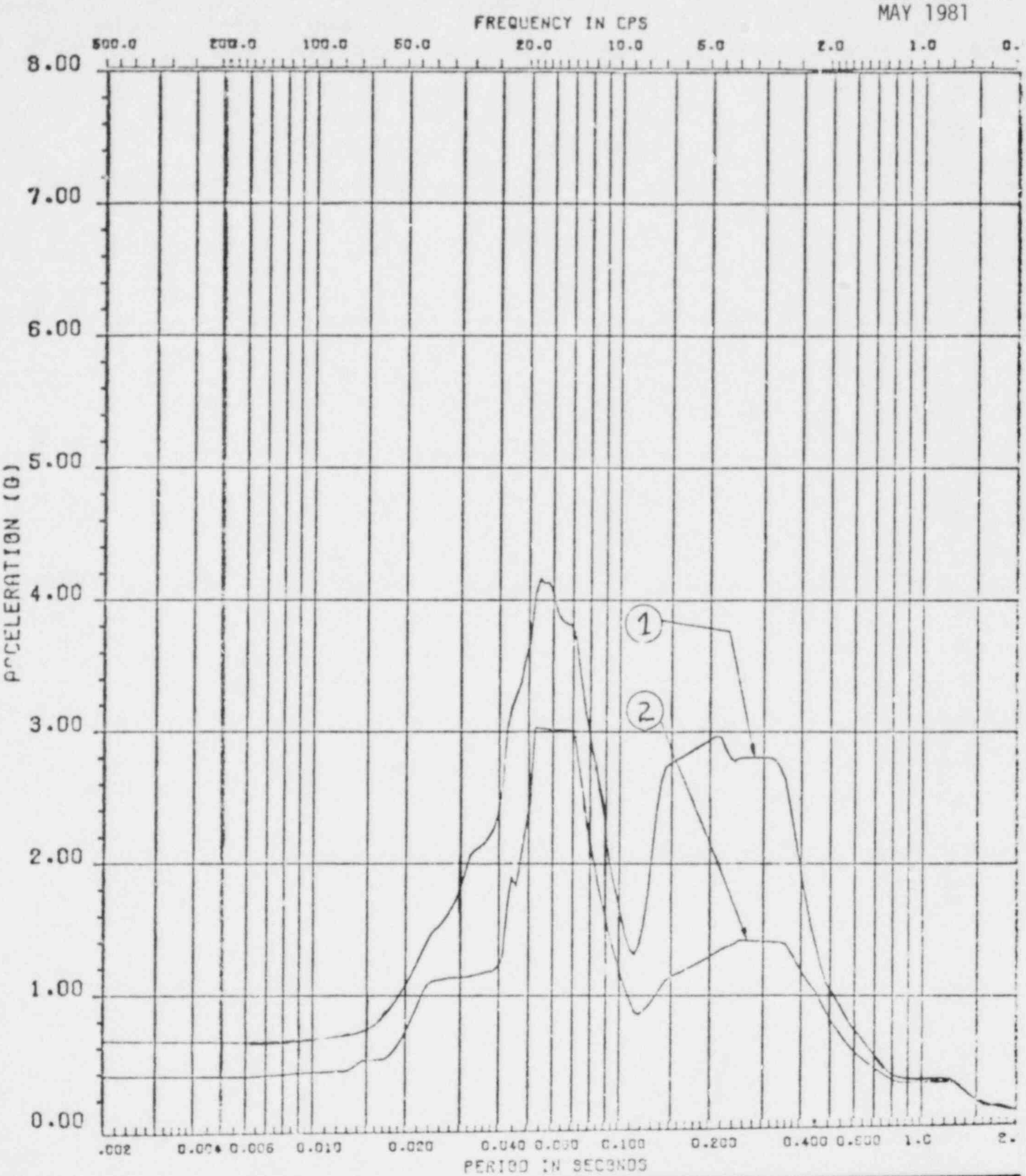

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FIGURE 5.3-34

4TCO LOADS VS. EXISTING DESIGN LOC 311 VERT

POOR ORIGINAL

TABLE 5.4-1 (Cont'd)

LOAD OR PHENOMENON	MARK II OWNERS GROUP LOAD SPECIFICATION	NRC REVIEW STATUS	ZIMMER POSITION ON ACCEPTANCE CRITERIA
- asymmetric loading condition	Maximum amplitude uniform below vent exit-linear attenuation to pool surface. 20 psi maximum overpressure, -14 psi maximum underpressure, 20-30 Hz frequency, peripheral variation of amplitude follows observed statistical distribution with maximum and minimum diametrically opposed.		
II. SRV-Related Hydrodynamic Loads			
A. Pool Temperature Limits for KWU and GE four-arm quencher	None specified	NRC Criteria II.1 and II.3 (1)	Acceptable
Quencher Air Clearing Loads	The methodology documented in the Susquehanna DAR is used for the T-quencher load definition.	NRC Criteria in Section II.B.5 of Supplement 1 to NUREG-0487 (2)	The Zimmer station is being assessed for the T-quencher loads. These loads are considered to be conservative and demonstrate the adequacy of the Zimmer design. A presentation on the impact of modifications to the SRV frequency range was given in the February 13, 1979 meeting. Results of an assessment of the SRV T-quencher frequency range was presented at the July 26, 1979 meeting. The conservatism of the T-quencher load in both amplitude and frequency is described in Subsection 5.2.2.1 A comparison of the frequency range with the criteria in NUREG-0487 is included in Subsection 5.2.3. 15 A further demonstration of the conservatism of the lead plant approach has been documented by Long Island Lighting Co. (SNRC-374, March 30, 1979, Mr. Novarro [LILCO] to Mr. S. A. Varga [NRC] transmitting a report entitled "Justification of Mark II Lead Plant SRV Load Definition.") In-plant tests will be run to demonstrate the adequacy and conservatism of the design loads.
B. Quencher Tie-Down Loads			
1. Quencher Arm Loads			
a) Four-Arm Quencher	Vertical and lateral arm loads developed on the basis of bounding assumptions for air/water discharge from the quencher and conservative combinations of maximum/minimum bubble pressure acting on the quencher.	Acceptable	Acceptable
b) KWU T-Quencher	T-quencher arm loads, as specified for SSES. (3)	Acceptable	Acceptable. These loads have been calculated using the methodology and assumptions described in DFFR for four-arm quenchers, as recommended in the Acceptance Criteria. KWU T-quencher methods were used to verify conservatism.

The inertia effects of the water surrounding the submerged portion of the structural elements were simulated by the addition of a water mass (Reference 1) equivalent to the displaced volume of the structural elements. The mass of water inside the submerged portion of the downcomers was also considered in the model for all dynamic loadings except the loads associated with the LOCA. For these loads, the water had been vented from the downcomer and, therefore, it was not included in the model. Depending upon the form of the loading function, both response spectrum and forced vibration methods were used to obtain the structural response.

7.3.2 Fatigue Evaluation of SRV Discharge Piping and Downcomer Vents in the Wetwell

In response to NRC concerns on bypass capability and cyclic loading on SRV piping and downcomers in the wetwell, the Mark II Owners' Group have addressed the fatigue analysis of these components. The design bases for these components are defined in the appropriate FSAR sections. Detailed evaluations have shown these design bases to be appropriate and conservative.

The Mark II Subcommittee on SRSS and Load Combinations/Acceptance Criteria has coordinated a consistent approach to the evaluations. Code Class 1 piping fatigue rules and methods have been employed. As required, mill certification material test results have been used in order to define better allowable stresses. The fatigue analyses have included all cyclic loading due to SRV discharge, chugging, and condensation oscillation. The 40-year plant life was divided into sub-events, 1 postulated LOCA, 1 SSE, and 5 OBE's. The cycle e mination method was used in calculating a cumulative fatigue usage factor. The SRSS method is used for combining dynamic responses. Detailed analyses for all significant thermal transient effects were also performed and considered in the fatigue evaluations. 15

The fatigue evaluations for the Zimmer SRV lines and downcomers are outlined as follows.

7.3.2.1 Downcomers

Downcomers are subjected to cyclic hydrodynamic loading, but they experience no significant thermal transients. Without thermal transient effects, the code class 2/3 piping rules (downcomer design basis) have been shown to be conservative for fatigue considerations.

The two governing locations on the downcomer were determined to be the drywell floor anchor point and the downcomer bracing elevation. The appropriate numbers of sub-event load cycles were determined at each of these locations. Assuming the downcomer Class 2/3 design-basis stress levels to be at the maximum allowable limits, cumulative fatigue usage factors were calculated. The results are shown below.

u_1 = 0.530 (drywell floor anchor point)

u_2 = 0.124 (bracing elevation)

7.3.2.2 SRV Piping

The two low set-point SRV discharge lines were determined to be governing, due to their much greater number of actuations over the 40-year plant life. The number of expected SRV cycles is obtained from the DFFR, Revision 3. The five critical locations on the piping were determined:

a. drywell floor penetration anchor,

b. reinforced tee connection at top of vertical riser, 15

c. 12 inch to 10 inch transition joint below drywell floor,

d. highest stressed elbow, and

e. vertical riser pipe at high water level.

Fatigue requirements have been incorporated into the recently revised drywell floor penetration design (item a). The penetration with governing piping reaction loads has been analyzed, and the acceptable fatigue results are documented in the penetration stress report.

Item b. was found to be the governing location, due to high peak stresses from internal pressure and thermal effects. The cumulative fatigue usage factor for the tee connection of the governing low set-point line is 0.438 (allowable = 1.0). Usage factors for piping locations 3, 4, and 5 were shown to be negligible ($u<0.05$).

The SRV line fatigue evaluation will be included in the formal piping stress analyses and verification of as-built conditions. No significant changes from the current fatigue results are expected.

7.3.3 References 15

1. Sir Horace Lamb, "Hydrodynamics," Sixth Edition, Dover Press, New York, 1945.

2. ASME Boiler and Pressure Vessel Code, Section II, Subsections NC, NF, and appendices of Division 1, 1978 edition, including the Winter Addenda.

E.4 FUNCTIONAL CAPABILITY

The piping analysis on the Wm. H. Zimmer Nuclear Power Plant complies with the GE Report, "Functional Capability Criteria for Essential Mark II Piping", NEDO-21985, September 1978, as described in the topical report evaluation[1] by the NRC dated July 19, 1980. This is applied to all essential lines for which functional capability must be ensured. 15

(1) Memorandum from J. P. Knight of NRC to R. L. Tedesco of NRC. 15