NORTHEAST UTILITIES

THE CONNECTICUT LIGHT AND POWER COMPANY
WESTERN MASSACHUSETTS ELECTRIC COMPANY
HOLYOKE WATER POWER COMPANY
NORTHEAST UTILITIES SERVICE COMPANY
NORTHEAST NUCLEAR ENERGY COMPANY

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June 29, 1984

Docket No. 50-423
B11252

Director of Nuclear Reactor Regulation
Mr. B. J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Reference: (1) W. G. Counsil to B. J. Youngblood, Millstone Nuclear Power Station, Unit No. 3, Meeting Summary of NRC Structural Audit, dated March 23, 1984.

Dear Mr. Youngblood:

Millstone Nuclear Power Station, Unit No. 3
Technical Review Meeting Summary
Structural Confirmatory Items

On June 15, 1984 representatives from Northeast Utilities Service Company (NUSCO) met with NRC Staff members from the Structural and Geotechnical Engineering Branch (SGEB) to discuss NUSCO's responses to Structural Audit Items 17 and 38. It was agreed at this time that the applicant's responses resolved all SGEB concerns. Mechanical Engineering Branch (MEB) was in attendance and raised no concerns on these matters. It was noted that the Environmental Qualification Branch (EQB) may review these same responses at a later time. Based upon the above, these items are considered "closed".

Attachment I is a list of meeting attendees and Attachment II provides NUSCO's responses to Structural Audit Items 17 and 38.

B001
1/40

If you have any concerns related to the information contained herein, please contact our licensing representative, Ms. C. J. Shaffer at (203) 665-3285.

Very truly yours,

NORTHEAST NUCLEAR ENERGY COMPANY
et. al.

BY NORTHEAST NUCLEAR ENERGY COMPANY,
Their Agent

W. G. Counsil
Senior Vice President

cc: Mr. Nilesh Chokshi - SGEB
Mr. David Jeng - SGEB
Ms. Y. C. Li - MEB
Mr. Arnold Lee - EQB

STATE OF CONNECTICUT)
) ss. Berlin
COUNTY OF HARTFORD)

Then personally appeared before me W. G. Counsil, who being duly sworn, did state that he is Senior Vice President of Northeast Nuclear Energy Company, an Applicant herein, that he is authorized to execute and file the foregoing information in the name and on behalf of the Applicants herein and that the statements contained in said information are true and correct to the best of his knowledge and belief.

Notary Public

My Commission Expires March 31, 1986

ATTACHMENT I

Millstone Nuclear Power Station, Unit No. 3
SGEB Technical Review Meeting
June 15, 1984

Name	Organization
Nilesh Chokshi	NRC - NRR - SGEB
Y. C. (Renee) Li	NRC - NRR - MEB
Walt Briggs	NUSCO - Generation Civil Engineering
Bob Skwirz	NUSCO - Generation Civil Engineering
Frank Mello	NUSCO - Generation Civil Engineering
Carol Shaffer	NUSCO - Generation Facilities Licensing

ATTACHMENT II

RESPONSES TO NRC STRUCTURAL AUDIT

ITEM 17 AND ITEM 38

Item 17 - Provide justification as to why vertical flexibility of floor slabs is not considered in generation of floor response spectra.

Response:

The generation of design amplified response spectra (ARS) at Millstone 3 were developed based upon the assumption that all slabs behaved rigidly in the vertical direction. A sensitivity study was undertaken to quantify the conservatisms in the design basis ARS and to demonstrate that the application of this ARS to equipment qualification leads to conservative design and qualification. The sensitivity study shows that the design basis ARS were conservative for most cases. For cases where design ARS were not conservative further analysis showed that systems or equipment have enough margin so that the floor flexibility did not affect their qualification. In all cases slab qualification was not adversely affected. The methodology employed in this sensitivity study along with a discussion of the results are presented herein.

The dynamic analyses and thus generation of ARS for nuclear power plant structures contains many conservatisms inherent in the analytical processes. The design basis of the Millstone 3 structures included many of these conservatisms some of which are a) lower damping values than those suggested by Regulatory Guide 1.61 b) the input time-history used to generate the ARS conservatively envelops the design response spectra and c) the lumped mass/spring model method used in the seismic response analysis of the structures produce more conservative results than the actual continuous system. The major emphasis of this effort was to compare the effects of these conservatisms to the original design basis.

The sensitivity study conducted assessed the impact of vertical flexibility of the floor slabs on the design ARS in the containment, auxiliary, and control buildings of Millstone 3. The buildings and elevations chosen were based upon a review of slabs in QA Category I buildings at Millstone 3 to determine which slabs would be most susceptible to floor flexibility effects. For purposes of this study ARS generated by methods used in the original analysis at 5% structural damping and 1% equipment damping were compared to ARS generated at 7% structural damping and 2% equipment damping. These higher damping values correspond to the present state of knowledge on the dynamic behavior of structures and equipment. New time-histories were generated from existing FSAR design response spectra according to criteria as set forth in the Standard Review Plan - Section 3.7.1.

Slabs in containment at the operating floor level and in the auxiliary building at elevation 43'-6" were investigated. These floor slabs were determined to be representative of slabs in QA Category I structures at Millstone 3. All but the one-foot thick slabs at the south end of the auxiliary building were found to have a fundamental vertical frequency greater than 33 hz. Because the fundamental frequency was greater than 33 hz the rigid assumption for these slabs was valid. The one-foot thick slabs at the south end of the auxiliary building elevation 43'-6" were found to have a fundamental vertical frequency below 33 hz. These slabs were modeled as single-degree-of-freedom oscillators each having the frequency and mass corresponding to the slabs fundamental vertical modes. These oscillators were attached at appropriate elevations to the vertical lumped-mass stick models of the structures. These coupled models were subjected to vertical ground motion as described above and new response time-histories and

spectra at structural nodes supporting the slabs were computed, and was input into a detailed finite element model of the one-foot thick slabs and spectra were generated at various points. The new ARS generated were compared to the original computed design ARS to determine the amount of conservatism in them. As shown in Figures 1 and 2, the design basis ARS is conservatively bounding except for some minor exceedances.

Because floor slabs in the control building are not sufficiently similar to the slabs described above, vertical floor flexibility of these slabs was also studied. Since the control building is a mainly soil-founded structure other conservatisms were present in the design basis analysis including soil-structure interaction (SSI) effects. A rigorous solution of the SSI problem yields soil springs which represent the flexibility of the foundation material under the structure, and a set of viscous dampers which represent the radiation damping effects. These quantities are both frequency dependent. In the sensitivity study, the soil flexibility and radiation damping are rigorously modeled by computing the structural responses in the frequency domain which will properly account for the frequency dependence of SSI effects. This approach mobilizes a realistic amount of radiation damping, particularly in the high frequency range and leads to responses which are lower than those obtained by employing a constant frequency independent soil spring which has no associated radiation damping. The entire control room floor was modeled. The model consisted of plate elements representing the concrete slab, beam elements representing the steel floor beams, and equivalent beam elements representing the walls. The model accurately accounted for the composite action of the beams and slab as well as the continuity of the concrete slab at the panel boundaries. The support points of the slabs at the perimeter walls and interior columns were rigidly connected to the mass point at elevation 47' of the lumped-mass stick model of the control building. The stick model includes single-degree-of-freedom oscillators at other elevations of the building representing the vertically flexible slabs of those elevations with SSI affects properly accounted for. The coupled finite-element model of the floor and the lumped-mass stick model was used to generate the vertical acceleration time-histories. These acceleration time-histories were used to generate ARS of different locations of the control room floor. A comparison of the sensitivity study to the design basis is shown on Figures 6 through 15. At most frequencies the ARS were less than the design basis ARS. Additionally a comparison of the ARS to the ARS used for qualifying various equipment was performed.

A review of the vertical ARS which considered floor flexibility was done to determine its effect on slab supported equipment in the control room. The vulnerable areas of the control room slabs are of course the central regions, away from the walls and column lines. The equipment which is supported from these areas of the slabs consists of floor mounted cabinets and panels, the main control board, and cable trays which are supported from the underside of the slabs. The results of this review are presented herein.

The seismic qualification reports on the majority of the safety-related floor mounted cabinets were reviewed. All of the equipment which was generically qualified by the manufacturers, for nuclear use, had test response spectra enveloping the flexible floor spectra developed for the control room. Two of the cabinets reviewed were specifically qualified for use at Millstone 3. The test

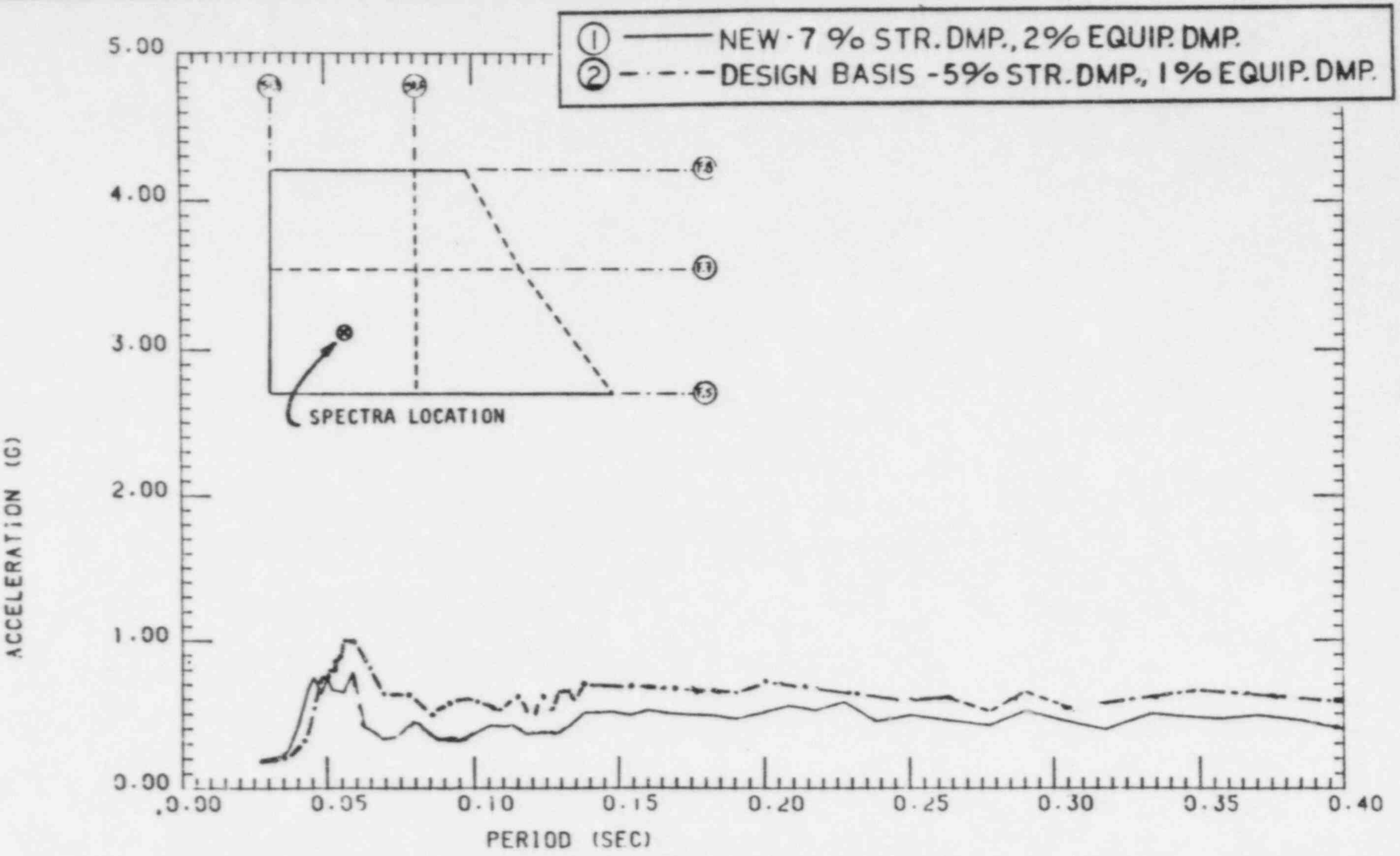
response spectra for each of these cabinets envelope the flexible floor spectra at their respective positions on the floor.

The main control boards and termination cabinets have been designed to be rigid. All safety-related equipment contained in these cabinets and panels will be qualified by either conforming to qualification provided by the equipment manufacturer, by testing, or by similarity arguments. A large sample of devices from the main control boards and the termination cabinets have been seismically tested. The vertical test spectrum enveloped the curves which considered floor flexibility. The components tested were chosen so that similiarity could be used to qualify the balance of equipment not specifically tested.

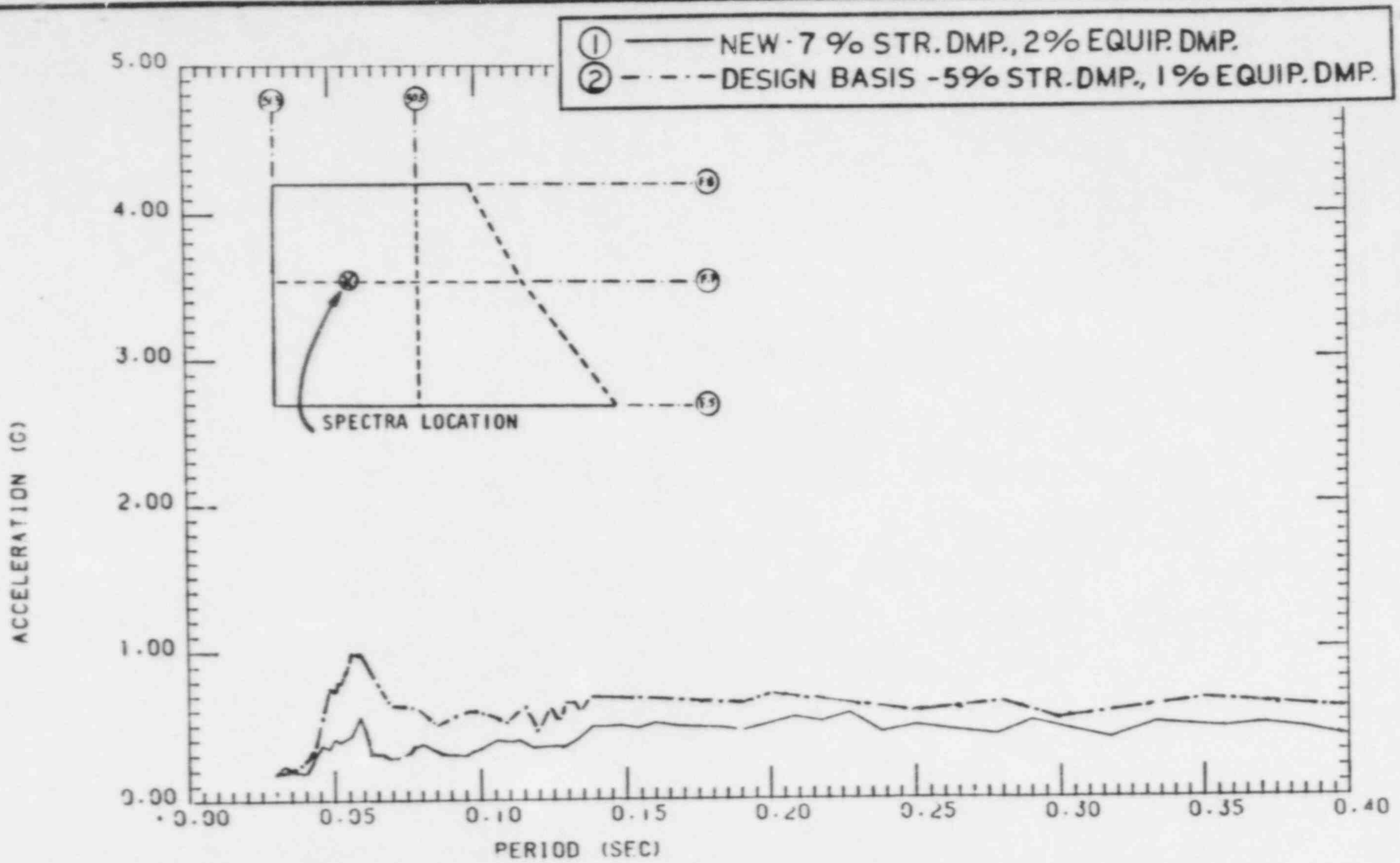
Cable trays located below the control room slabs are supported almost exclusively from the walls and areas of the slabs close to walls and column lines. The cable tray systems are passive and highly damped. Due to the conservative standardization of cable tray supports, the consideration of vertical floor spectra does not adversely affect the integrity of the systems.

In summary, all of the slab mounted equipment in the control room is qualified with enough margin to assure functionability even when vertical floor flexibility is considered. The increase in spectral accelerations calculated for flexible control room slabs does not affect the validity of the equipment qualification reports.

In conclusion, a sensitivity study showed that floor flexibility effects do not adversely affect Millstone 3 structures or equipment and therefore the design basis ARS is appropriate.



FLOOR FLEXIBILITY SENSITIVITY STUDY FIG. 1
MILLSTONE - 3 - AUX SLAB VERT. RESPONSE SPECTRA
ELEVATION - 43.5 FT.

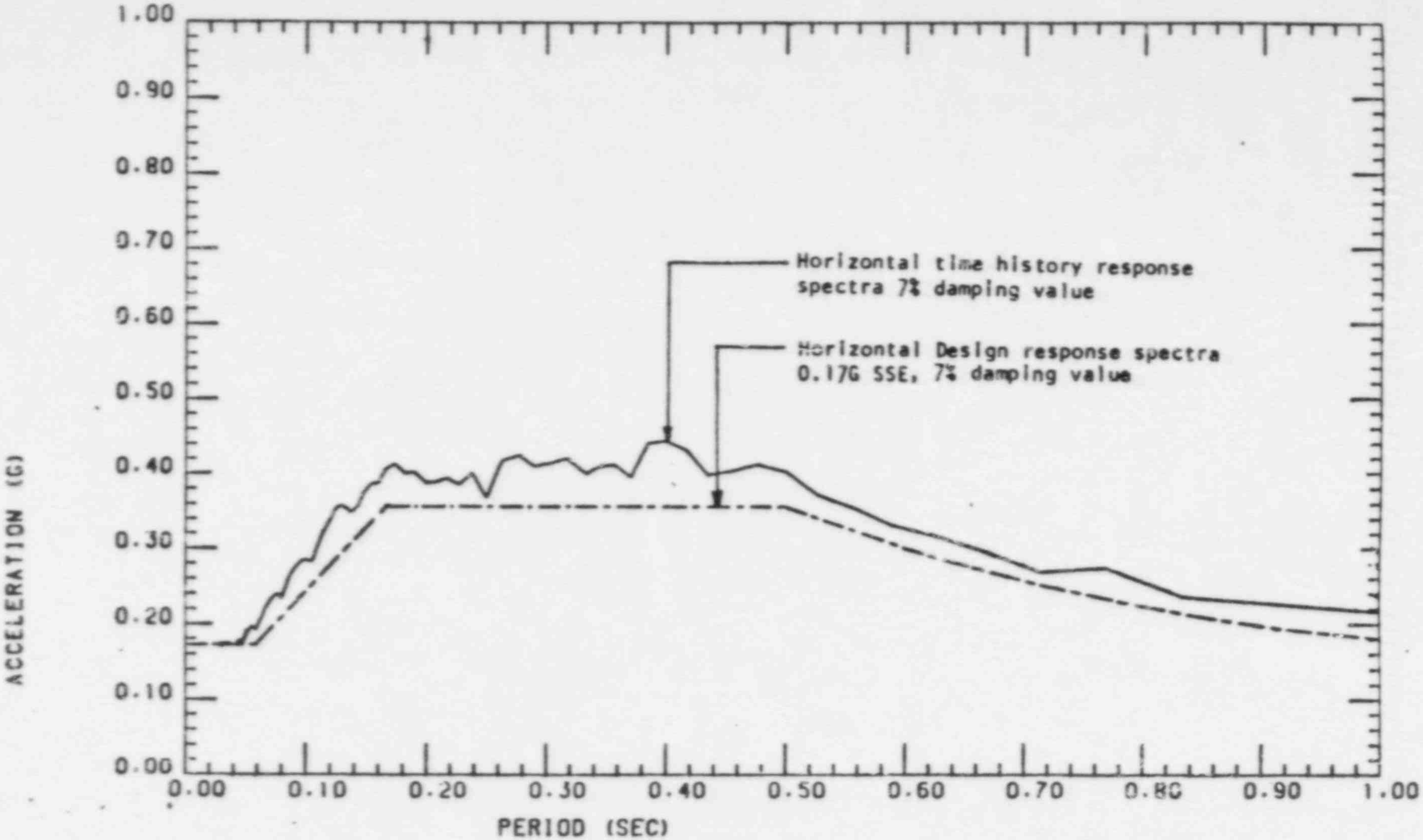


FLOOR FLEXIBILITY SENSITIVITY STUDY

MILLSTONE - 3 - AUX SLAB VERT. RESPONSE SPECTRA

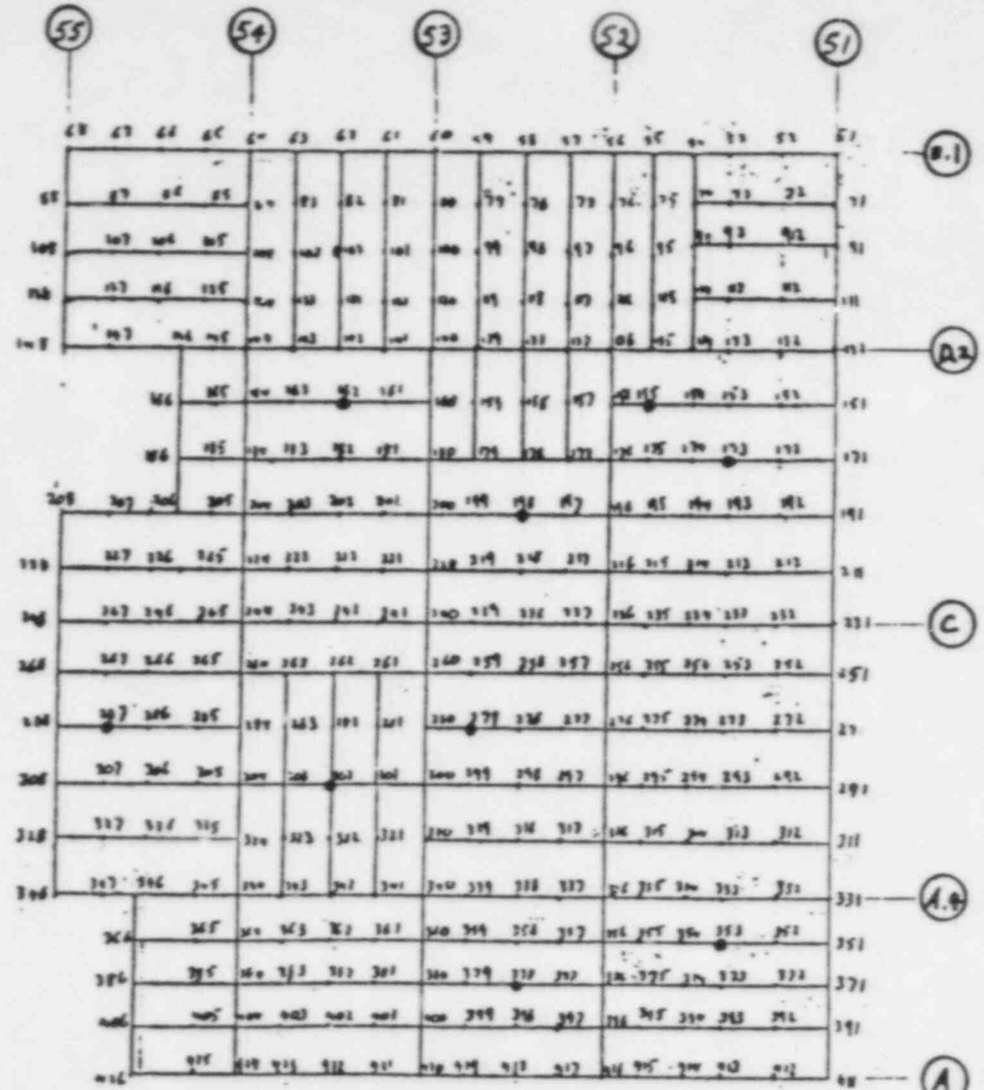
ELEVATION - 43.5 FT.

FIG. 2



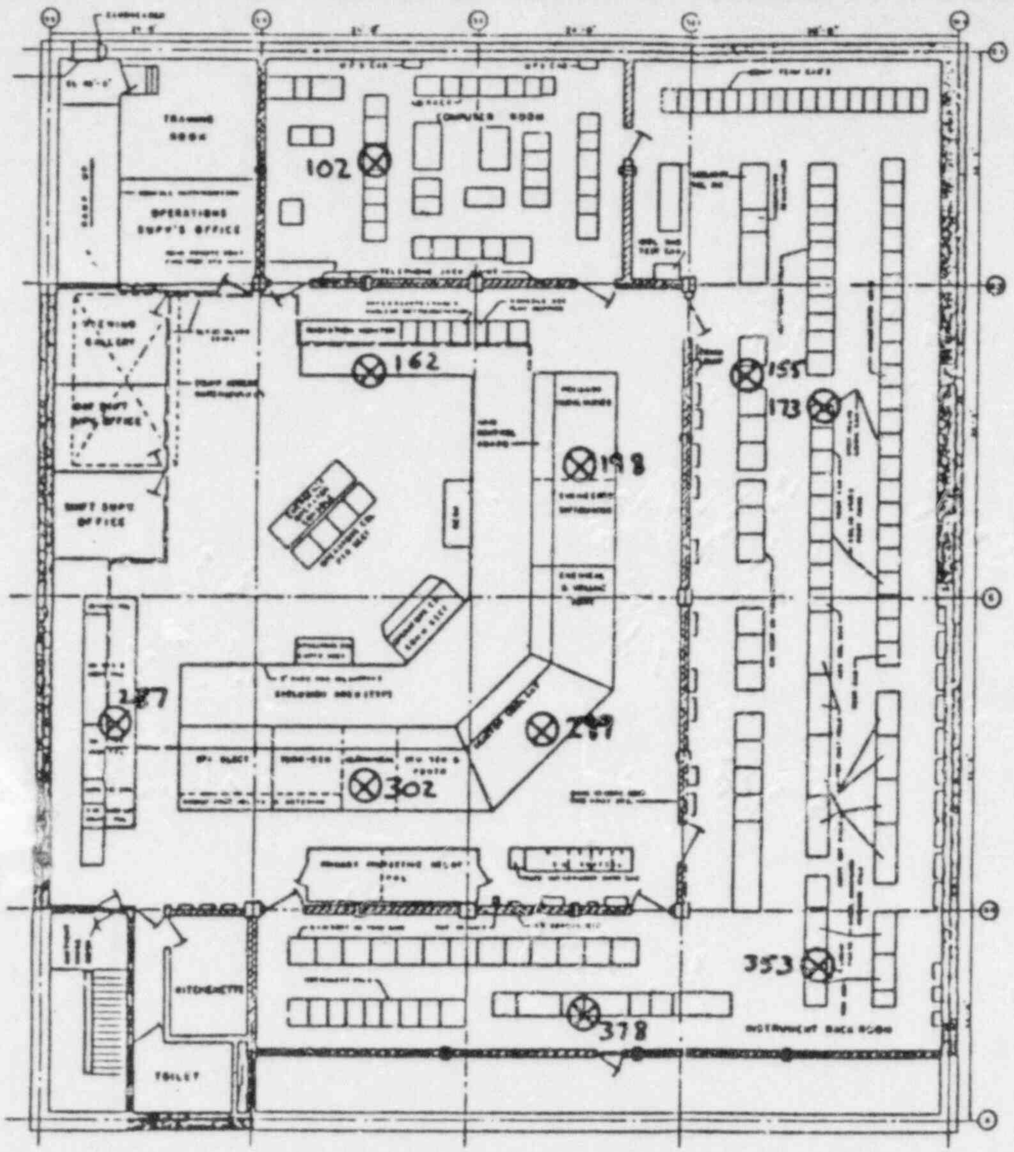
FLOOR FLEXIBILITY SENSITIVITY STUDY
MILLSTONE -3

FIG. 3



FLOOR FLEXIBILITY SENSITIVITY STUDY
MILLSTONE-3 — CONTROL BLDG. NODAL LAYOUT
ELEVATION-47 FT.

FIG. 4

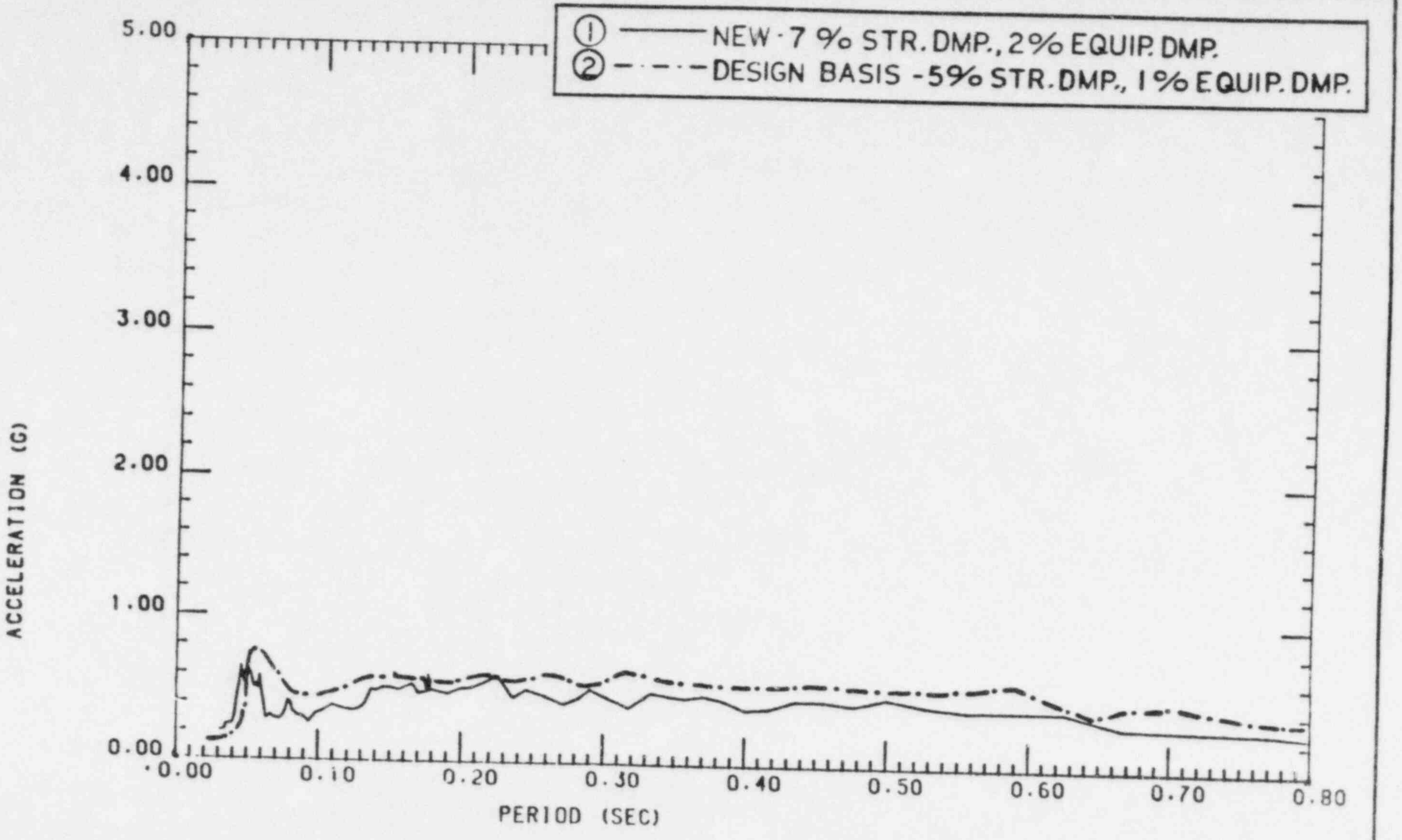


FLOOR FLEXIBILITY SENSITIVITY STUDY

FIG. 5

MILLSTONE -3 -CONTROL BLDG.

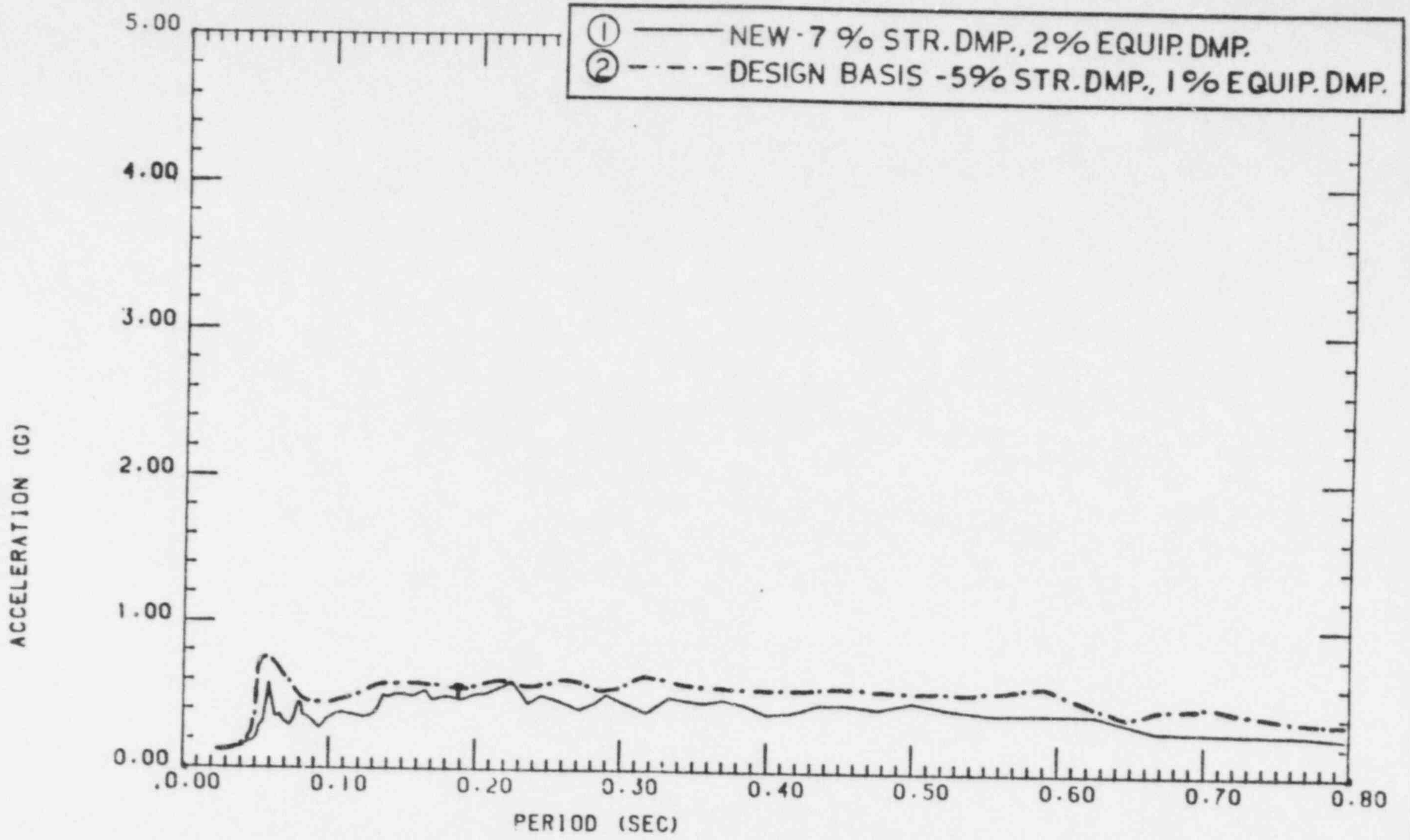
ELEVATION -47 FT. SPECTRA LOCATION AND NODAL NUMBER



FLOOR FLEXIBILITY SENSITIVITY STUDY
MILLSTONE - 3 - CONTROL BLDG. VERT. RESPONSE SPECTRA
ELEVATION - 47 FT.

FIG. 6

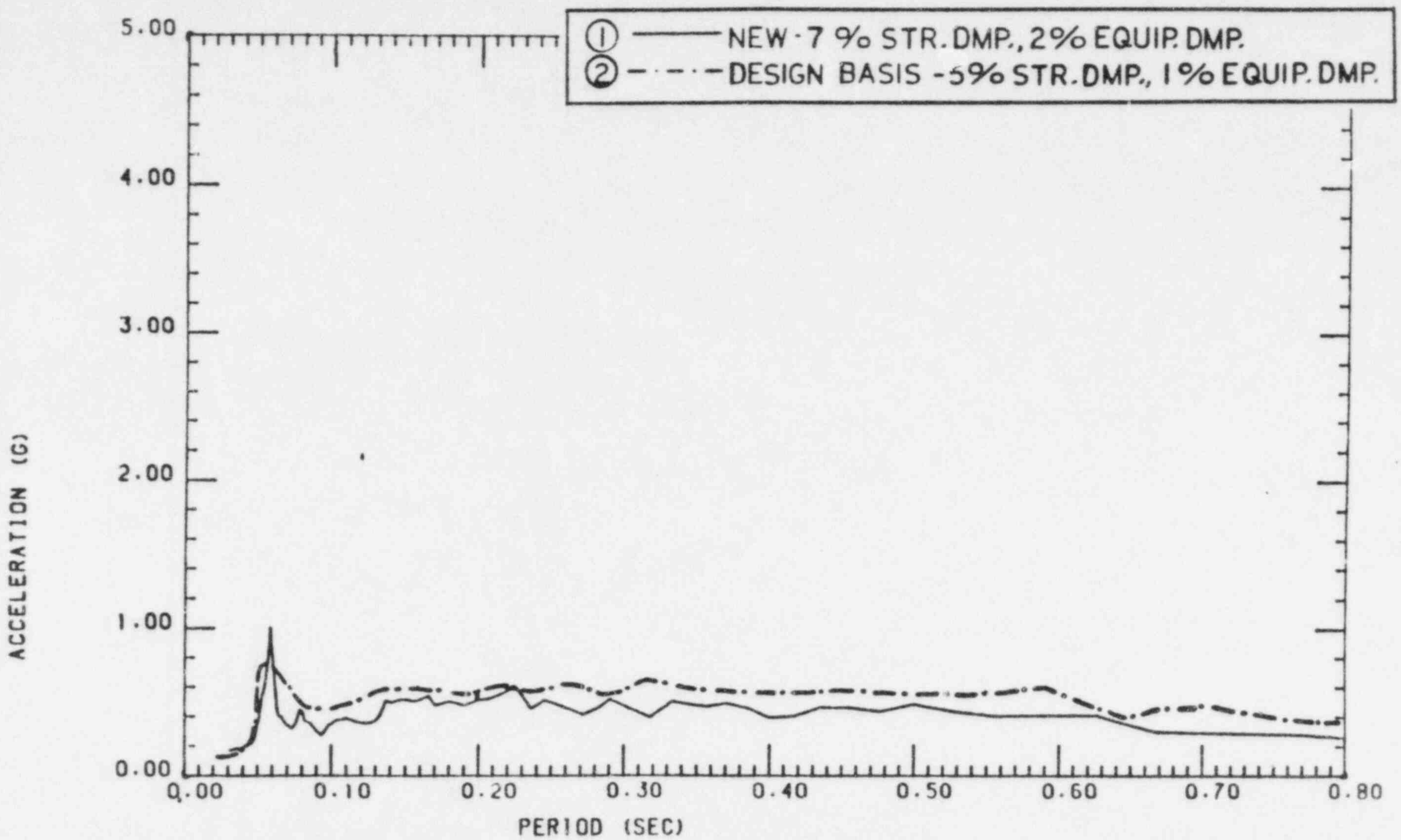
NODE - 102



FLOOR FLEXIBILITY SENSITIVITY STUDY
MILLSTONE - 3 - CONTROL BLDG. VERT. RESPONSE SPECTRA
ELEVATION - 47 FT.

FIG. 7

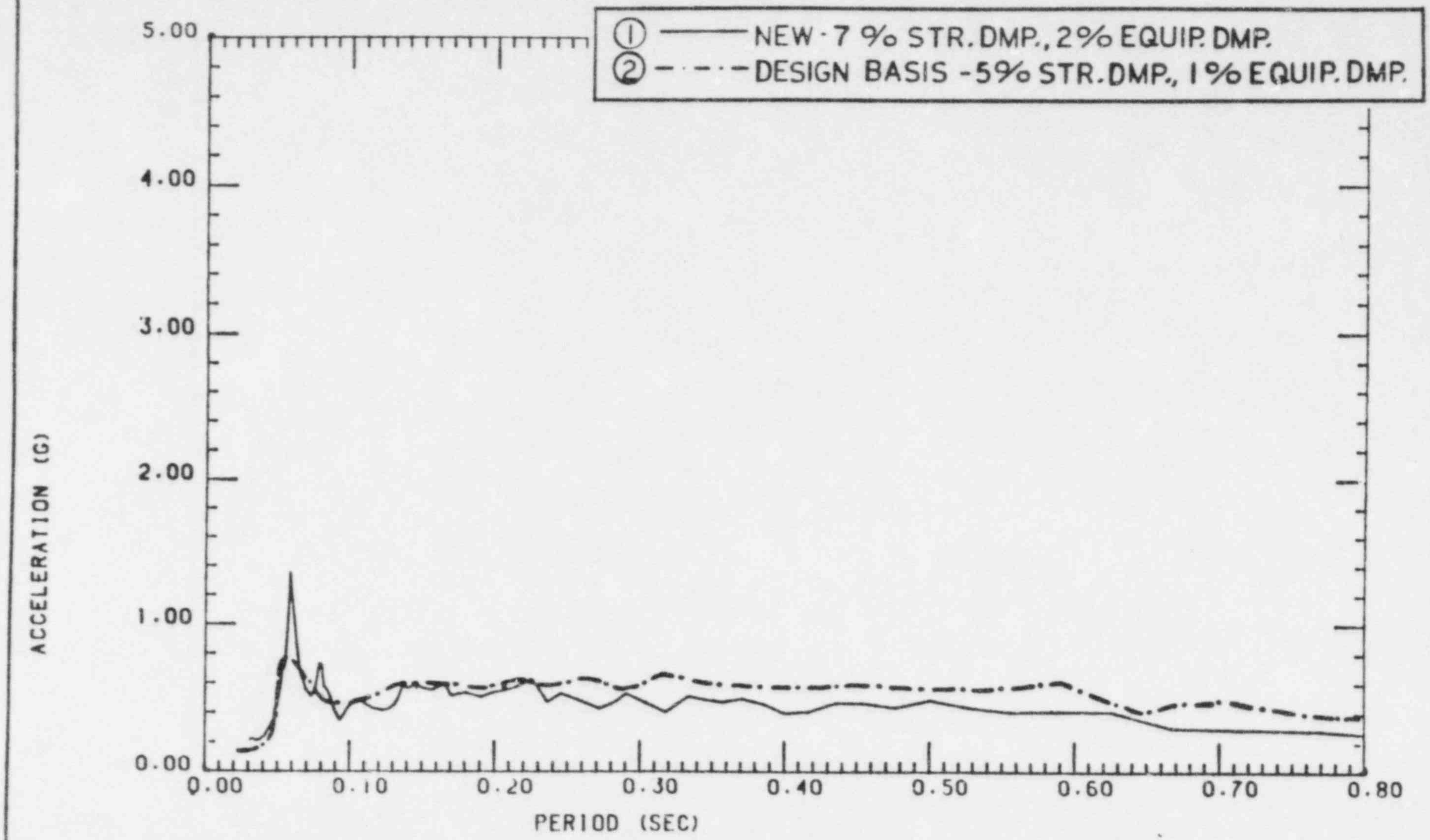
NODE - 155



FLOOR FLEXIBILITY SENSITIVITY STUDY — FIG. 8

MILLSTONE - 3 - CONTROL BLDG. VERT. RESPONSE SPECTRA

ELEVATION - 47 FT. — NODE - 162



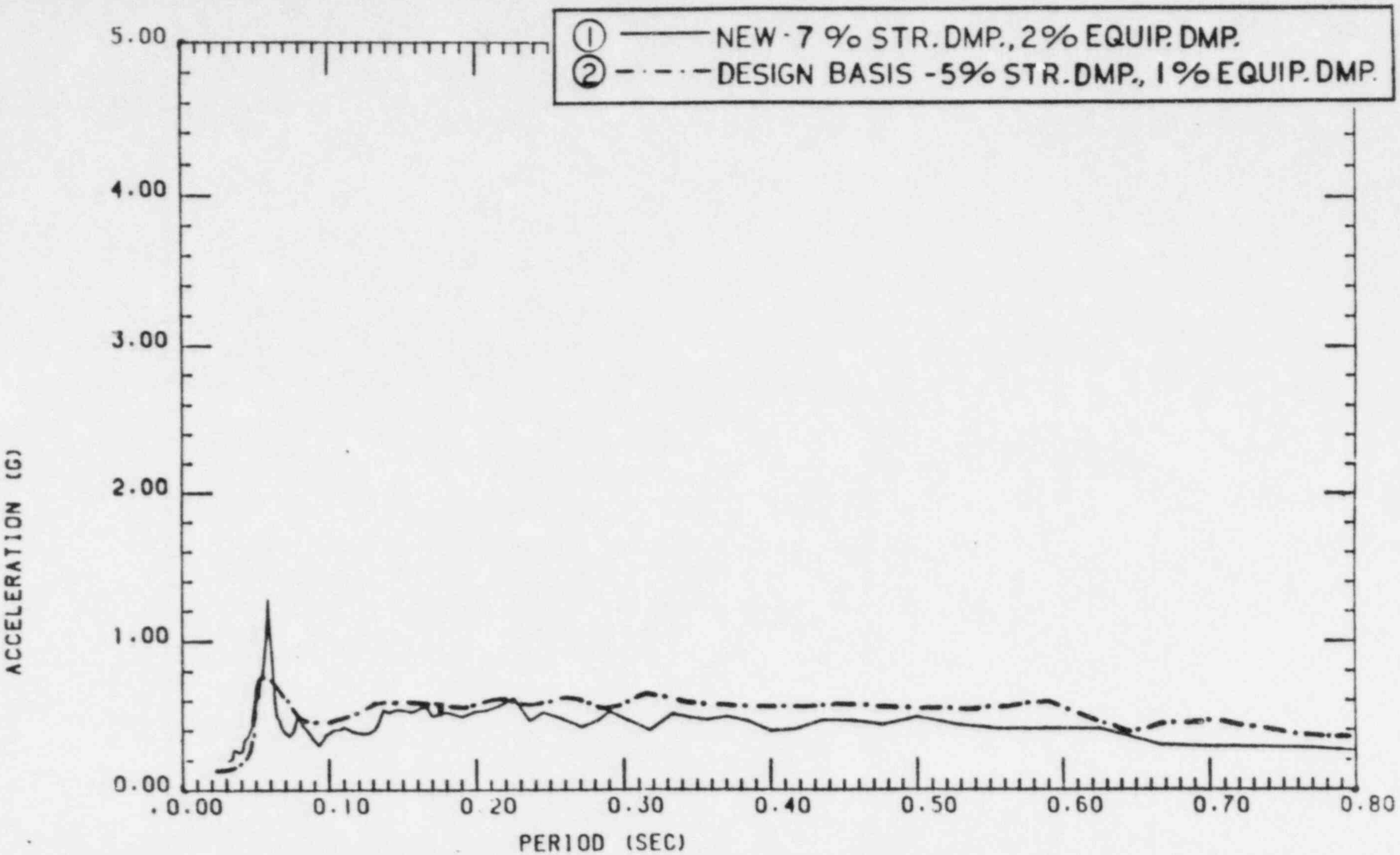
FLOOR FLEXIBILITY SENSITIVITY STUDY

MILLSTONE - 3 - CONTROL BLDG. VERT. RESPONSE SPECTRA

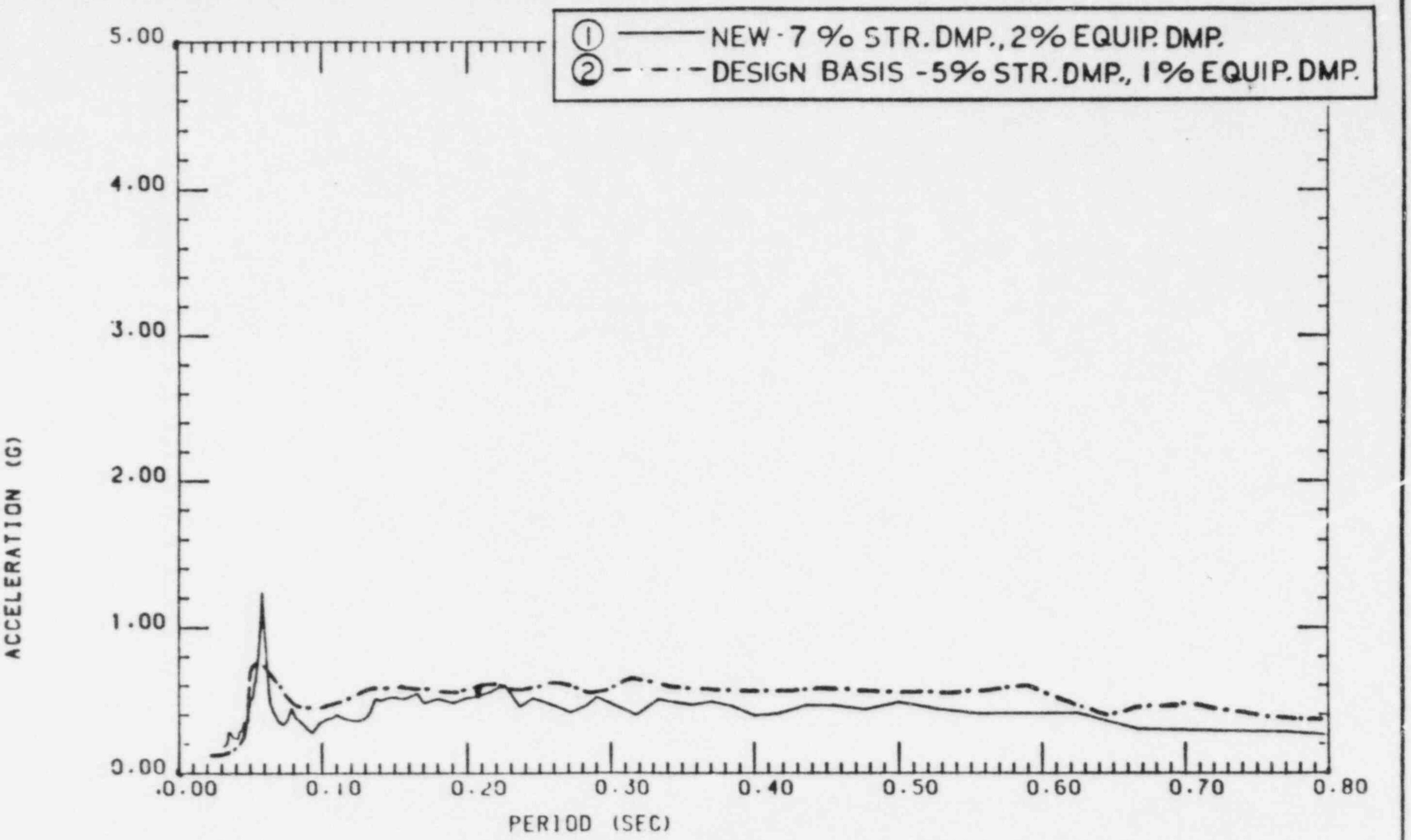
ELEVATION - 47 FT.

FIG. 9

NODE - 173



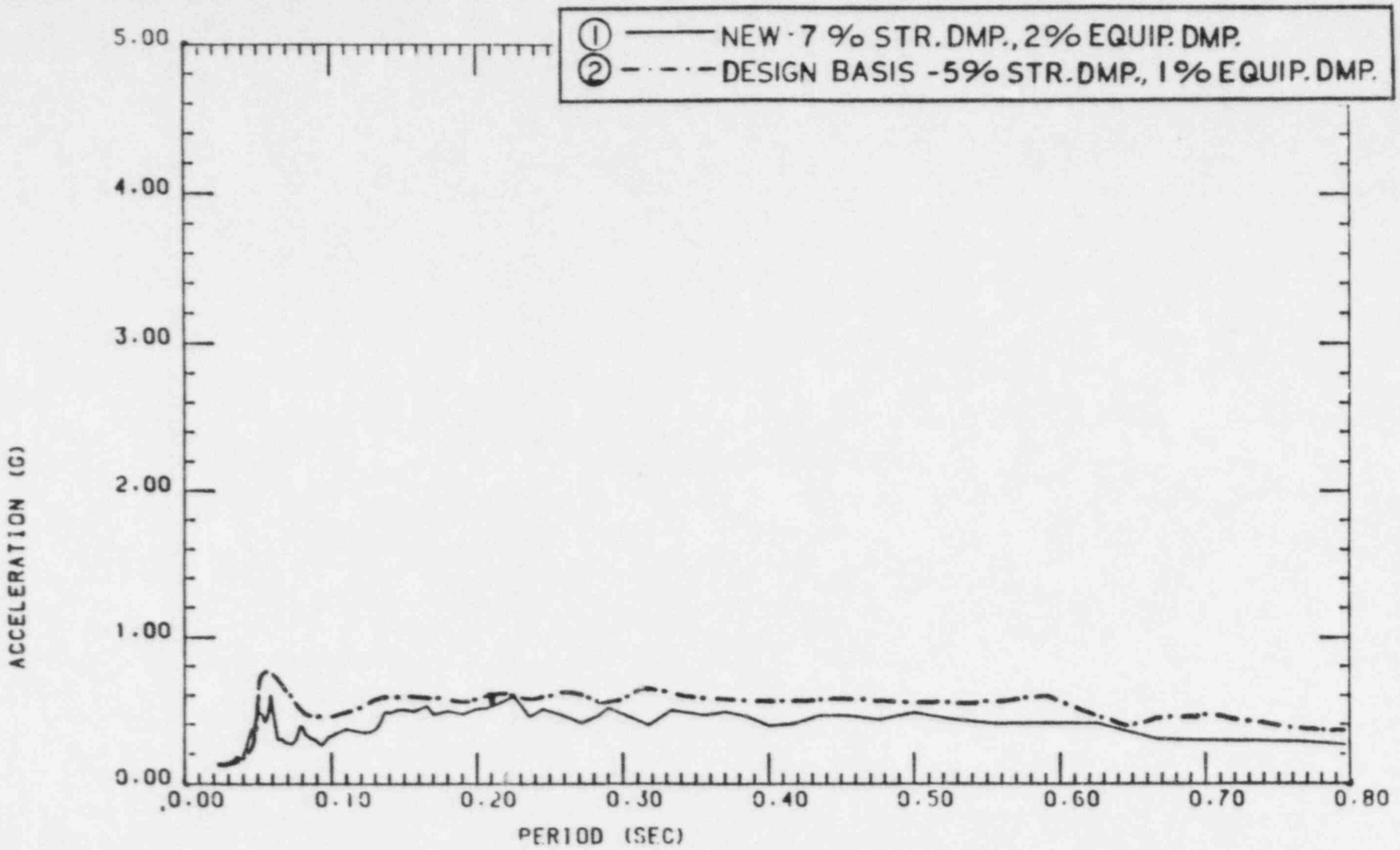
FLOOR FLEXIBILITY SENSITIVITY STUDY FIG. 10
MILLSTONE - 3 - CONTROL BLDG. VERT. RESPONSE SPECTRA
ELEVATION - 47 FT. NODE - 198



FLOOR FLEXIBILITY SENSITIVITY STUDY — FIG. 11

MILLSTONE - 3 - CONTROL BLDG. VERT. RESPONSE SPECTRA

ELEVATION - 47 FT. — NODE - 279



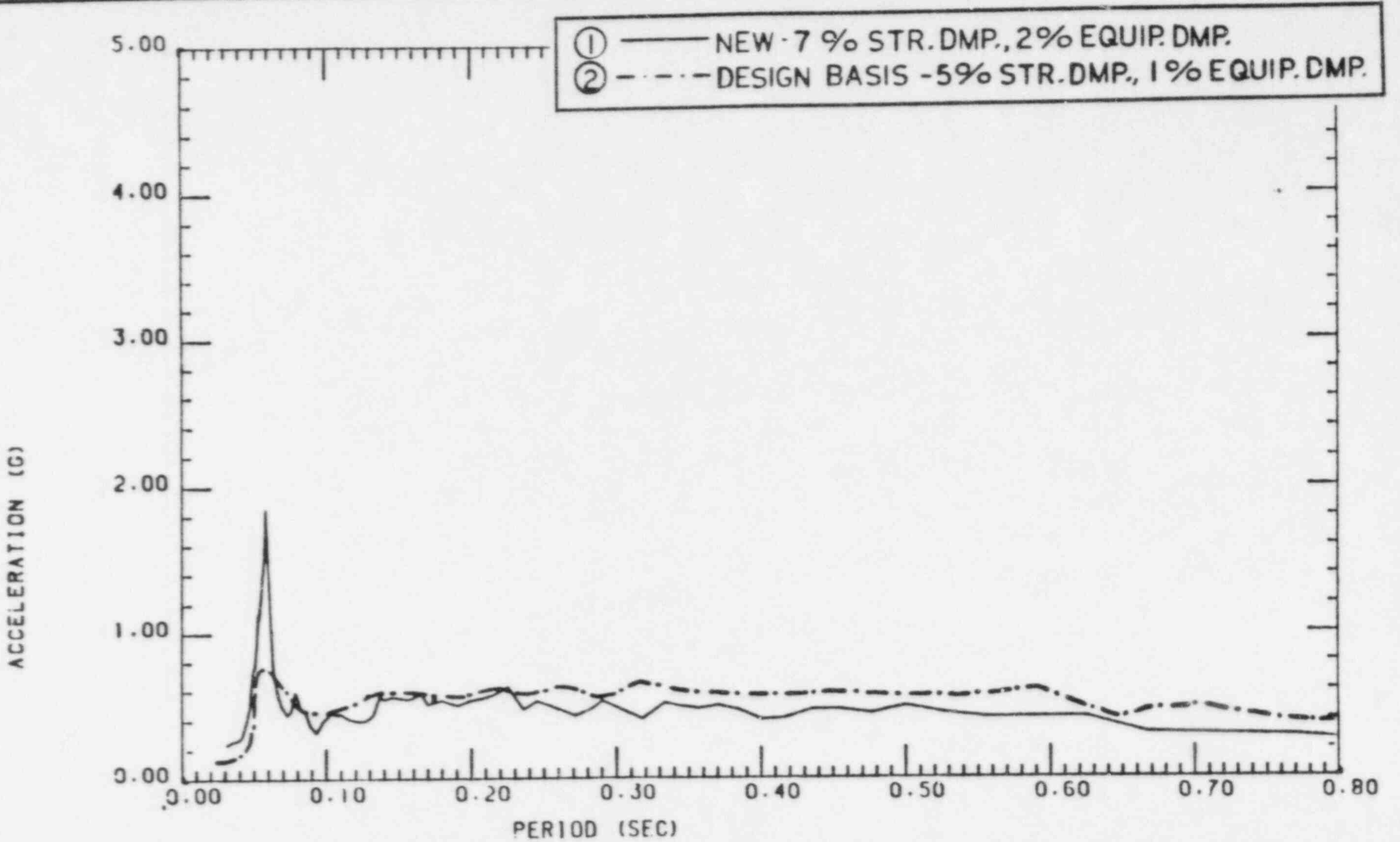
FLOOR FLEXIBILITY SENSITIVITY STUDY

MILLSTONE -3 - CONTROL BLDG. VERT. RESPONSE SPECTRA

ELEVATION - 47 FT.

FIG. 12

NODE - 287



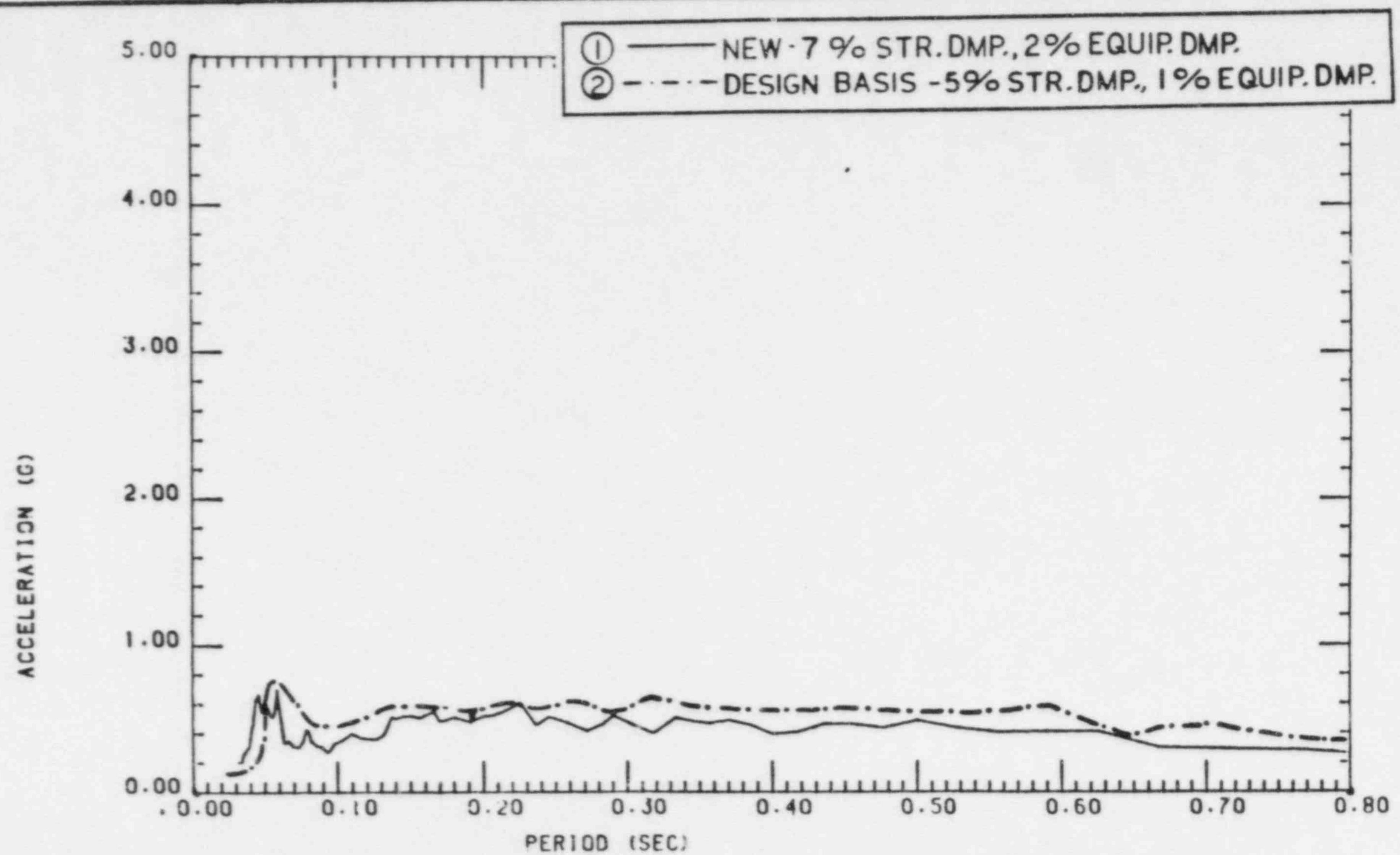
FLOOR FLEXIBILITY SENSITIVITY STUDY

MILLSTONE -3 - CONTROL BLDG. VERT. RESPONSE SPECTRA

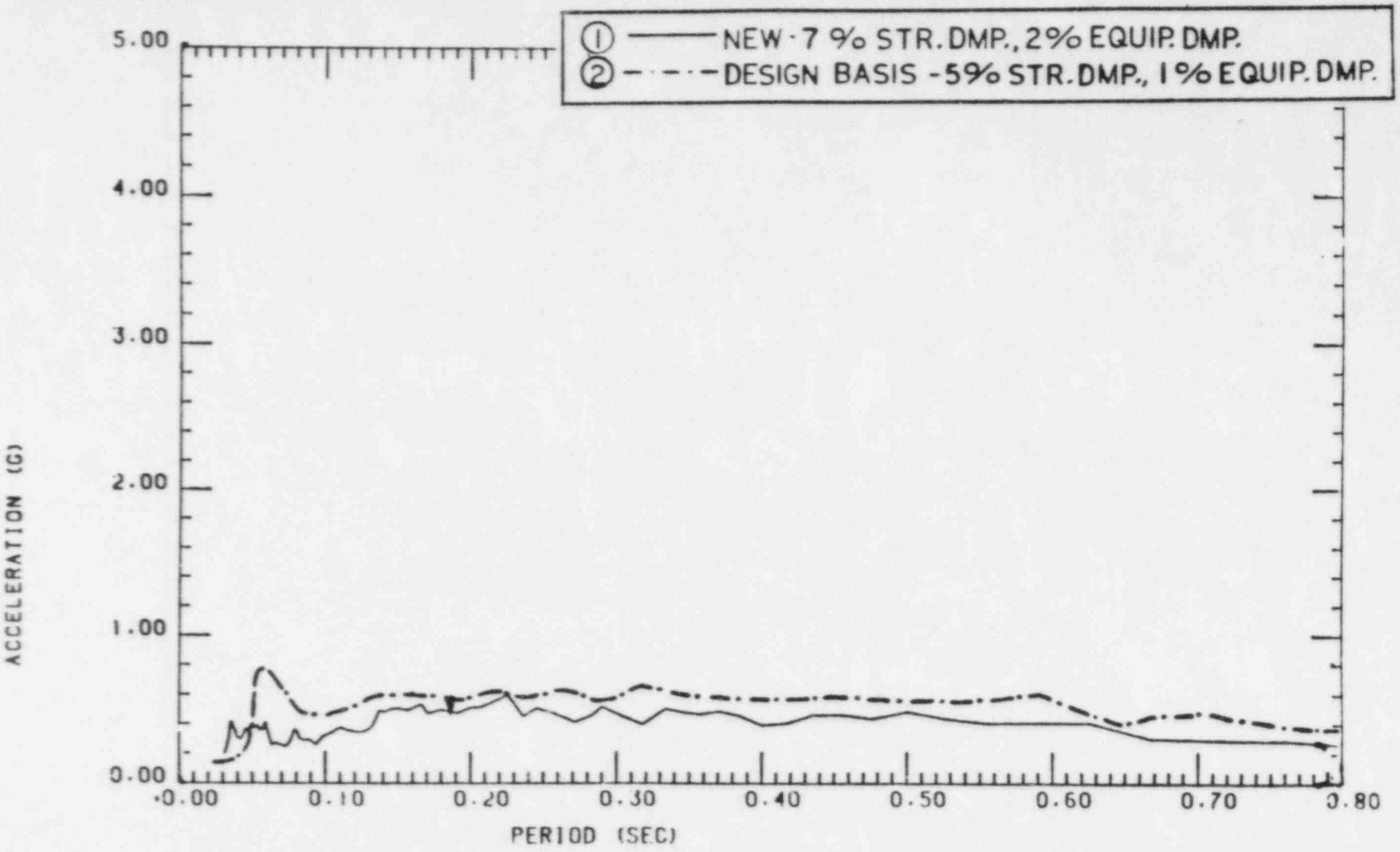
ELEVATION - 47 FT.

FIG. 13

NODE -302



FLOOR FLEXIBILITY SENSITIVITY STUDY — FIG. 14
MILLSTONE - 3 - CONTROL BLDG. VERT. RESPONSE SPECTRA
ELEVATION - 47 FT. — NODE - 353



FLOOR FLEXIBILITY SENSITIVITY STUDY FIG. 15

MILLSTONE - 3 - CONTROL BLDG. VERT. RESPONSE SPECTRA

ELEVATION - 47 FT. NODE - 378

Item 38 - Justify the Peak Broadening Procedure in Relation to Reg. Guide 1.122.

Response

The implementation section of Reg. Guide 1.122 states that the guide will be used in the evaluation of construction permit applications. The mathematical methods suggested in the guide were not applied to the original Millstone 3 design basis spectra. Due to this fact a sensitivity study was conducted which showed the design spectra used at Millstone 3 are conservative and meet the intent of Reg. Guide. 1.122.

A description of the Millstone 3 peak broadening criteria follows:

- o Millstone 3 ARS peaks are broadened plus and minus 15 percent in all cases, and the broadened peaks are bounded by vertical lines.

The methods and criteria used in the generation of the original amplified response spectra for Millstone 3 contain many conservatisms. One major conservatism is the fact that lower damping values than those suggested by Reg. Guide 1.61 were utilized. In order to show the peak broadening techniques used in the generation of the original amplified response spectra meet the intent of Reg. Guide 1.122 original amplified response spectra generated at 5% structural damping, 1% equipment damping, and peak broadened according to Millstone 3 peak broadening criteria were compared to amplified response spectra generated at 7% structural damping, 2% equipment damping, and peak broadened according to Reg. Guide 1.122 criteria.

As described above, amplified response spectra were generated and compared to the design basis amplified response spectra for the containment, auxiliary, and fuel buildings. These buildings were chosen for this study because of the following reasons:

a) the Containment Building is classified as an independent structure.

b) the Auxiliary Building is classified as being representative of a QA Cat I structure.

c) the Fuel Building is classified as a highly coupled structure.

For all three buildings it was determined that a 10% peak broadened spread could be justified for the new ARS. This was based upon a review of criteria as set forth in Reg. Guide 1.122 where such parameters as construction material properties, soil properties, equipment weights, and analytical methodology are factored into the analysis.

The results of this study are presented on Figures 1 thru 15. The following curves are plotted:

1) ARS generated at 7% structural damping and 2% equipment damping (SRSS of the three ARS components) peak broadened according to criteria set forth in R.G. 1.122 with a 10% peak broadened spread.

2) ARS generated at 5% structural damping and 1% equipment damping peak-broadened according to Millstone 3 criteria. This was used for equipment design.

Figures 1 through 3 also contain an additional curve.

3) Envelope of ARS generated at 5% structural damping and 1% equipment damping peak broadened according to Millstone 3 criteria. This is an example of the curves used for systems supported at multiple locations in one or more buildings such as piping systems. This ARS curve is taken as the upper bound envelope of all the individual response spectra for these locations.

A review of Figures 1 thru 15 shows that in all but a few isolated cases the original design spectra is bounded by the sensitivity study spectra which employs Reg. Guide 1.122 and Reg Guide 1.61 section criteria. The effects of these exceedances will be discussed in the following criteria.

A review of the original amplified response spectra versus the new response spectra developed utilizing current licensing criteria demonstrates the overall conservatism in the existing MP3 criteria for equipment analysis. The seismic analyses or tests performed for equipment at MP3 can be grouped into a few categories. A review of the behavior of the equipment in these categories can readily show the conservatism inherent in the present design basis:

1. Flexible Equipment

   The vast majority of piping and equipment at MP3 fall into this category. The primary analytical methods utilized for this category of equipment are the response spectrum method or the equivalent static method. The dynamic response spectrum method applied to flexible equipment will clearly result in a more severe design basis using the design basis ARS. Examination of the sample ARS provided show peak 'g' levels occurring in the frequency range of flexible piping and equipment response.

   The peak levels for the design basis curves are from 1.5 to 3.0 times as severe as those based on current licensing criteria. The frequency range, where in a few of the sample ARS curves the new curves exceed the design basis curves, are at a very limited frequency range and in almost all cases would only affect higher modes of equipment response.

   A second method for analyzing flexible equipment at MP3 was the equivalent static method. The primary use of this method was in cases where natural frequencies of the equipment were not calculated and the peak of the response spectra were utilized for design. In these cases, the design basis was extremely conservative when compared to current criteria.

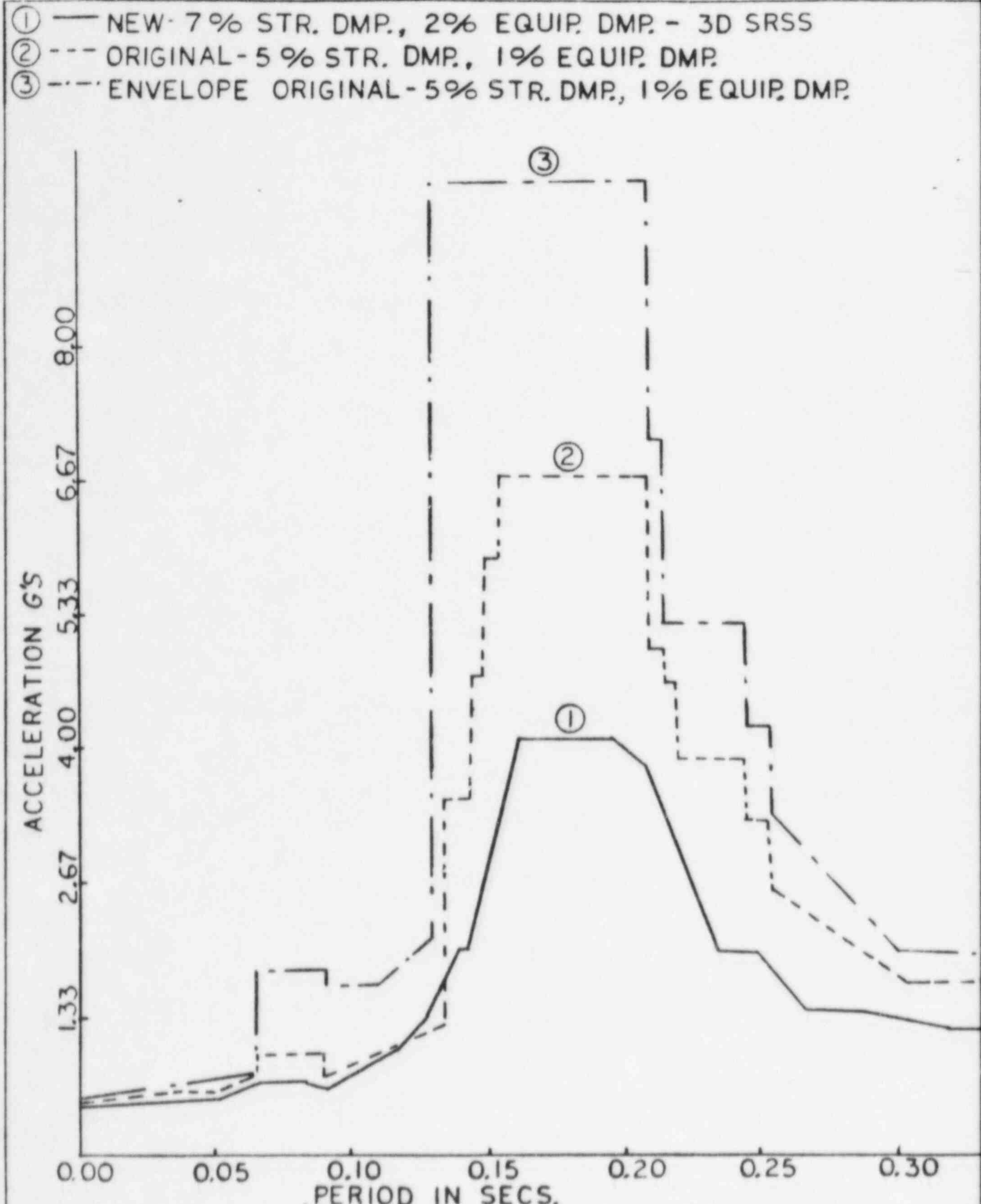
2. Rigid Equipment

Some equipment at MP3 behaves as rigid components. For the most part, this rigid behavior is a design requirement. The primary example of this is electrical cabinets, panels, and racks. Design requirements established for a large percentage of types of components resulted in the equipment being analyzed for the zero period acceleration (ZPA) of the ARS. Examination of the sensitivity study and design basis ARS demonstrate no change in the ZPA acceleration levels.

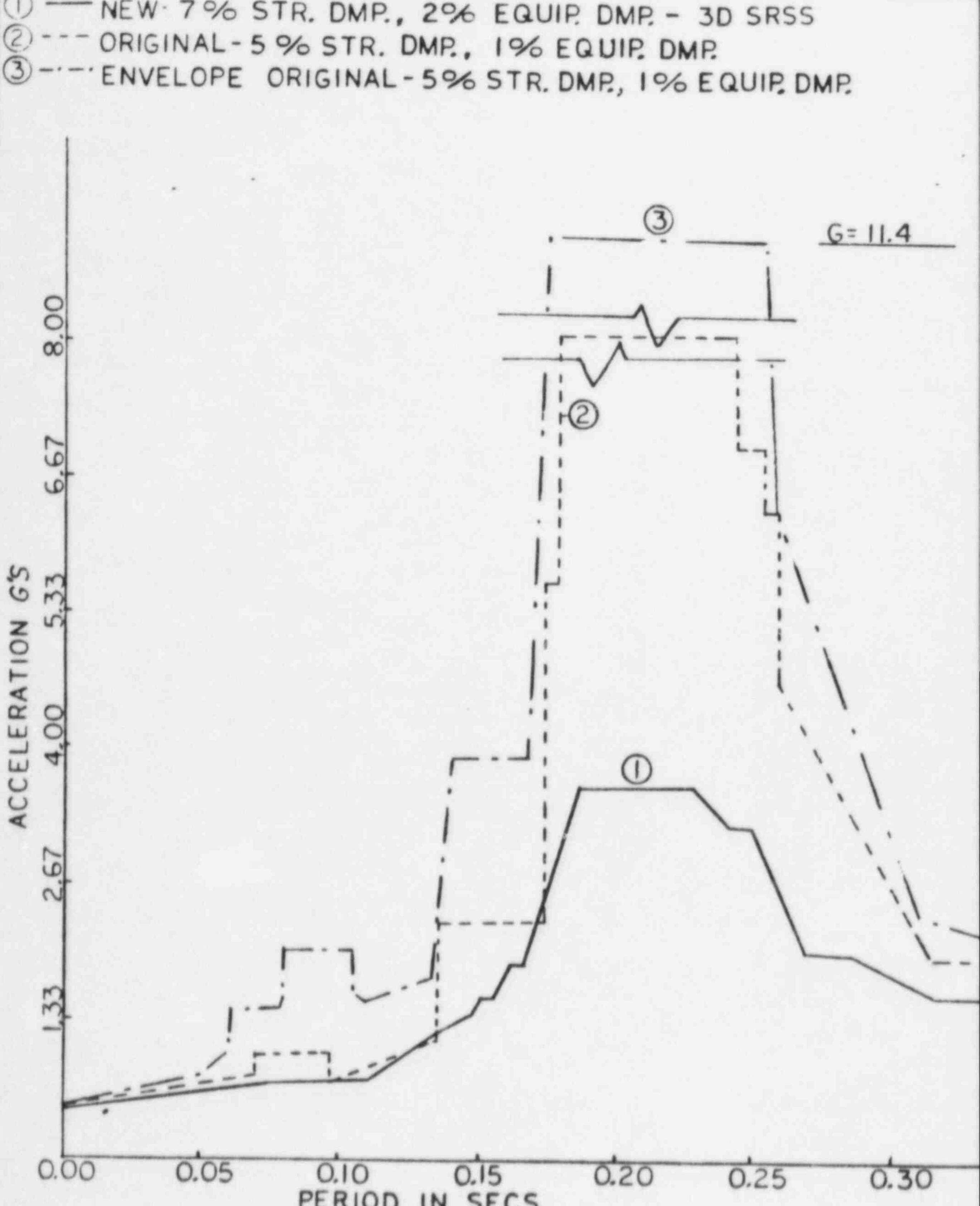
3. Equipment Qualified by Testing

A large percentage of electrical equipment was qualified by testing. Out of the group of equipment qualified by test, many of the components were subjected to generic testing, i.e. qualification for service at several nuclear plant sites. The generic qualification approach has led to broad frequency range qualification and very conservative enveloping of the design basis ARS in many cases. In addition, typical test response spectra (TRS) shown in qualification reports tend to be broader and smoother than the required response spectra (RRS) due to equipment limitations.

In summary, samples of ARS developed utilizing current licensing criteria were compared to the design basis ARS. The differences between the two sets of spectra were examined to determine what effect they might have with regard to seismic equipment design of MP3. The conclusion drawn is that the current licensing basis is a much more severe seismic design basis than would result from application of current licensing criteria. This conclusion is felt to apply to the entire range of equipment types utilized by MP3.



REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 1
MILLSTONE 3-CONTAINMENT STRUCTURE
EL. 52'-4" N-S (SSE)

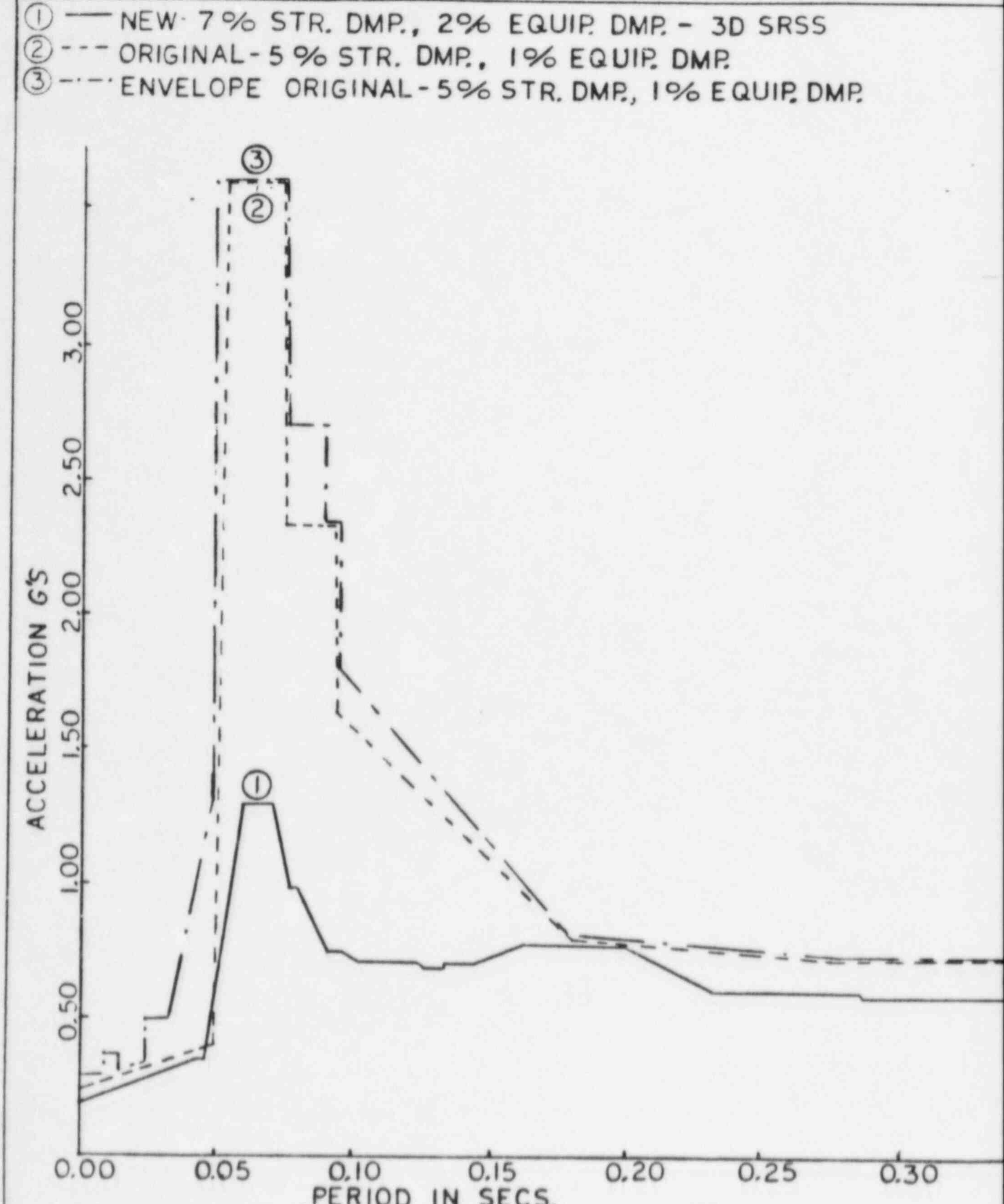


REG. GUIDE 1.122 SENSITIVITY STUDY

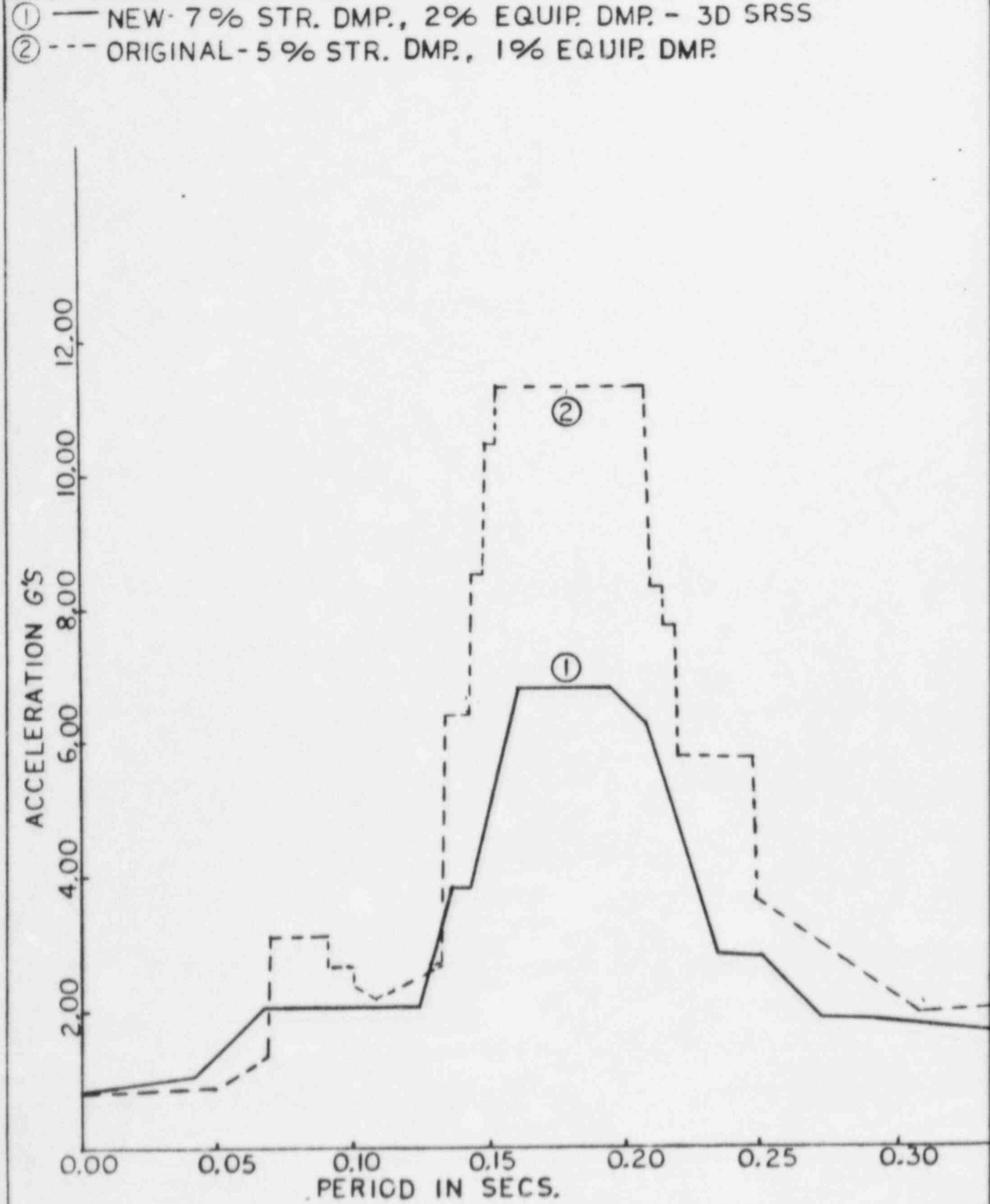
MILLSTONE 3 - CONTAINMENT STRUCTURE

EL. 52'-4" E-W (SSE)

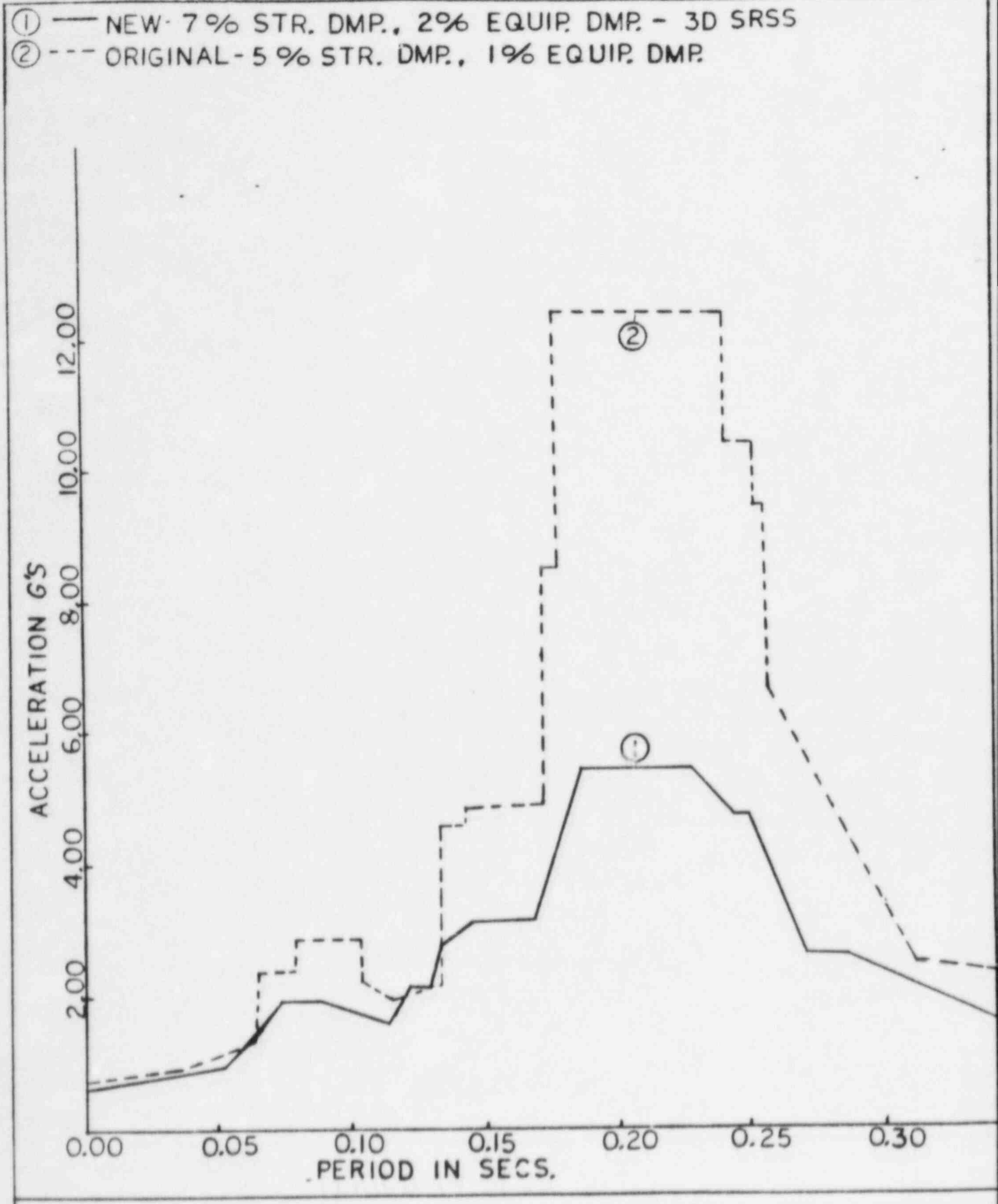
FIG. 2



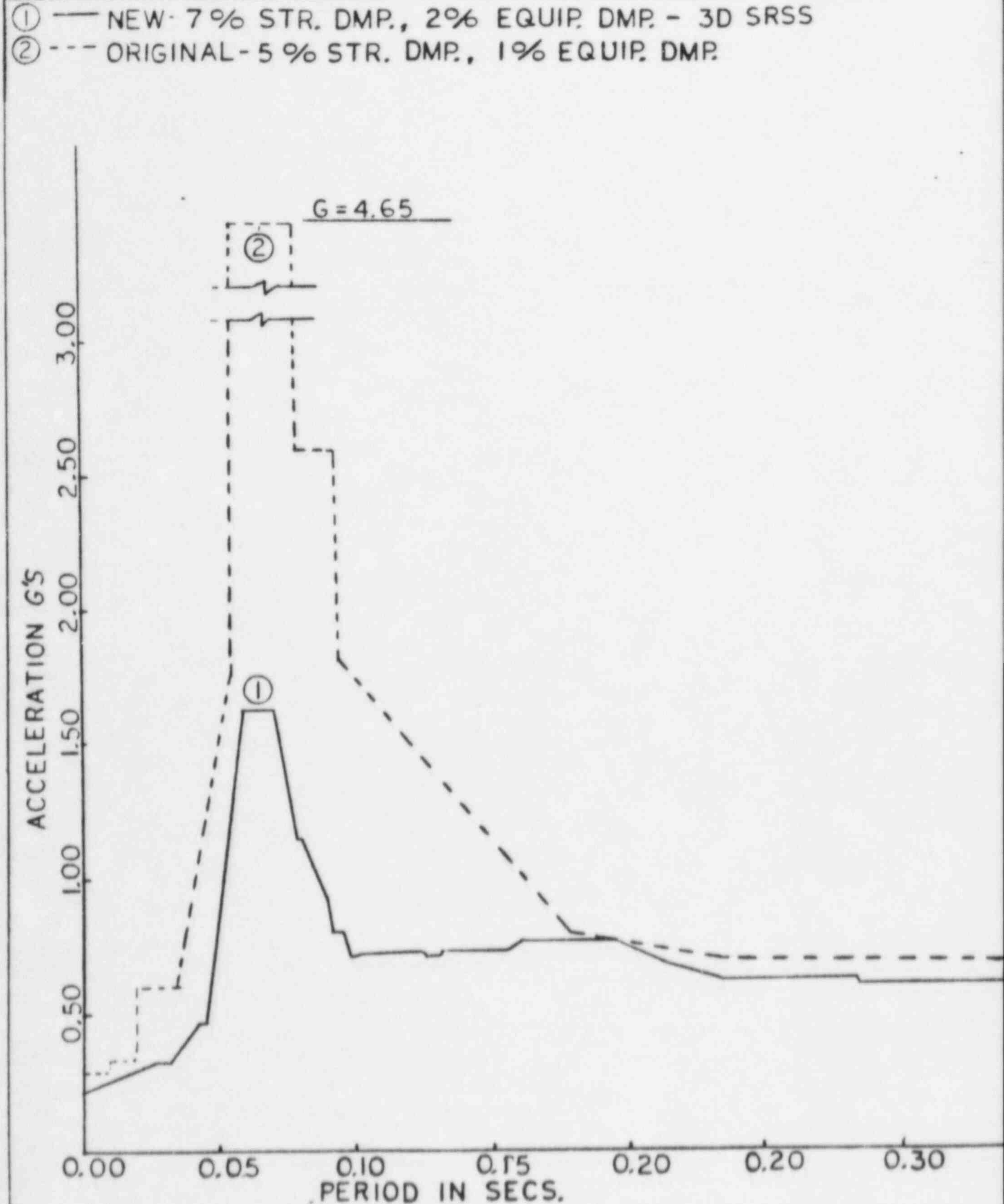
REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 3
MILLSTONE 3 - CONTAINMENT STRUCTURE
EL. 52'-4" VERTICAL (SSE)



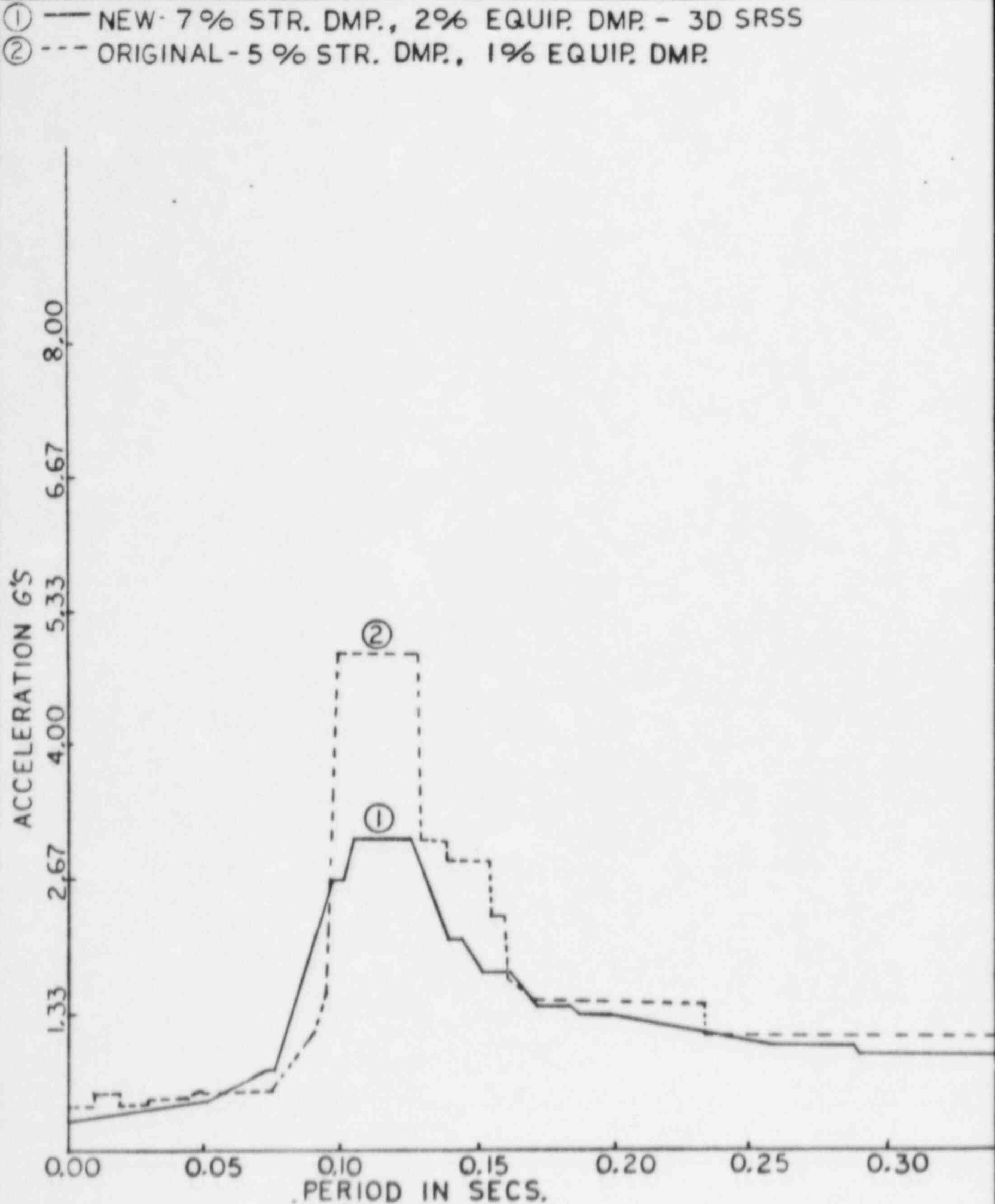
REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 4
MILLSTONE 3 - CONTAINMENT STRUCTURE
EL. 109'-1" N-S (SSE)



REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 5
MILLSTONE 3 – CONTAINMENT STRUCTURE
EL. 109'-1" E-W (SSE)

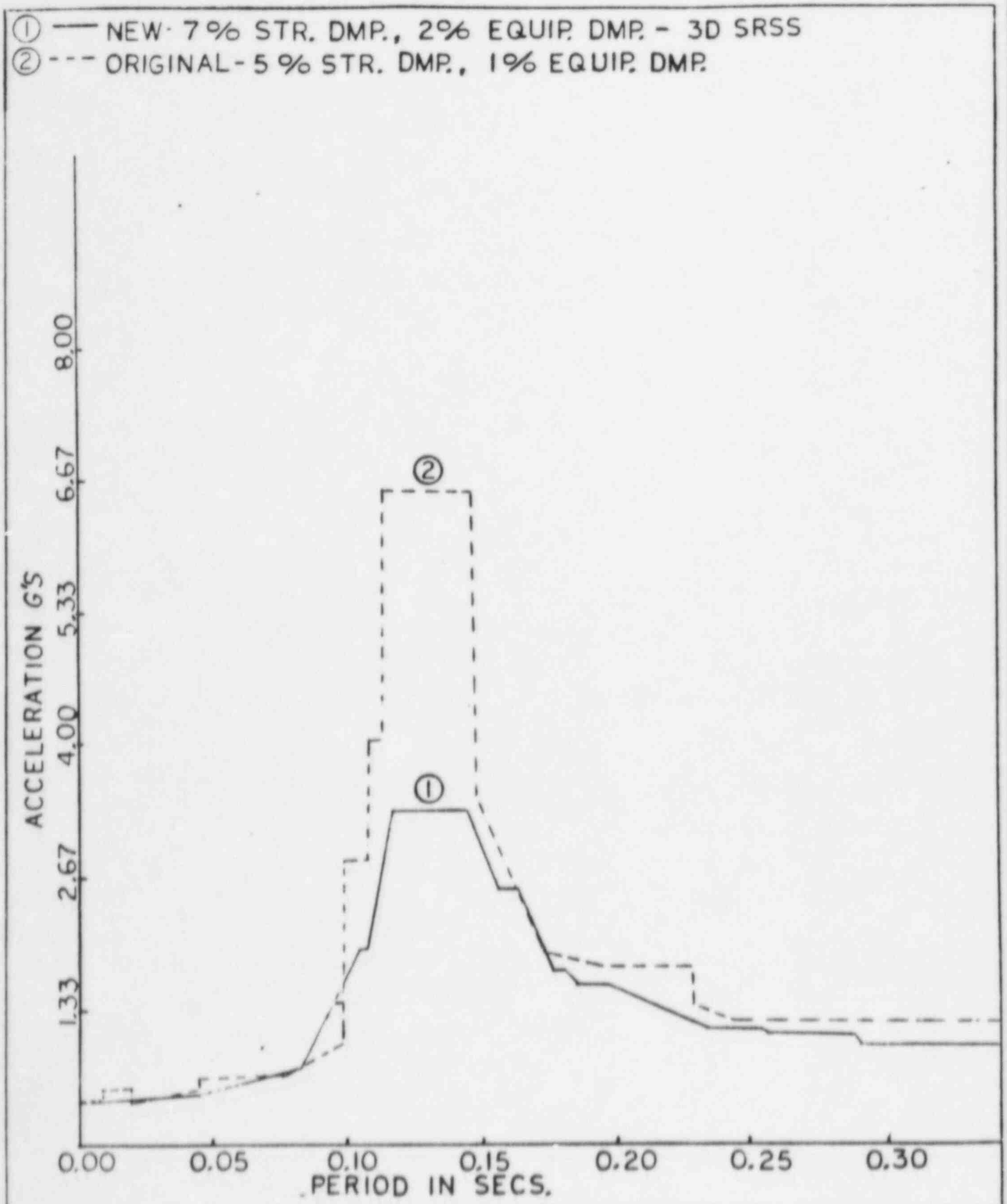


REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 6
MILLSTONE 3-CONTAINMENT STRUCTURE
EL. 109'-1" VERTICAL (SSE)

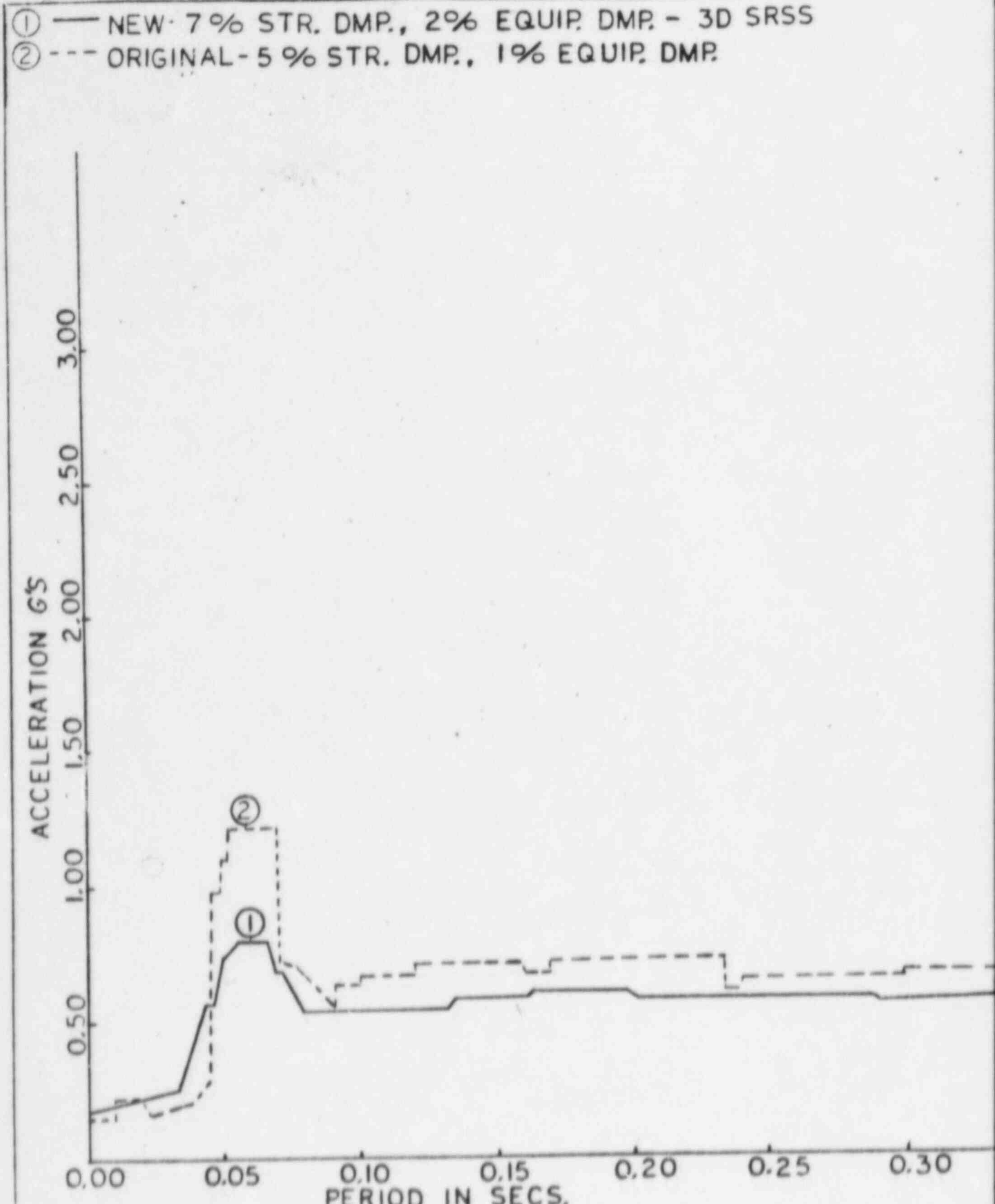


REG. GUIDE 1.122 SENSITIVITY STUDY
MILLSTONE 3 — AUX BUILDING
EL. 66'-6" N-S (SSE)

FIG. 7

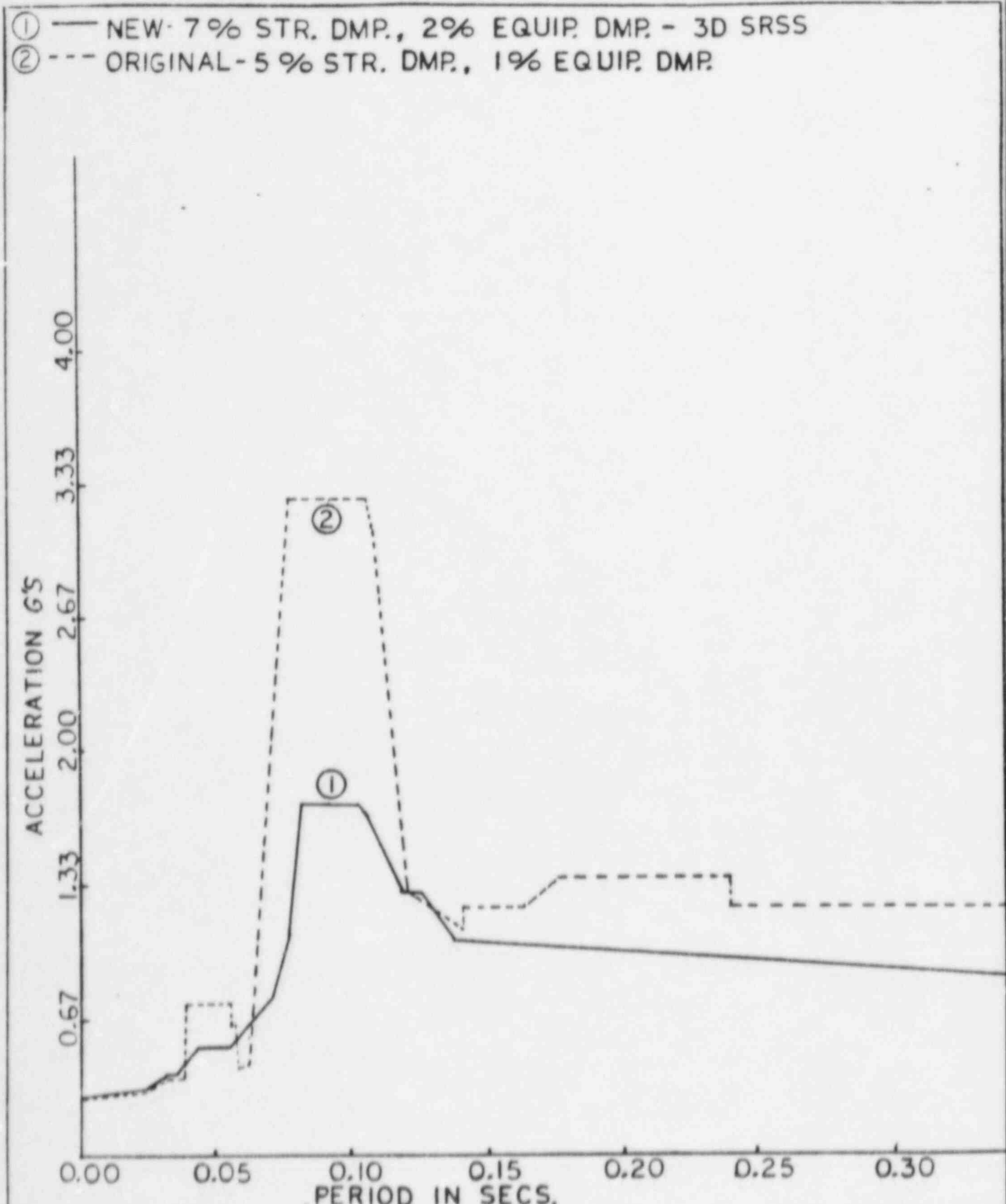


REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 8
MILLSTONE 3 — AUX BUILDING
EL. 66'-6" E-W (SSE)



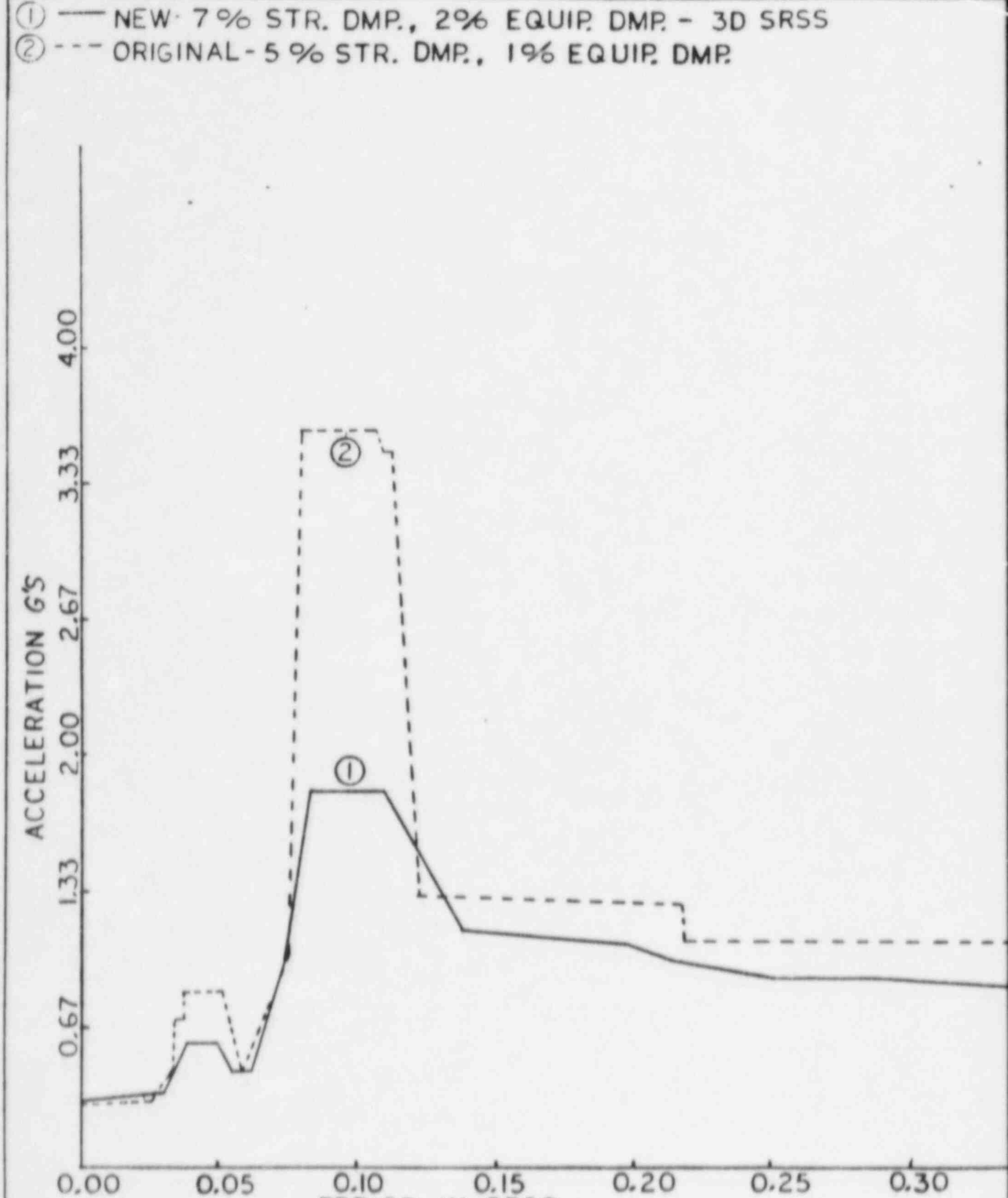
REG. GUIDE 1.122 SENSITIVITY STUDY
MILLSTONE 3 - AUX BUILDING
EL. 66'-6" VERTICAL (SSE)

FIG. 9

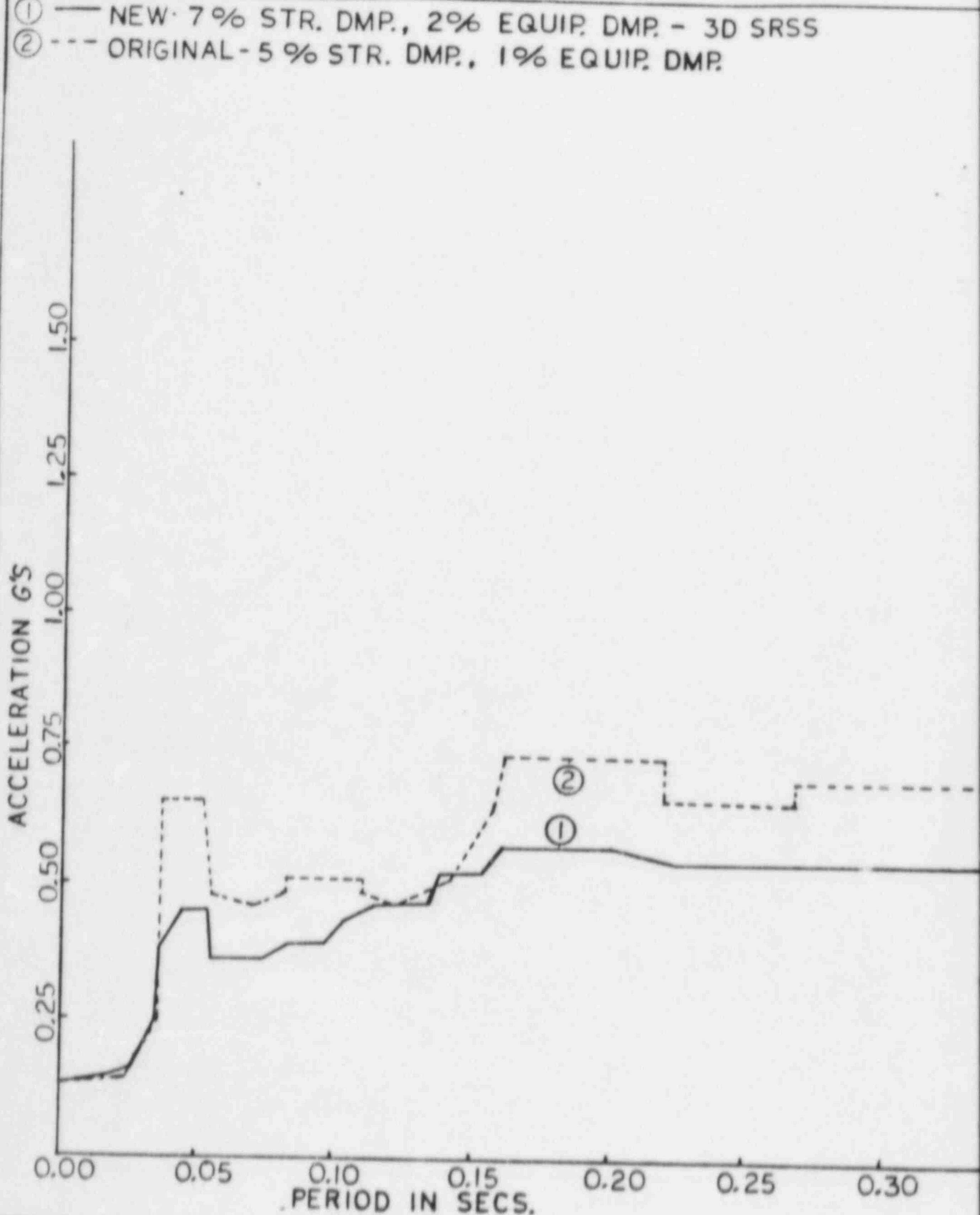


REG. GUIDE 1.122 SENSITIVITY STUDY
MILLSTONE 3 – FUEL BUILDING
EL. 52'-4" N-S (SSE)

FIG. 10

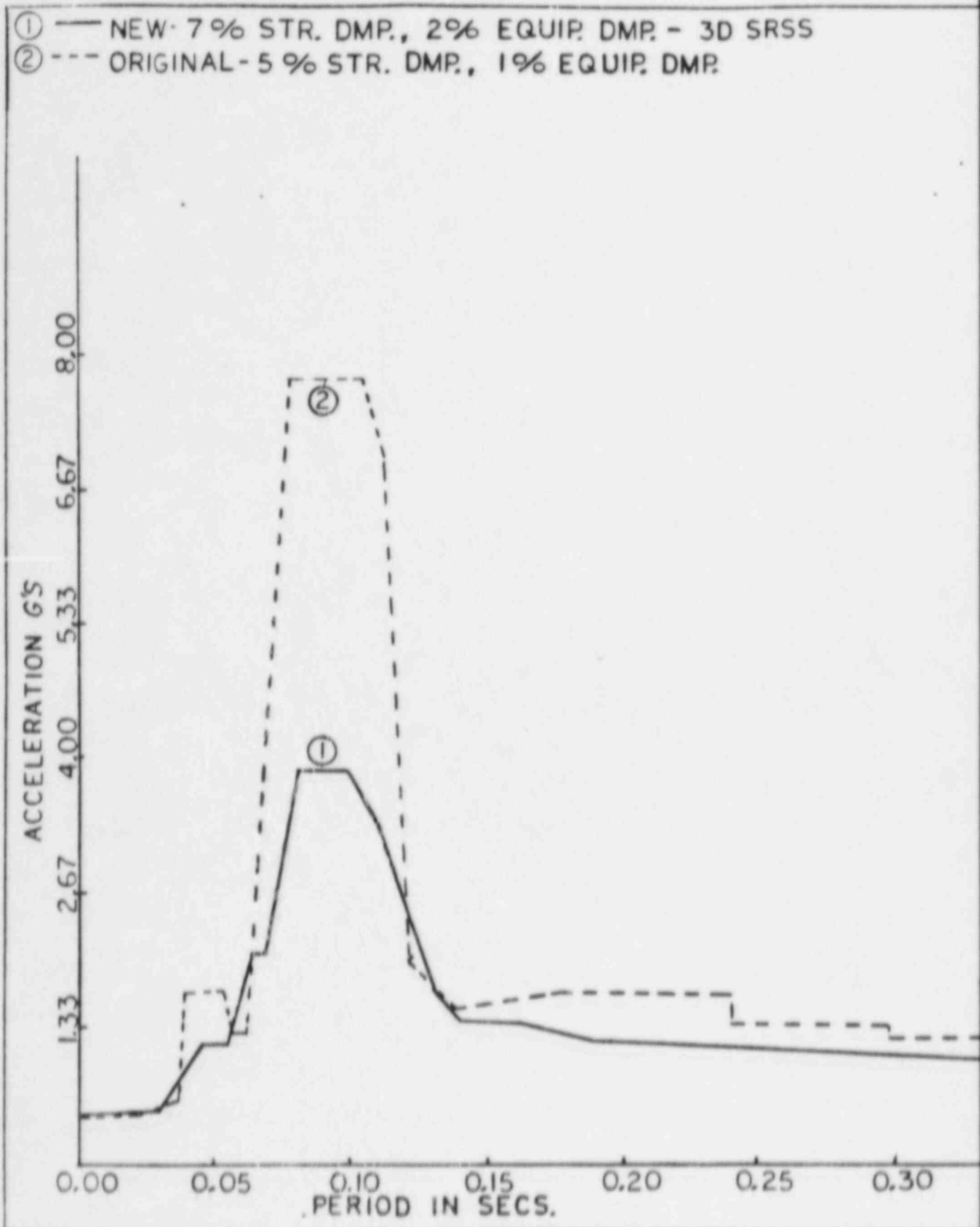


REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 11
MILLSTONE 3 — FUEL BUILDING
EL. 52'-4" E-W (SSE)

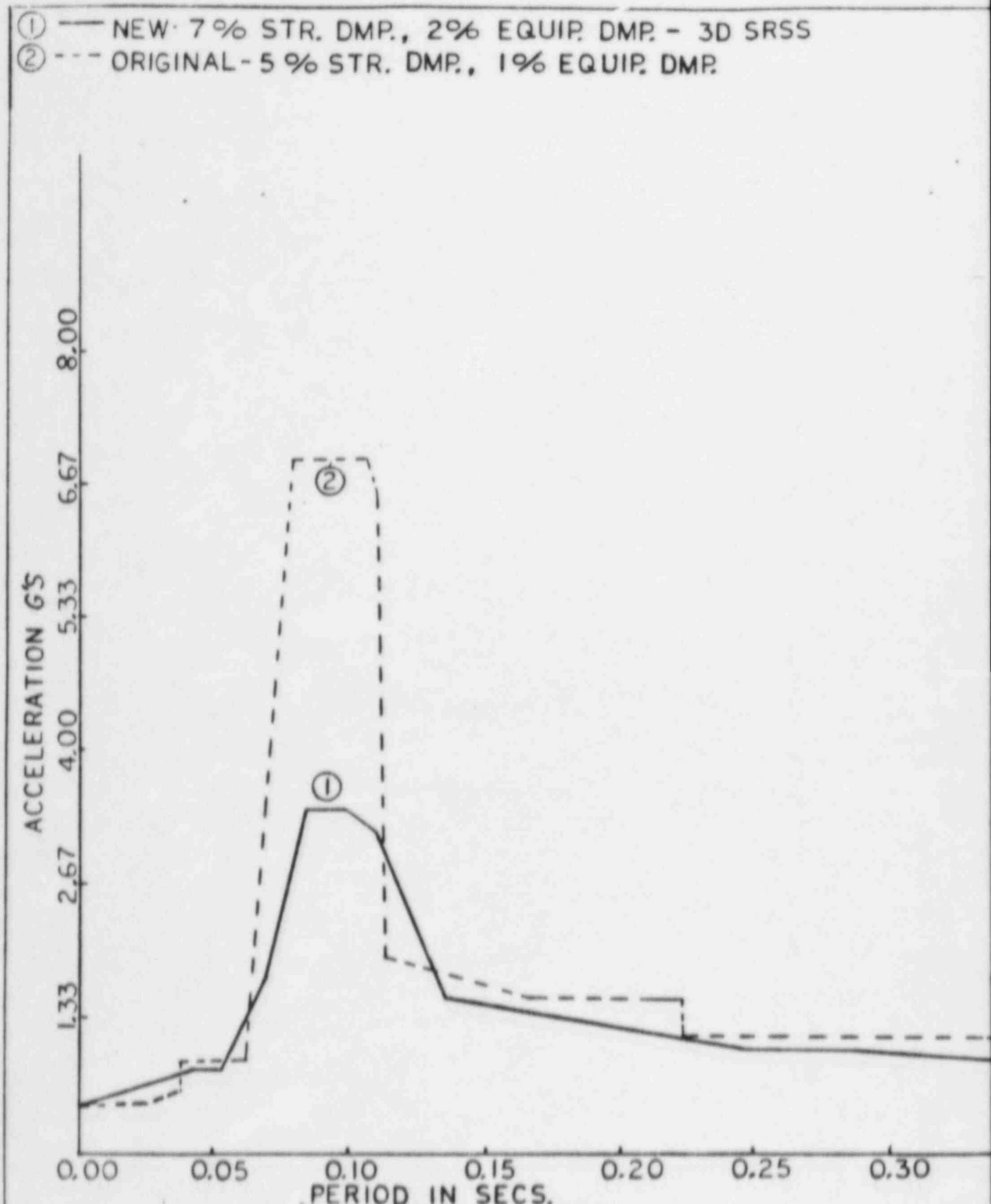


REG. GUIDE 1.122 SENSITIVITY STUDY
MILLSTONE 3 — FUEL BUILDING
EL. 52'-4" VERTICAL (SSE)

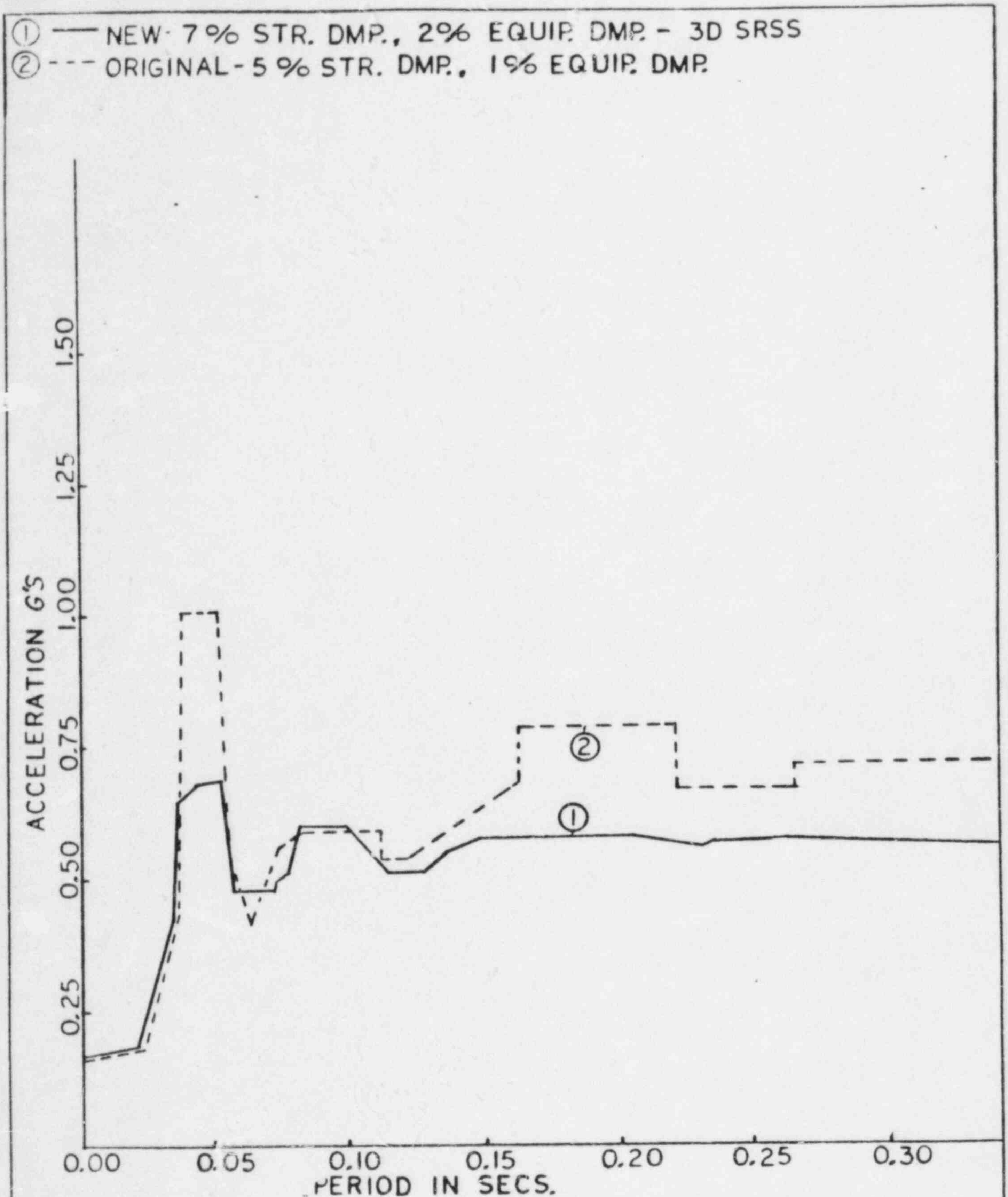
FIG. 12



REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 13
MILLSTONE 3 - FUEL BUILDING
EL. 93'-10" N-S (SSE)



REG. GUIDE 1.122 SENSITIVITY STUDY FIG. 14
MILLSTONE 3 — FUEL BUILDING
EL. 93'-10" E-W (SSE)



REG. GUIDE 1.122 SENSITIVITY STUDY
MILLSTONE 3 — FUEL BUILDING
EL. 93′—10″ VERTICAL (SSE)

FIG. 15