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SUBJECT: Forwards nonproprietary addl info supporting util position that Kuosheng safety relief valve test data confirms that conservative design of Mark III containment for hydrodynamic loads & plant-unique tests not required.

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SUBJECT: Incorporates proprietary data into supporting util position that Susquehanna safety relief valve test data confirms that conservative design of Mark II containment for hydrodynamic loads & plant-unique test, not required.

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Dalwyn R. Davidson
VICE PRESIDENT
SYSTEM ENGINEERING AND CONSTRUCTION

November 17, 1982

Mr. A. Schwencer, Chief
Licensing Branch No. 2
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Perry Nuclear Power Plant
Docket Nos. 50-440; 50-441
Additional Information on SRV
Hydrodynamic Loads

Dear Mr. Schwencer:

Our letter of October 15, 1982 provided to you proprietary documentation in support of the Cleveland Electric Illuminating Company (CEI) position that the Kuosheng SRV test data has confirmed the conservative design of the Mark III containment for SRV hydrodynamic loads and plant-unique tests of SRV discharge are not required for Perry. That letter also responded to questions raised by Containment Systems Branch (CSB), Structural Engineering Branch (SEB), and Mechanical Engineering Branch (MEB). We additionally committed to providing non-proprietary documentation of this position. Attached is the non-proprietary documentation (Attachment 1).

Further analysis has been performed in response to a request by the SEB reviewer in the telephone conference call of August 20, 1982. This analysis utilized a pressure time history from the Kuosheng tests as the forcing function input to the Perry structural models to predict the response of the containment and internal structures to the SRV loads. Resulting response spectra at selected node points demonstrate that the Perry models effectively predict the accelerations measured at Kuosheng. This analysis further verified that significant conservatism exists in the Perry design based on a comparison of Perry SRV design response spectra and Perry predicted response spectra using Kuosheng measured pressure time history. Discussion of this analysis and selected comparisons of acceleration response spectra (ARS) are provided herein, (Attachment 2).

During the tests at Kuosheng, exceedances in the high frequency region were noted. As anticipated, our analysis predicted similar exceedances, and a program has been developed to evaluate these. This program includes re-analysis of a piping system with active valves and a piece of equipment located within containment areas where these exceedances were noted. At Kuosheng, although high frequency exceedances occurred at various points in the structure, measured responses of piping and equipment in these areas were quite low. This, coupled with other conservatisms will demonstrate adequate design margins at Perry.

B001

A discussion of the amplification factors used to compare Kuosheng test data to the Perry design values was originally provided in response to Question 4 of the CSB concerns in our October 15, 1982 letter. As a result of a telephone conversation with Mr. F. Eltawila, CSB reviewer, on November 3, 1982, we are also transmitting a revised response to clarify how these factors were developed, (Attachment 3).

Finally, we have requested a meeting with the NRC staff MEB, SEB and CSB reviewers to discuss our responses to their concerns and present the results of our analysis of the Kuosheng data in the Perry containment models. This meeting is scheduled for November 22, 1982 and a proposed agenda is attached (Attachment 4).

This submittal completes our evaluation and justification that in-plant SRV testing is not required for Perry. The plant design and ARS comparisons presented to-date confirm a conservative design. Differences in the spectra have been addressed and a program to demonstrate that there is no impact to design has been developed. Therefore, our commitment to confirm conservatism in the SRV hydrodynamic load definition used in the Perry design is satisfied and no additional testing is planned.

If you have any questions, please let me know.

Very truly yours,

Ronald L. Farrell for

Dalwyn R. Davidson
Vice President
System Engineering and Construction

DRD:kh

cc: J. Silberg
J. Stefano
M. Gildner
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N. Chokshi
F. Eltawila

PERRY NUCLEAR POWER PLANT

DOCKET NOS. 50-440; 50-441

NON-PROPRIETARY INFORMATION

ON

SAFETY RELIEF VALVE

HYDRODYNAMIC LOADS

1.0 INTRODUCTION

1.1 THE PERRY NUCLEAR POWER PLANT UNITS 1 AND 2 ARE TWIN (GE) BWR6-238 REACTORS HOUSED IN MARK III CONTAINMENTS. THE CONTAINMENT SYSTEM UTILIZED IS A STIFFENED FREE STANDING STEEL CONTAINMENT VESSEL SURROUNDED BY A CONCRETE SHIELD BUILDING. STRUCTURAL CONCRETE FILLS THE ANNULAR SPACE BETWEEN THE CONTAINMENT AND SHIELD BUILDING IN THE SUPPRESSION POOL REGION. THIS AIDS TO MITIGATE THE CONTAINMENT RESPONSE INDUCED BY SUPPRESSION POOL HYDRODYNAMIC LOADS INCLUDING BLOWDOWN OF THE PLANT SAFETY/RELIEF VALVES (SRVs).

THE MAGNITUDE AND FREQUENCY CONTENT OF THE SRV HYRODYNAMIC LOADS WAS IDENTIFIED AS A CONCERN DURING THE PERRY CONSTRUCTION PERMIT HEARINGS. SINCE THESE HEARINGS THE NRC HAS PUBLISHED NUREG-0763 "GUIDELINES FOR CONFIRMATORY INPLANT TESTS OF SAFETY-RELIEF VALVE DISCHARGES FOR BWR PLANTS", DATED MAY 1981. A LARGE-SCALE SRV TEST PROGRAM WAS CONDUCTED IN THE REPUBLIC OF CHINA, AT THE KUOSHENG NUCLEAR POWER STATION UNIT I, IN AUGUST 1981. A CONFIRMATORY SRV TEST PROGRAM IS ALSO PLANNED FOR THE GRAND GULF NUCLEAR STATION UNIT I DURING STARTUP TESTING IN 1983. BASED ON THE EXISTING TEST DATA, AND NUREG-0763 CRITERIA, NO IN-PLANT SRV TESTS ARE REQUIRED AT PERRY.

1.2 THE PURPOSE OF THIS REPORT IS TO DEMONSTRATE THAT THE REQUIREMENTS OF NUREG-0763 HAVE BEEN SATISFIED FOR PERRY AND THAT A PLANT UNIQUE TEST IS NOT REQUIRED. HEREIN WE DEMONSTRATE THAT THE REQUIREMENTS OF SECTION 4, OF THE NUREG; "RATIONALE FOR PLANT-SPECIFIC TESTS," HAVE BEEN SATISFIED. THE TESTS PERFORMED AT KUOSHENG, AND THOSE TO BE CONDUCTED AT GRAND GULF, WILL FORM A PROTOTYPICAL DATA BASE THAT WILL ADEQUATELY CONFIRM THE HYDRODYNAMIC LOAD DEFINITION BASIS FOR SRV DISCHARGE. THIS DATA BASE WILL SATISFY THE PERRY LICENSING COMMITMENTS TO ADDRESS THE SUPPRESSION POOL SRV HYDRODYNAMIC LOAD CONCERNS.

2.0 NUREG-0763 REQUIREMENTS FOR PLANT-SPECIFIC TESTS

NUREG-0763 SETS FORTH GUIDELINES TO BE USED IN DETERMINING THE NEED FOR PLANT-SPECIFIC TESTS AND DEFINES THE TYPES OF TEST AND INSTRUMENTATION REQUIRED TO SATISFY THE NRC CRITERIA. THE KEY PARAMETERS AFFECTING THE SUPPRESSION POOL HYDRODYNAMIC LOADS HAVE BEEN IDENTIFIED BY EXTENSIVE GENERIC TEST PROGRAMS. SECTION 4, "RATIONALE FOR PLANT-SPECIFIC TESTS," OF NUREG-0763 INCLUDES THIS STATEMENT: " . . . , APPLICANTS MAY BE ABLE TO DEMONSTRATE THAT DISCHARGE CONDITIONS IN THEIR PLANTS ARE SUFFICIENTLY SIMILAR TO CONDITIONS PREVIOUSLY TESTED TO OBVIATE THE NEED FOR ANY NEW TESTS . . . ". IT IS THE INTENT OF THIS REPORT TO ADDRESS EACH OF THE FIVE, SECTION 4 CRITERIA OF NUREG-0763 AND DEMONSTRATE THAT SUCH SIMILARITIES DO EXIST BETWEEN KUOSHENG, GRAND GULF AND PERRY, AND A SOUND BASIS EXISTS FOR THE DEFINITION OF THE SRV HYDRODYNAMIC LOADS.

2.1 CRITERION 1 WOULD REQUIRE A PLANT SPECIFIC TEST IF:

"THE DISCHARGE DEVICE IS GEOMETRICALLY DIFFERENT FROM DEVICES TESTED PREVIOUSLY."

DISCUSSION

A COMPARISON OF THE DIMENSIONAL SIMILARITIES OF THE QUENCHERS INSTALLED AT KUOSHENG, GRAND GULF AND PERRY SHOWS THAT THE QUENCHERS ARE GENERALLY THE SAME CONFIGURATION. THE MAJOR DIFFERENCE BETWEEN THESE QUENCHERS IS THE ANGLE OF THE REDUCER TAPER, WHERE PERRY'S IS (10.75°), KUOSHENG'S IS (17.1°), AND GRAND GULF'S IS (10.4°). AN INSIGNIFICANTLY SMALLER QUENCHER HUB I.D. ALSO EXISTS FOR PERRY.

ANY EFFECT OF THE REDUCER ANGLE ON WATER CLEARING LOADS WILL BE ADEQUATELY DEMONSTRATED BY A COMPARISON OF THE RESULTS OF THE GRAND GULF TESTS WITH THE KUOSHENG TEST RESULTS.

2.2 CRITERION 2 WOULD REQUIRE A PLANT SPECIFIC TEST IF:

"THE DISCHARGE-LINE PARAMETERS--LINE LENGTH, AREA AND VOLUME, QUENCHER SUBMERGENCE, VACUUM BREAKER SIZE, AND AVAILABLE POOL AREA PER QUENCHER--DIFFER SIGNIFICANTLY FROM VALUES PREVIOUSLY TESTED. AN ASSESSMENT OF SIGNIFICANT DIFFERENCES SHALL BE BASED ON PREVIOUSLY ESTABLISHED EMPIRICAL CORRELATIONS BETWEEN CHANGES IN THESE PARAMETERS AND RESULTANT CHANGES IN VARIABLES OF INTEREST, OR ON ANALYTICAL CONSIDERATIONS."

DISCUSSION

A COMPARISON OF THE SRV DISCHARGE LINE PARAMETERS FOR KUOSHENG, GRAND GULF AND PERRY SHOWS THAT THE QUENCHER SUBMERGENCE AND AVAILABLE POOL AREA PER QUENCHER DO NOT DIFFER SIGNIFICANTLY. THE SRV DISCHARGE LINE LENGTH, VOLUME AND VACUUM BREAKER SIZE ARE SOMEWHAT DIFFERENT BETWEEN PLANTS, HOWEVER, THOSE FOR PERRY DO NOT VIOLATE THE MAXIMUM LINE PRESSURE CRITERIA NOR CREATE A BACK PRESSURE PROBLEM ON THE SRV.

AS DISCUSSED IN SECTION 3BA.2 OF ATTACHMENT A TO APPENDIX 3B OF GESSAR, THE SRV DISCHARGE LINE AIR VOLUME IS THE CRITICAL PARAMETER IN THE DETERMINATION OF THE PEAK POOL PRESSURES. THIS DOCUMENT RECOMMENDS THAT THE MAXIMUM LINE VOLUME BE LESS THAN 56.13 CUBIC FEET. THE MAXIMUM LINE VOLUME AT PERRY IS 55.7 CUBIC FEET WHICH MEETS THIS CRITERION AND IS LESS THAN THE PROPOSED TEST LINE AT GRAND GULF.

TABLE 3BA-3 OF APPENDIX 3B TO GESSAR PROVIDES RECOMMENDATIONS FOR THE DESIGN OF THE SRV DISCHARGE LINE. THE RATIONALE FOR THESE RECOMMENDATIONS IS TO ENSURE THAT THE MAXIMUM PIPE PRESSURE DOES NOT EXCEED 625 PSI AND THUS MAINTAIN CHOKED FLOW THROUGH THE SRV. THE MAXIMUM SRV DISCHARGE LINE LENGTH AT PERRY IS 30% LONGER THAN THE MAXIMUM LINE LENGTH TESTED AT KUOSHENG. THERE ARE TWO POSSIBLE EFFECTS FROM THIS INCREASED LENGTH:

1. THE AIR VOLUME MUST BE CONTROLLED BY THE SELECTION OF PIPE SIZES. AS THE DISCHARGE LINE GEOMETRY EXISTS, THE MAXIMUM PERRY AIR VOLUME IS LESS THAN THE PROPOSED GRAND GULF TEST LINE AND MEETS THE GENERAL ELECTRIC MAXIMUM AIR VOLUME CRITERIA. THEREFORE, THE LONGER LINE LENGTH AT PERRY IS NOT A CONCERN.

2. A LONGER SRV DISCHARGE LINE WILL INCREASE THE LINE PRESSURE DROP DUE TO HIGHER FRICTIONAL LINE LOSSES, I.E., F1/D INCREASES. THIS WILL INCREASE THE BACK PRESSURE AT THE SRV EXIT. IF THIS INCREASE WERE PERMITTED TO BECOME LARGE ENOUGH, THE SRV COULD BECOME UNCHOCKED, REDUCING ITS EFFECTIVENESS TO DECREASE REACTOR PRESSURE.

IN ADDRESSING ITEM 2 ABOVE, SRV BACK PRESSURES HAVE BEEN ESTIMATED FOR THE KUOSHENG PLANT. THEY ARE BASED ON THE MEASURED SRV DISCHARGE LINE PRESSURES AND EXTRAPOLATED BACK TO THE SRV EXIT BY USING AN APPROPRIATE FRICTIONAL LOSS FACTOR F1/D AND A LOCAL LOSS FACTOR, K. I.E.,

SRV BACK PRESSURE = MEASURED PRESSURE DOWNSTREAM OF THE SRV

$$+ \frac{\bar{v}^2}{2g} (F1/D + K) \frac{\bar{\rho}}{144} \text{ PSIG}$$

WHERE:

$\bar{v}$ = AVERAGE STEAM VELOCITY BETWEEN THE SRV EXIT AND MEASURED PRESSURE LOCATION.

F = SRV DISCHARGE LINE FRICTION FACTOR.

1 = SRV DISCHARGE LINE LENGTH FROM SRV EXIT TO MEASURED PRESSURE LOCATION, FT.

D = SRV DISCHARGE LINE I.D., FT.

K = SUMATION OF LOCAL LOSSES (I.E. PIPE BENDS, REDUCERS, ETC.)

$\bar{\rho}$ = AVERAGE STEAM DENSITY BETWEEN SRV EXIT AND MEASURED PRESSURE LOCATION, lbm/ft.

THE ESTIMATED BACK PRESSURE WAS APPROXIMATELY A FACTOR OF TWO BELOW ALLOWABLE. ASSUMING THE Fl/D FACTOR FOR PERRY IS GREATER THAN KUOSHENG'S BY THE RATIO OF THE LINE LENGTHS AND THE SUMMATION OF THE LOCAL LOSS COEFFICIENTS, K, ARE ESSENTIALLY EQUAL, THE PRESSURE DROP FOR PERRY UNDER THE SAME TEST CONDITIONS AND RELATIVE SENSOR LOCATION CAN BE ESTIMATED AND SHOWN TO BE WITHIN 3 PSID OF THE KUOSHENG VALUE.

BASED ON THIS SMALL INCREASE IN PRESSURE DROP IT IS OBVIOUS THAT THE PERRY DISCHARGE LINE LENGTH IS ACCEPTABLE.

FROM THE ABOVE DISCUSSION, THE LONGEST SRV DISCHARGE LINE AT PERRY WILL PRODUCE LOWER THAN PREDICTED POOL PRESSURES WHILE ENSURING THAT THE SRV FLOW REMAINS CHOKED AND THE LINE PRESSURES WELL BELOW THE ALLOWABLE.

THE ONLY DIFFERENCE OF ANY SIGNIFICANCE BETWEEN THE PERRY SRV DISCHARGE LINES AND THOSE AT KUOSHENG AND GRAND GULF IS THE SIZE OF THE VACUUM BREAKERS. THE INFLUENCE OF THE VACUUM BREAKERS IS ONLY IMPORTANT IN THE DEFINITION OF THE HYDRODYNAMIC LOADS FOR A CONSECUTIVE VALVE ACTUATION (CVA). THE TEST RESULTS FOR THE KUOSHENG CVA CASES SHOWED THAT THE MEASURED CVA PRESSURES WERE SUBSTANTIALLY LESS THAN THE PREDICTED/DESIGN VALUES.

IN ADDITION TO THIS, THE GE CRITERIA PROVIDED IN APPENDIX 3B OF THE PERRY FSAR WERE DEVELOPED FROM THE CAORSO TESTS WITH VARIABLE AREA VACUUM BREAKERS. THESE CRITERIA REQUIRE THAT A MINIMUM $A/\sqrt{K}$ OF 0.3 SQ. FT. MUST BE SUPPLIED FOR THE VACUUM BREAKERS. THE TWO SIX INCH DIAMETER VACUUM BREAKERS SUPPLIED ON EACH OF THE PERRY SRV DISCHARGE LINES HAVE AN $A/\sqrt{K}$ OF 0.31 SQ. FT. AND ALSO MEET THE OTHER FOUR GE SPECIFIED CRITERIA OF APPENDIX 3B. THEREFORE, ALTHOUGH THE VACUUM BREAKERS ARE DIFFERENT FROM THOSE TESTED AT KUOSHENG AND GRAND GULF, THE DIFFERENCES WILL NOT HAVE ANY SIGNIFICANT EFFECT ON CVA SUPPRESSION POOL PRESSURES.

THE KUOSHENG TEST DATA INDICATED THAT THE SRV DISCHARGE LINE PRESSURE STABILIZED BELOW NORMAL WATER LEVEL WITHIN 3 TO 4 SECONDS FOLLOWING SRV CLOSURE. THE TIME INTERVAL IS DIRECTLY RELATED TO THE VACUUM BREAKER FLOW CAPACITY AND THE SRV DISCHARGE LINE AIR VOLUME, I.E.,

$$t\ (\text{SEC.}) = \frac{\text{SRVDL AIR VOLUME (CU.FT.)}}{\dfrac{\text{VACUUM BREAKER CAPACITY (scfm)}}{60}}$$

RATIOING THE RELEVANT LINE AIR VOLUME AND VACUUM BREAKER CAPACITY PARAMETERS FROM KUOSHENG TO PERRY GIVES THE FOLLOWING TIME TO STABILIZE THE WATER LEVEL IN THE SRV DISCHARGE LINE AT PERRY, TAKING INTO ACCOUNT THE LARGEST AIR VOLUME AND SMALLER VACUUM BREAKERS: 8.8 SECONDS.

THIS VALUE IS SIGNIFICANTLY LESS THAN THE MINIMUM CALCULATED TIME OF 45 SECONDS FOR A CONSECUTIVE VALVE ACTUATION TO OCCUR. THUS, THERE IS AMPLE TIME FOR THE WATER LEG TO STABILIZE AND PREVENT AN SRV ACTUATION WITH ELEVATED WATER LEVEL IN THE SRV DISCHARGE LINE.

2.3 CRITERION 3 STATES:

"THE FLOW RATE OF THE STEAM PER UNIT AREA OF DISCHARGE LINE AND THE NET FLOW RATE OF THE STEAM THROUGH THE LINE MAY DETERMINE THE AIR-COLUMN COMPRESSION DYNAMICS AND POOL TEMPERATURE GRADIENTS DURING AN EXTENDED ACTUATION. IF EITHER OF THESE DIFFERS SIGNIFICANTLY FROM CONDITIONS PREVIOUSLY TESTED, NEW IN-PLANT TESTS SHALL NORMALLY BE REQUIRED."

DISCUSSION:

THE DESIGN STEAM FLOW RATES, AND THE STEAM PER UNIT AREA, ARE THE SAME FOR KUOSHENG, GRAND GULF, AND PERRY. THE EXTENDED VALVE ACTUATION TESTS PERFORMED AT KUOSHENG CONCLUSIVELY DEMONSTRATED THAT THE X-QUENCHER PERFORMS IN A SATISFACTORY MANNER AND MEETS ITS DESIGN CRITERIA. SINCE THE PERRY QUENCHERS ARE SIMILAR TO THOSE AT KUOSHENG, THE EXTENDED ACTUATION BEHAVIOR OF THE PERRY SUPPRESSION POOL WILL BE SIMILAR TO THAT DOCUMENTED FOR KUOSHENG, AND THERE IS NO NEED TO PERFORM AN EXTENDED VALVE ACTUATION TEST. THIS HAS BEEN DOCUMENTED FOR GRAND GULF BY THE NRC STAFF IN APPENDIX C TO SUPPLEMENT NO. 1 OF THE GRAND GULF SAFETY EVALUATION REPORT (NUREG-0831), DATED DECEMBER 1981. HERE IT IS STATED THAT THE GENERIC MARK III ISSUES RESOLVED BY THE PROTOTYPE (KUOSHENG) TESTING WERE THE POOL THERMAL MIXING AND X-QUENCHER CONDENSATION PERFORMANCE.

2.4 CRITERION 4 STATES THAT:

"QUENCHER LOCATION AND ORIENTATION IN THE POOL AND THE POOL GEOMETRY MAY AFFECT PEAK BOUNDARY PRESSURES AND FREQUENCIES OF AIR-BUBBLE OSCILLATION. THERMAL MIXING IN THE POOL IS ALSO EXPECTED TO BE AFFECTED BY THESE VARIABLES. NO QUANTITATIVE CRITERIA CAN BE FORMULATED FOR DETERMINING WHEN QUENCHER/POOL CONFIGURATION CHANGES MAY BE SUFFICIENT TO REQUIRE NEW IN-PLANT TESTS. AS THE RANGE OF PLANT AND POOL GEOMETRIES THAT HAVE BEEN TESTED INCREASES, THE NEED FOR TESTING ALL NEW POOL CONFIGURATIONS MAY DISAPPEAR. PRESENT POLICY SHALL BE TO REQUIRE IN-PLANT TESTING IF IT CANNOT BE SHOWN THAT ALL FEATURES OF THE POOL CONFIGURATION ARE SIMILAR TO THOSE PREVIOUSLY TESTED IN A PLANT."

DISCUSSION

THE QUENCHER LOCATIONS FOR KUOSHENG, GRAND GULF, AND PERRY ARE ALL SIMILAR. ALL PLANTS UTILIZE QUENCHERS WITH 80°-80°-80°-120° ARM ANGLES WITH THE VERTICAL HUB CENTER LINES 5 FEET FROM THE DRYWELL WALL.

THERE IS AN INSIGNIFICANT VARIATION IN THE DISTANCE FROM THE HORIZONTAL ARM CENTERLINE TO THE POOL FLOOR OF FROM 4.5 FT. TO 5.5 FT. POOL WIDTHS VARY FROM 17.5 FEET AT KUOSHENG TO 20.5 FEET AT GRAND GULF. THE POOL WIDTH AT PERRY IS 18.5 FEET. THE GRAND GULF TESTS WILL DEMONSTRATE WHETHER POOL WIDTH CAUSES A SIGNIFICANT DIFFERENCE ON AIR-BUBBLE FREQUENCIES FROM THOSE SEEN AT KUOSHENG. THE SUBMERGENCE DEPTH FOR ALL THREE PLANTS IS SIMILAR WITH AN INSIGNIFICANT VARIATION FROM 13.8 to 14.0 FEET.

THE MAIN DIFFERENCE IN THE QUENCHER DESIGNS IS THE METHOD OF SUPPORT. KUOSHENG USES DOUBLE BOX BEAM SUPPORTS CANTILEVERED FROM THE DRYWELL WALL; GRAND GULF HAS A HORIZONTAL CANTILEVER WELDED FROM THE DRYWELL WALL TO A VERTICAL PEDESTAL UNDER THE QUENCHER AND DIAGONAL STRUTS FROM THE DRYWELL WALL TO THE SRV DISCHARGE LINE.

THE PERRY QUENCHER, AS SHOWN IN FIGURE 1, IS SUPPORTED DIRECTLY TO BASE MAT EMBEDMENTS WITH DIAGONAL STRUTS FROM THE DRYWELL WALL TO THE SRV DISCHARGE LINE. THE KUOSHENG SUPPORT MAY TEND TO CONFINE THE DISCHARGING BUBBLE AND INTRODUCE MINOR VARIATIONS INTO THE AIR-BUBBLE PRESSURE AND FREQUENCY. THE GRAND GULF AND PERRY SUPPORTS ARE SIMILAR AND WOULD BE EXPECTED TO HAVE AN INSIGNIFICANT INFLUENCE ON THE FREQUENCY OR PRESSURE AMPLITUDE OF THE DISCHARGING BUBBLES. THEREFORE, RESULTS OF THE GRAND GULF TEST SHOULD BE DIRECTLY APPLICABLE TO PERRY.

THE HORIZONTAL QUENCHER SUPPORT FOR PERRY IS STAINLESS STEEL AND IT IS WELDED TO THE STAINLESS STEEL DISCHARGE LINE PIPE. FINITE ELEMENT ANALYSIS IS BEING PERFORMED TO QUALIFY THE LOCAL STRESSES DUE TO EXTERNAL LOADS, INCLUDING THOSE CAUSED BY THERMAL EXPANSION OF THE PIPING.

IN ADDITION, THERMAL GRADIENT STRESSES IN THE WELDED ATTACHMENT ARE MINIMIZED BY:

a) ENSURING THAT ATTACHMENT MATERIALS HAVE THE SAME THERMAL CHARACTERISTICS AS THE PIPING TO WHICH THEY ATTACH.

b) CONSIDERATIONS OF THE GEOMETRY OF THE ATTACHMENT TO THE PIPING INCLUDING THE FOLLOWING:

1) THICKNESS OF THE PLATE.

2) DIMENSIONS OF THE PLATE.

3) PIPE TO ATTACHMENT PLATE WELD SIZE.

2.5 CRITERION 5 STATES:

"THE CHARACTERISTICS OF THE CONTAINMENT STRUCTURE MAY AFFECT PEAK BOUNDARY PRESSURE AND FREQUENCIES OF AIR-BUBBLE OSCILLATION. FOR EXAMPLE, IN-PLANT TESTS CONDUCTED IN A CONCRETE CONTAINMENT WILL NOT BE CONSIDERED TO HAVE DIRECT APPLICATION FOR A FREE-STANDING STEEL CONTAINMENT UNLESS ADEQUATE JUSTIFICATION FOR FLUID/STRUCTURE INTERACTION HAS BEEN DEMONSTRATED. OTHERWISE, IN-PLANT TESTS WILL BE REQUIRED FOR PLANTS WHOSE STRUCTURAL CHARACTERISTICS ARE SIGNIFICANTLY DIFFERENT FROM PREVIOUS TESTS."

DISCUSSION

IN THE REGION OF THE SUPPRESSION POOL, THERE IS NO DIFFERENCE IN STRUCTURAL CHARACTERISTICS BETWEEN PERRY, KUOSHENG, AND GRAND GULF IN THAT IN THIS REGION THEY ARE ALL STEEL LINED CONCRETE CONTAINMENTS. THE THICKNESS OF PERRY'S STEEL VESSEL IS 1-1/2 INCHES WHILE THE STEEL LINER AT KUOSHENG AND GRAND GULF IS APPROXIMATELY 1/4 INCH THICK.

THE TOTAL THICKNESS OF THE CONTAINMENT IN THE POOL REGION VARIES FROM 3.5 FEET AT GRAND GULF TO 8.5 FEET AT KUOSHENG. THE THICKNESS AT PERRY IS 8.0 FEET.

THE DRYWELL WALLS FOR ALL THREE PLANTS ARE AN IDENTICAL 5.0 FEET THICK, WHILE THE BASEMATS VARY FROM 9.5 FEET AT GRAND GULF TO 12.5 FEET AT PERRY.

THE PERRY POOL DIMENSIONS LIE BETWEEN THOSE FOR KUOSHENG AND GRAND GULF; AND, BECAUSE OF THE SIMILARITIES IN THE CONTAINMENT STRUCTURES IN THE VICINITY OF THE SUPPRESSION POOL, FLUID/STRUCTURE EFFECTS ON PEAK BOUNDARY PRESSURE AND FREQUENCY OF AIR BUBBLE OSCILLATION WOULD BE NO DIFFERENT THAN THOSE DEFINED BY THE KUOSHENG TEST.

THE COMPUTER CODE USED TO ANALYZE THE EFFECTS OF SRV LOADS FOR PERRY, GRAND GULF AND KUOSHENG IS THE GHOSH-WILSON AXISYMMETRICAL SHELL OF REVOLUTION PROGRAM ASHSD.

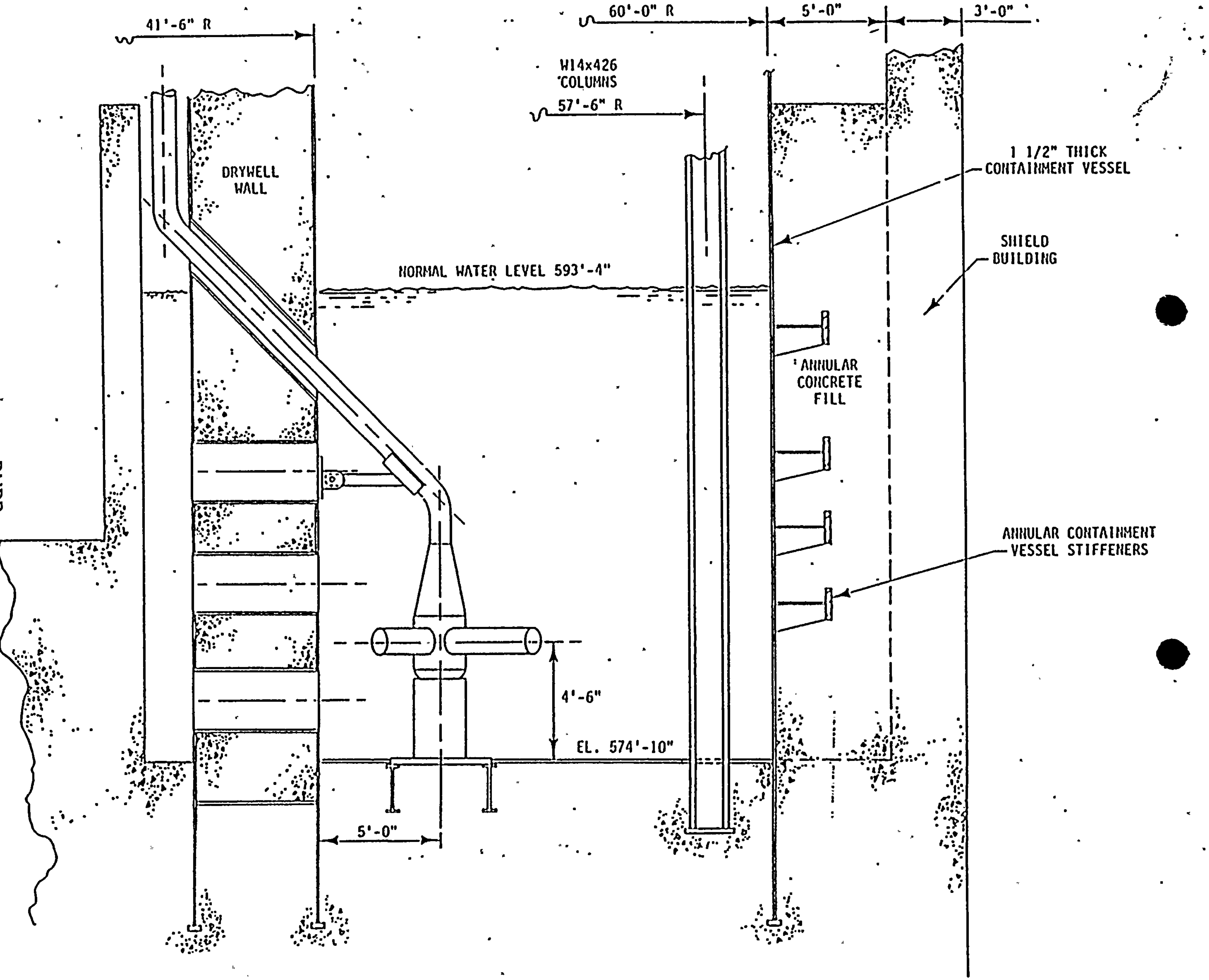
THE RESPONSE OF THE CONTAINMENT AND INTERNAL STRUCTURES TO THE SRV LOADS IS DETERMINED THROUGH THE DURATION OF THE EVENT BY THE DIRECT INTEGRATION SOLUTION TECHNIQUE IN ASHSD. THE RESULTS OF THIS ANALYSIS ARE DISPLACEMENT, STRESS AND ACCELERATION TIME HISTORIES AT EACH NODE POINT THROUGHOUT THE STRUCTURE. SOIL STRUCTURE INTERACTION EFFECTS ARE ACCOUNTED FOR IN THE ASHSD MODEL, AND THE ANALYTICAL RESULTS SHOW NO SIGNIFICANT CARRY OVER OF RESPONSE TO THE ADJACENT STRUCTURES. THIS HAS BEEN SHOWN TO BE CORRECT BY THE MEASURED ACCELEROMETER RESULTS FOR ADJACENT STRUCTURES DURING THE KUOSHENG TESTS.

THE PERRY ANALYSIS FOR THE SRV LOADS WAS PERFORMED USING TWO MODELS. THE FIRST MODEL CONSISTED OF A STRUCTURAL MODEL OF THE COMPLETE REACTOR BUILDING AND SURROUNDING SOIL. A SECOND MODEL CONSISTING OF THE CONTAINMENT, ANNULAR FILL AND SHIELD BUILDING, WAS USED FOR THE DETAILED ANALYSIS OF THE ANNULAR STRUCTURAL CONCRETE AND ITS EFFECTS. RESULTS FROM THESE TWO MODELS WERE USED IN THE DESIGN OF THE REACTOR BUILDING STRUCTURES, PIPING AND EQUIPMENT.

3.0 CONCLUSION

IN CONCLUSION, A REVIEW OF THE PRECEDING PRESENTATION DEMONSTRATES THAT THE IMPORTANT PARAMETERS OF THE PERRY PLANT SATISFY THE CRITERIA OF SECTION 4 OF NUREG-0763. THE DISCHARGE DEVICE IS GEOMETRICALLY SIMILAR, THE DISCHARGE LINE PARAMETERS ARE SIMILAR. THE STEAM FLOW RATES ARE IDENTICAL, THE QUENCHER LOCATIONS AND ORIENTATION ARE SIMILAR, AND FINALLY THE CONTAINMENT STRUCTURES ARE SIMILAR IN THE POOL REGION. THIS MEANS THAT THE TEST DATA GENERATED FROM THE KUOSHENG TESTS AND THAT EXPECTED FROM GRAND GULF <u>WILL</u> BE SUFFICIENT TO ESTABLISH THE CONSERVATIVE NATURE OF THE SRV HYDRODYNAMIC LOADS. THE EXISTING SRV HYDRODYNAMIC LOAD TEST DATA BASE IS SUFFICIENT TO ESTABLISH THAT THE GESSAR APPENDIX 3B LOAD METHODOLOGY HAS BEEN EFFECTIVELY DEVELOPED FOR THE AIR-BUBBLE PRESSURE AND FREQUENCY TIME HISTORIES. ADDITIONAL TESTING AT PERRY WOULD SERVE NO USEFUL PURPOSE IN EXTENDING THE LIMITS OF THIS DATA BASE SINCE THE IMPORTANT PERRY DESIGN PARAMETERS ARE SIMILAR TO THOSE FOR KUOSHENG AND GRAND GULF. THEREFORE, THE DATA FROM THE KUOSHENG AND GRAND GULF TESTS WILL PROVIDE THE PROTOTYPICAL DATA BASE REQUIRED TO SATISFY THE PERRY COMMITMENT TO CONFIRM THE SRV HYDRODYNAMIC LOADS USED IN THE DESIGN OF THE PLANT AND NO IN-PLANT TEST SHOULD BE REQUIRED AT PERRY.

10/H/11/kf



PNPP
Figure 1
SUPPRESSION POOL GEOMETRY

In the region of the suppression pool, there is virtually no difference in the horizontal structural characteristics of Perry, Kuosheng, and Grand Gulf in that, in this region, they are all steel lined concrete containments. The three plants are also similar in their vertical structural characteristics regarding fluid structure interaction, but similarity of vertical structural response is not anticipated.

The safety relief valve discharge phenomenon involves the thermodynamics of the steam-water interface, fluid dynamics of the water, fluid structure interaction at the water containment structure interface and structural dynamics of the containment structure. Because of the complexity of the overall phenomenon, the design pressures applied on the containment structure were based on small scale model tests, and then were conservatively adjusted by GE using full scale test results. The basis of all safety relief valve loading is the idealized pressure time history of GESSAR II Appendix 3B. The structural dynamic responses are calculated using this design pressure as input to an axisymmetrical finite element model using shell analysis. The computer code used to analyze the effects of the SRV loads for Perry, Grand Gulf, and Kuosheng is the Ghosh-Wilson axisymmetrical shell of revolution program ASHSD. The response of the containment and internal structures to the SRV loads is determined through the duration of the event by the direct integration solution technique in ASHSD. The results of this analysis are displacement, stress and acceleration time histories at each node point throughout the structure. Soil structure interaction effects are accounted for in the ASHSD model, and the analytical results also show no significant carry over of response to the adjacent structures.

SRV tests have been performed for a Mark II Concrete Containment (Caorso), a Mark II Steel Containment (Tokai No. 2), and a Mark III Concrete Containment (Kuosheng). They all have led to the following conclusions:

1. Recorded pressures at the water-containment interface are generally bounded by the GE design valves.

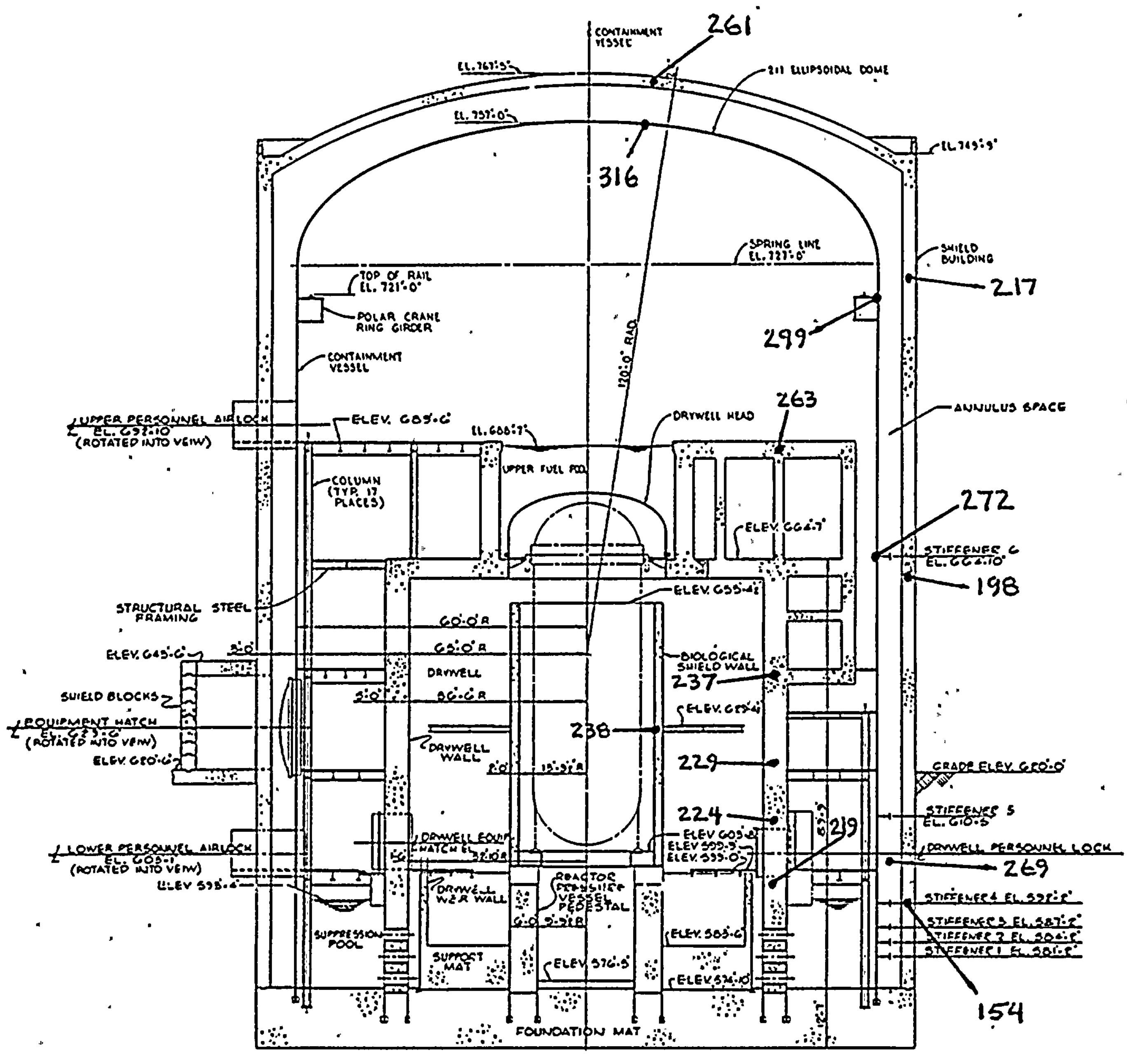
2. Recorded structural dynamic responses are much lower than calculated structural dynamic responses. There are, however, some exceedances in certain areas in the higher frequency range.

Using Kuosheng test data as input to Perry's containment models, these conclusions have been effectively demonstrated. Test data selected for input was based on the highest pressure recorded during any of the single valve tests.

Figure 3.8-1 indicated the location of node points used in this analysis.

Response spectra, 1, 2 and 3 plot Perry predicted response in the pool region using Kuosheng measured pressure time history and compare these curves with Kuosheng measured acceleration. Selection of node points was based on locations which approximate accelerometer locations at Kuosheng. The intent of these curves is to show that the Perry models conservatively predict Kuosheng's response, since in the pool region Perry and Kuosheng containments are structurally similar in the radial direction. Therefore, any fluid structure interaction which could have affected peak boundary pressure and frequency of air-bubble oscillation are taken into account. Slight high frequency exceedances will be addressed by the program discussed in the cover letter. This program will be explained in detail at the CEI/NRC meeting on November 22, 1982.

Response spectra 4 through 22 plot Perry SRV design response spectra throughout the drywell and containment, and compare these curves with Perry predicted response spectra curves using Kuosheng test data as the forcing function in the Perry containment models. The Perry predicted response spectra using the Kuosheng pressure time history have been factored by 1.4 as previously discussed in our response to CSB question number 4 (see Attachment 3). The intent of these curves is to show that significant conservatism exists between the Perry design based on the GE methodology and the predicted Perry response based on measured data at Kuosheng. As previously discussed, our program has been developed for evaluation of high frequency exceedances and will be explained in detail in the November 22, 1982, meeting.



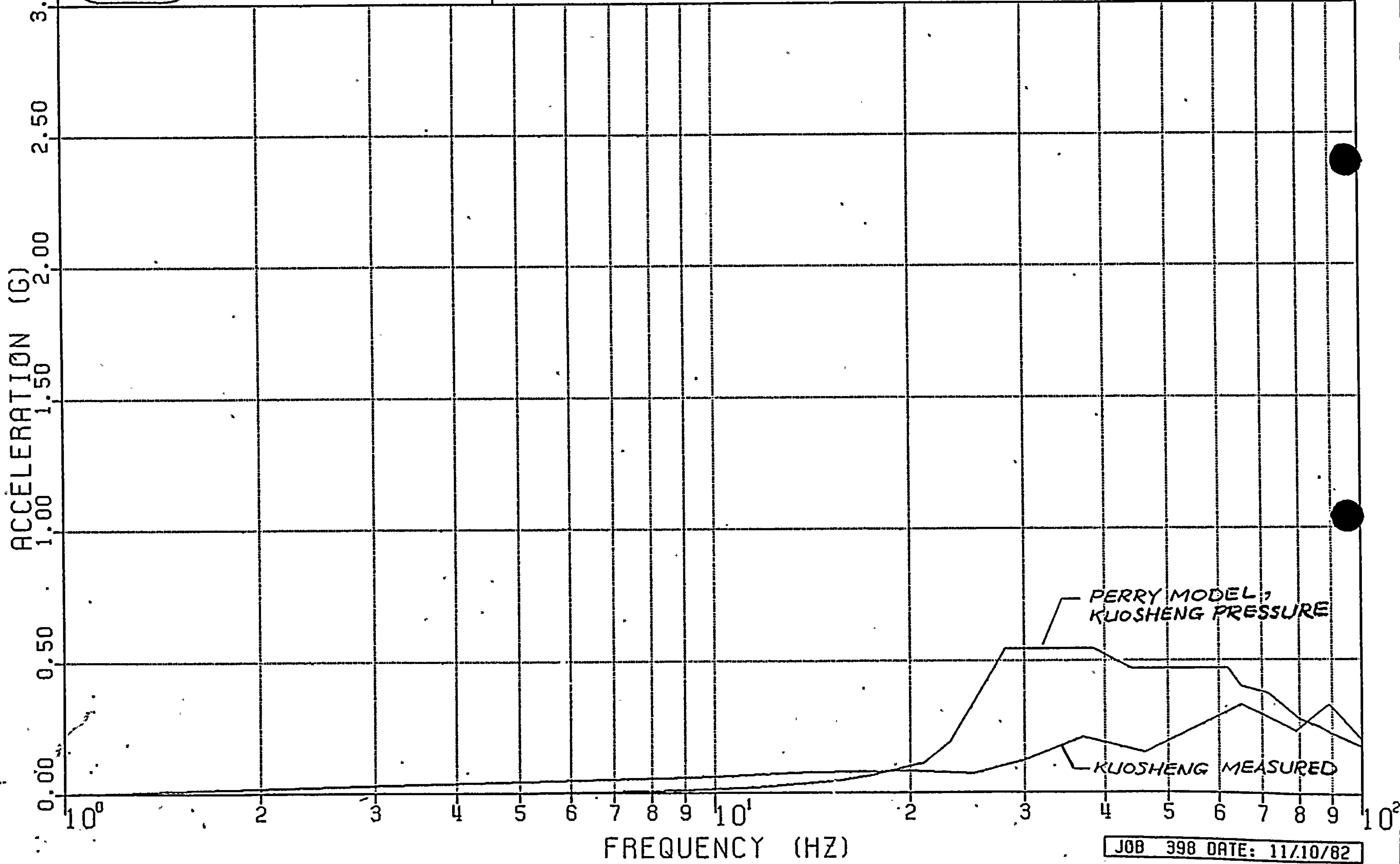
PERRY NUCLEAR POWER PLANT
THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

Typical Section of Reactor Building Complex

Figure 3.8-1

GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
NODE 219 VS ACCELEROMETER 46
RADIAL DIRECTION - 2% DAMPING



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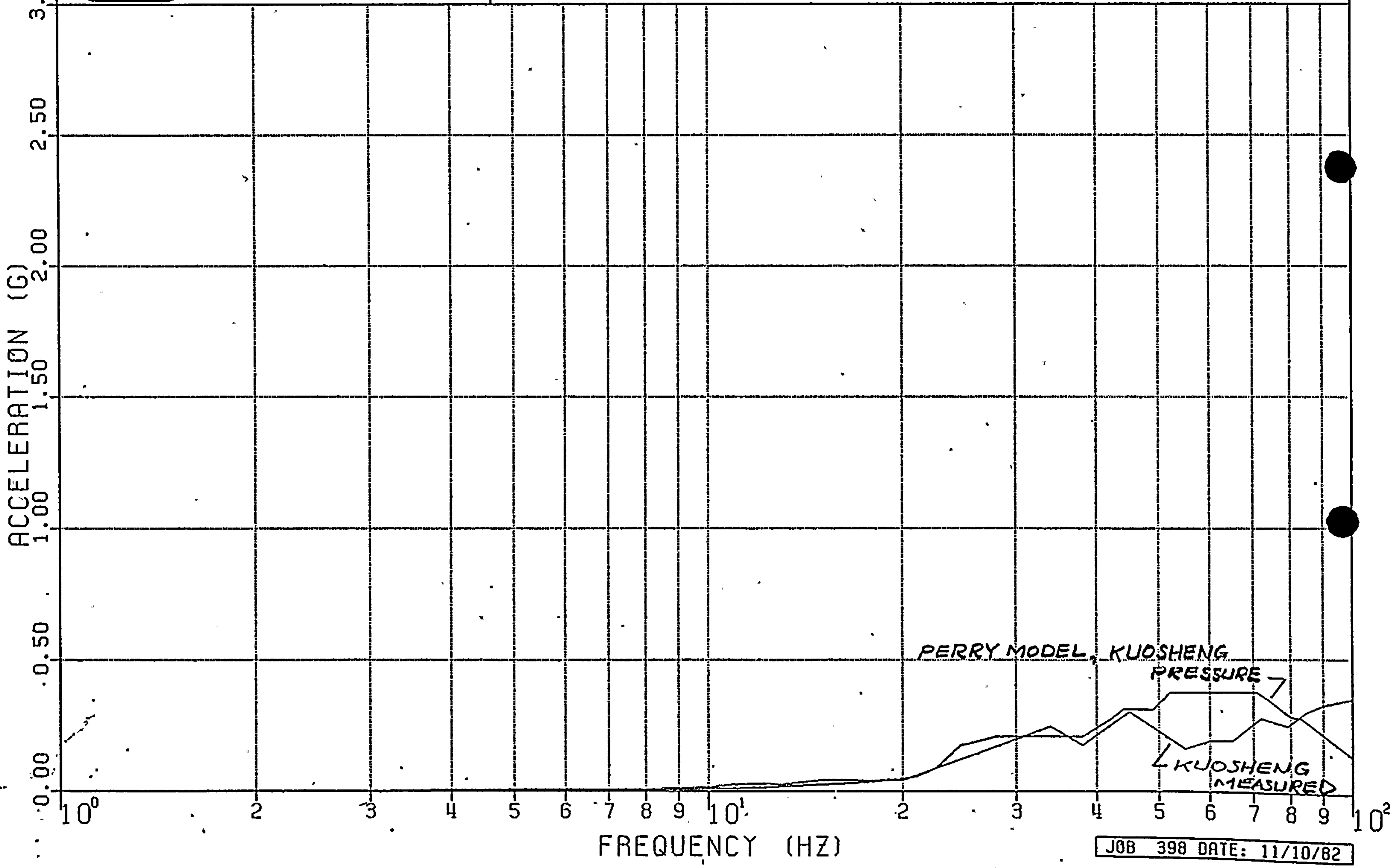
GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(E) (A126) BROAD BAND NODE 154
RADIAL DIRECTION - 2% DAMPING

2



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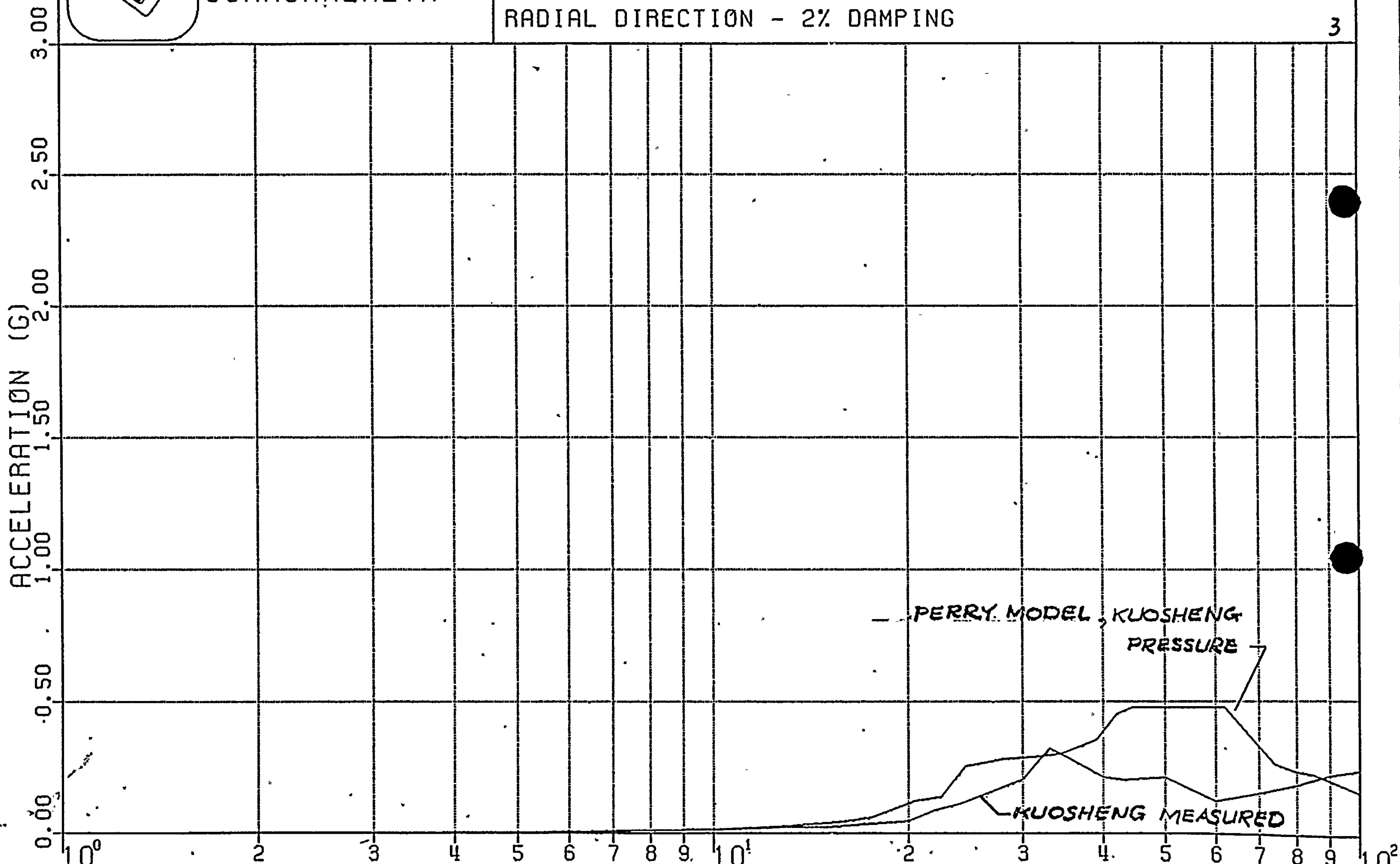
GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(E) (A128) BROAD BAND Node 269
RADIAL DIRECTION - 2% DAMPING

3



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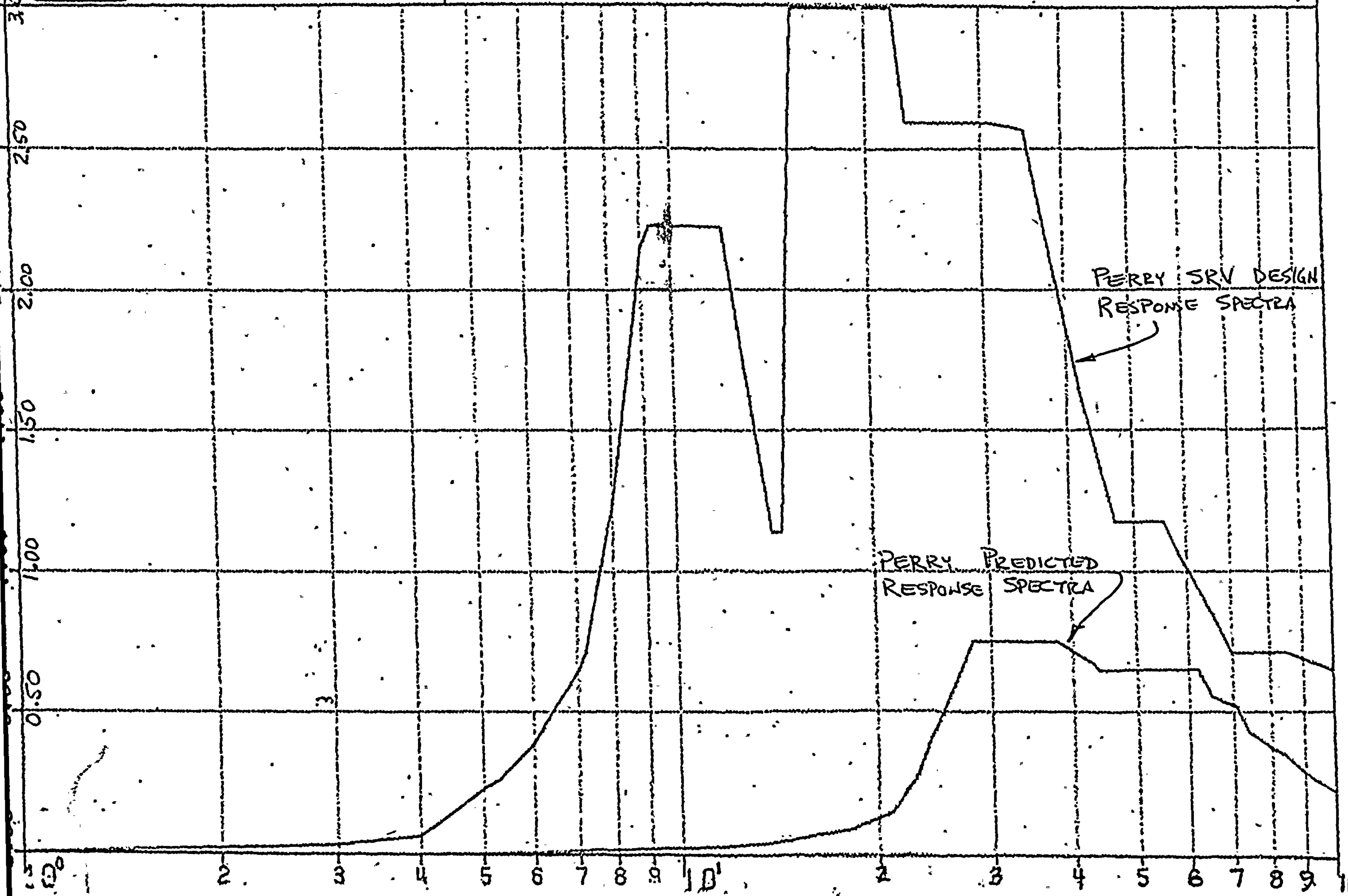
GILBERT / COMMONWEALTH

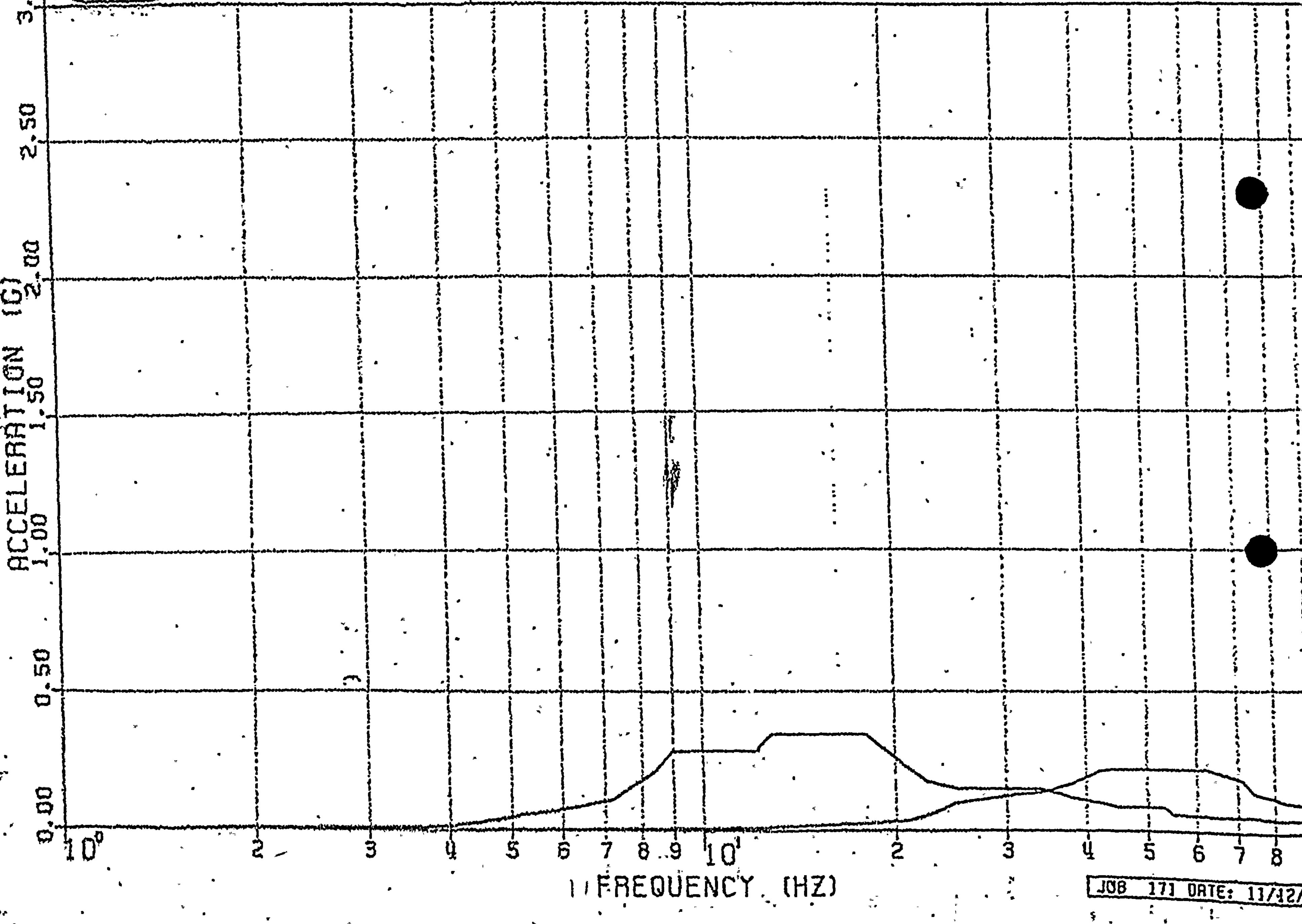
CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(C) (NODE 219)
RADIAL DIRECTION - 2% DAMPING



GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(C) (NODE 219)
VERTICAL DIRECTION - 2% DAMPING

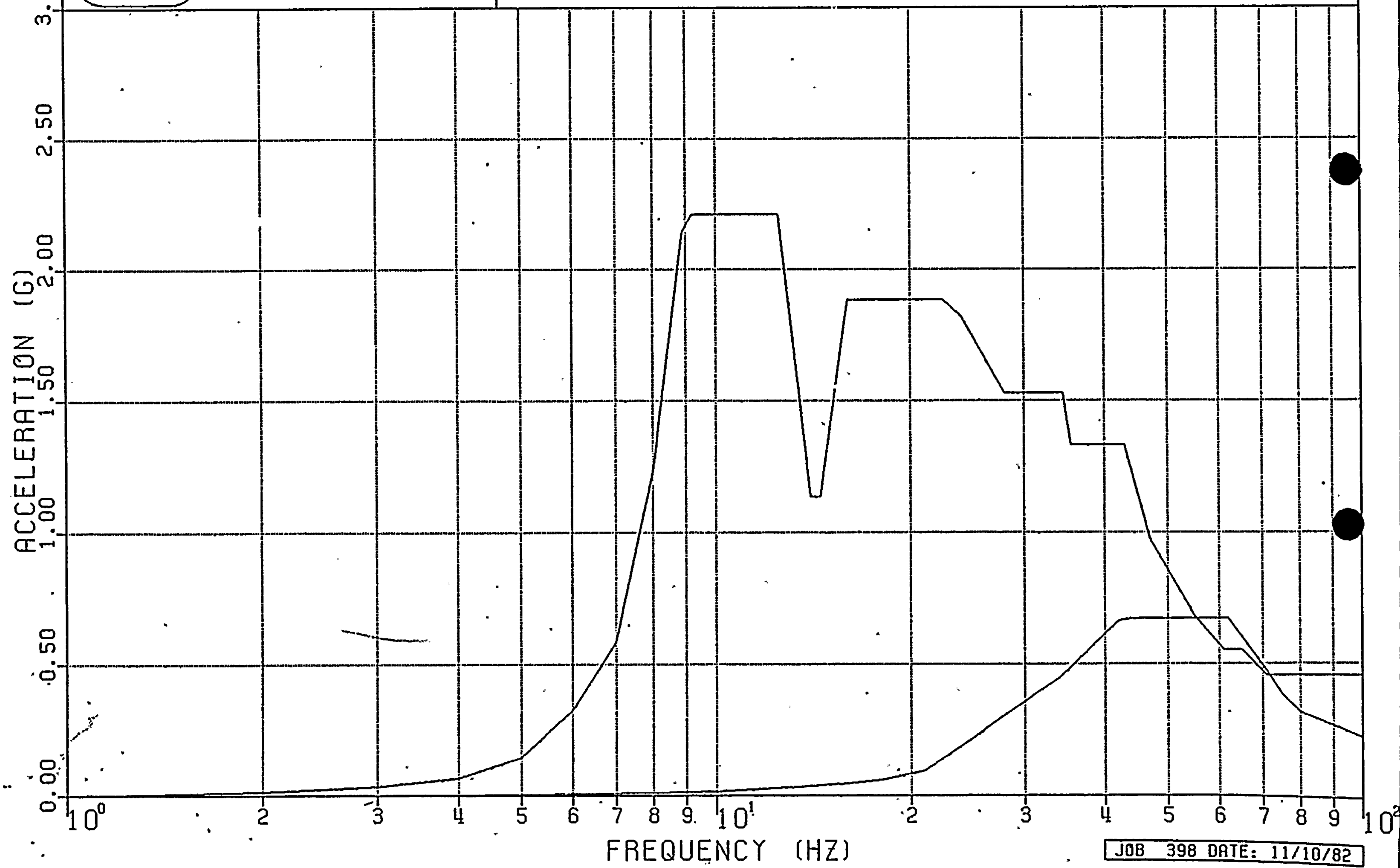
5



GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 224)
RADIAL DIRECTION - 2% DAMPING

6



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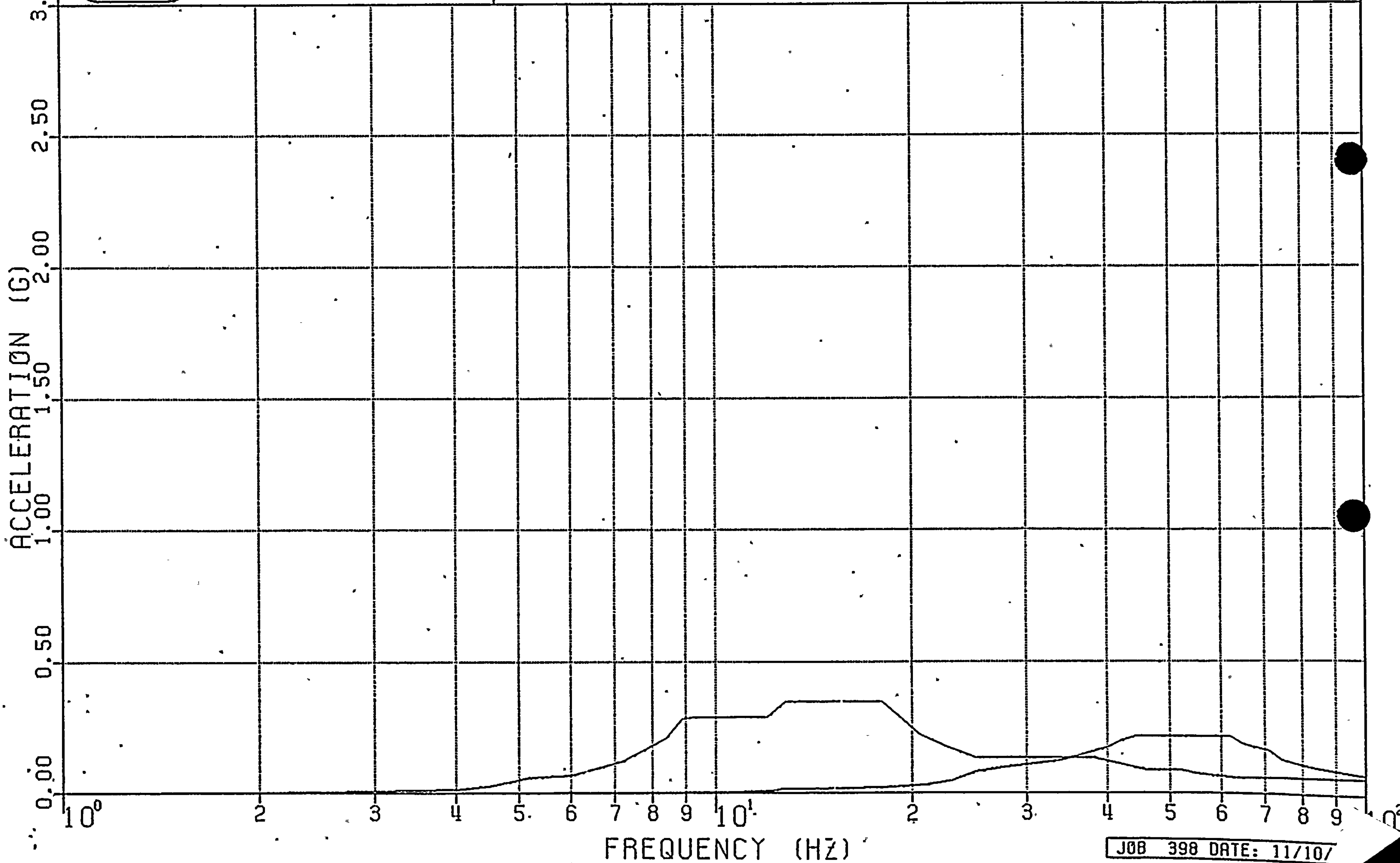
GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 224)
VERTICAL DIRECTION - 2% DAMPING

7

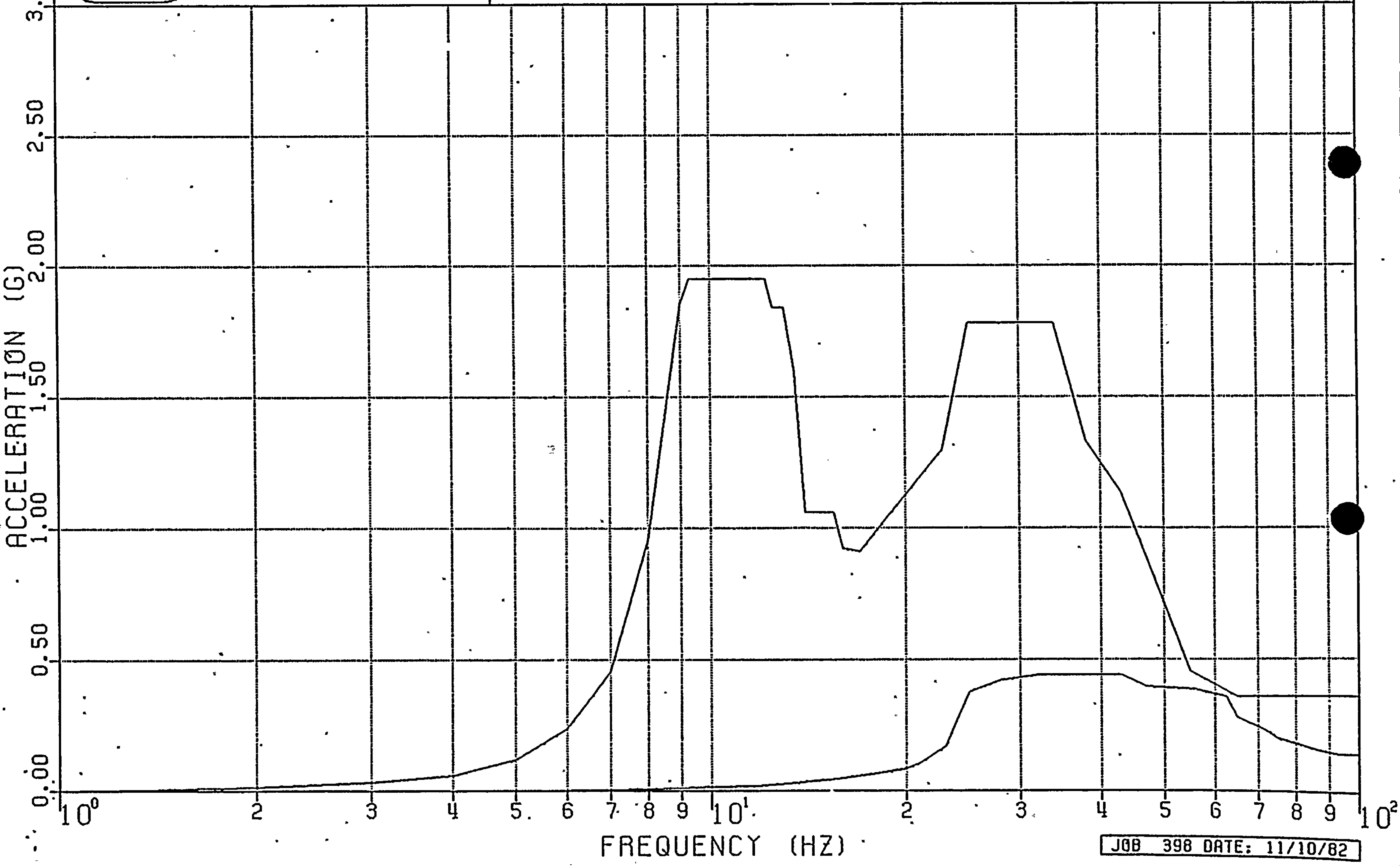


JOB 398 DATE: 11/10/

GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 229)
RADIAL DIRECTION - 2% DAMPING

8

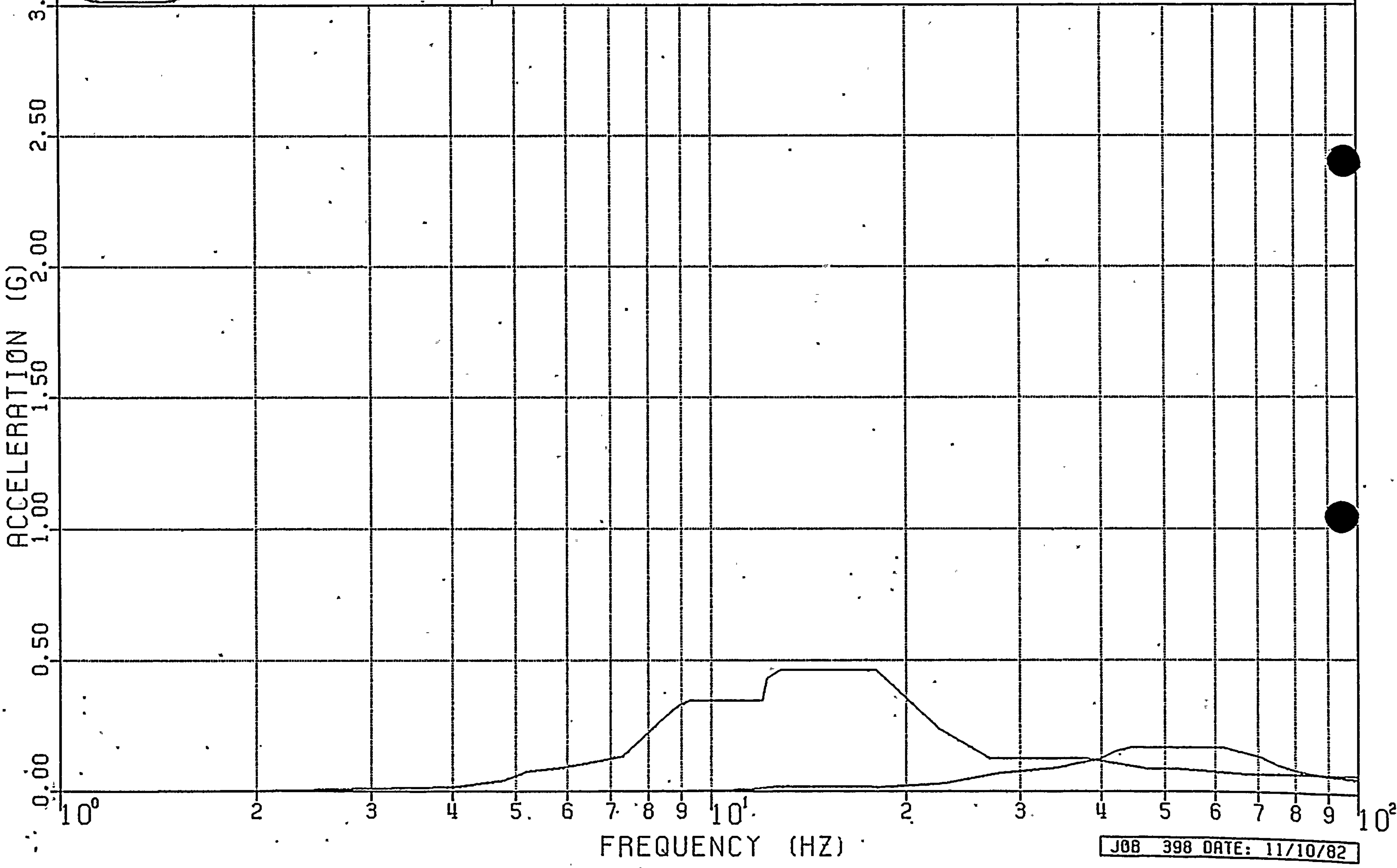


JOB 398 DATE: 11/10/82

GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 229)
VERTICAL DIRECTION - 2% DAMPING

9



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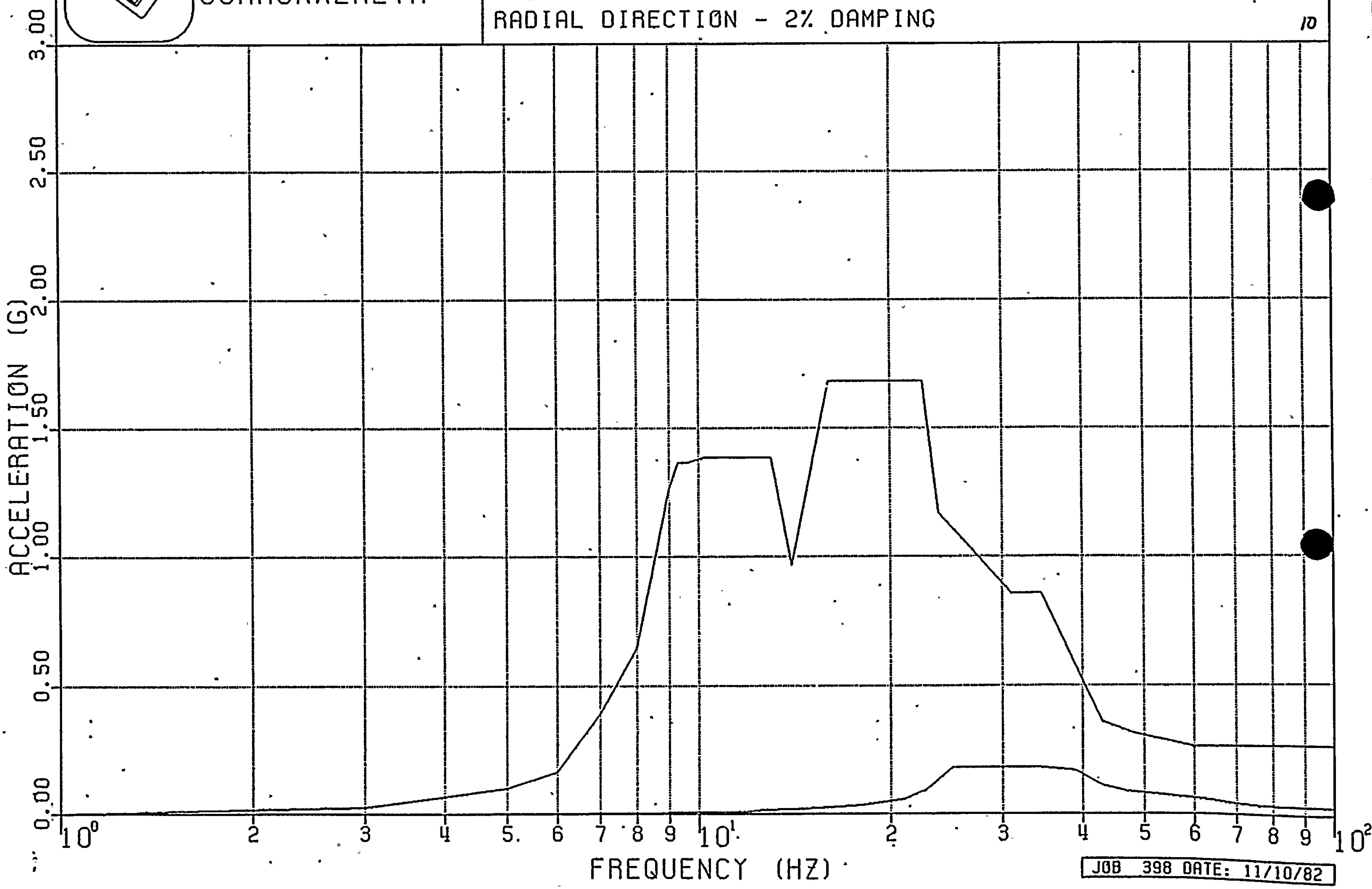
GILBERT / COMMONWEALTH

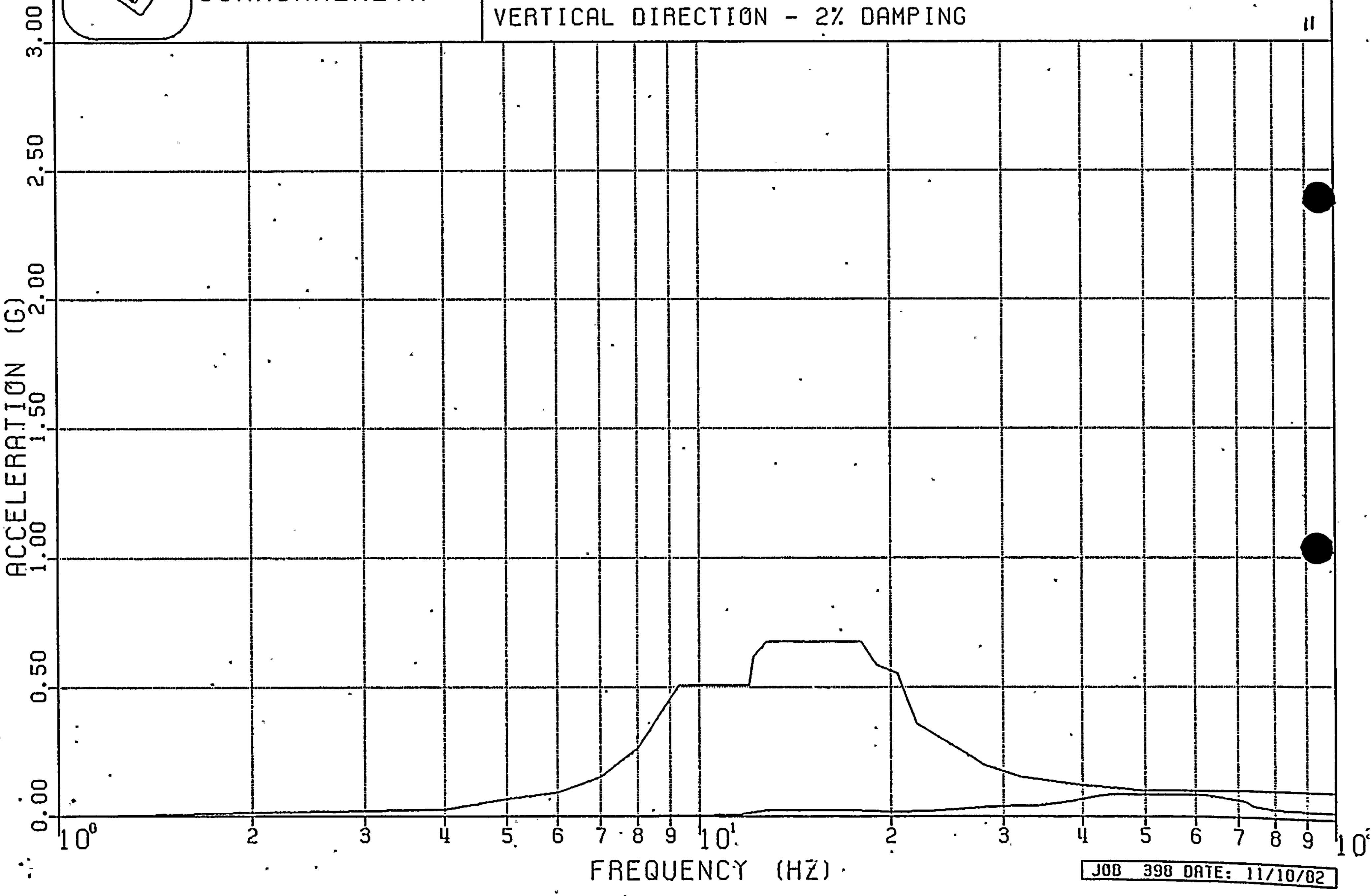
CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 237)
RADIAL DIRECTION - 2% DAMPING

10



GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 237)
VERTICAL DIRECTION - 2% DAMPING



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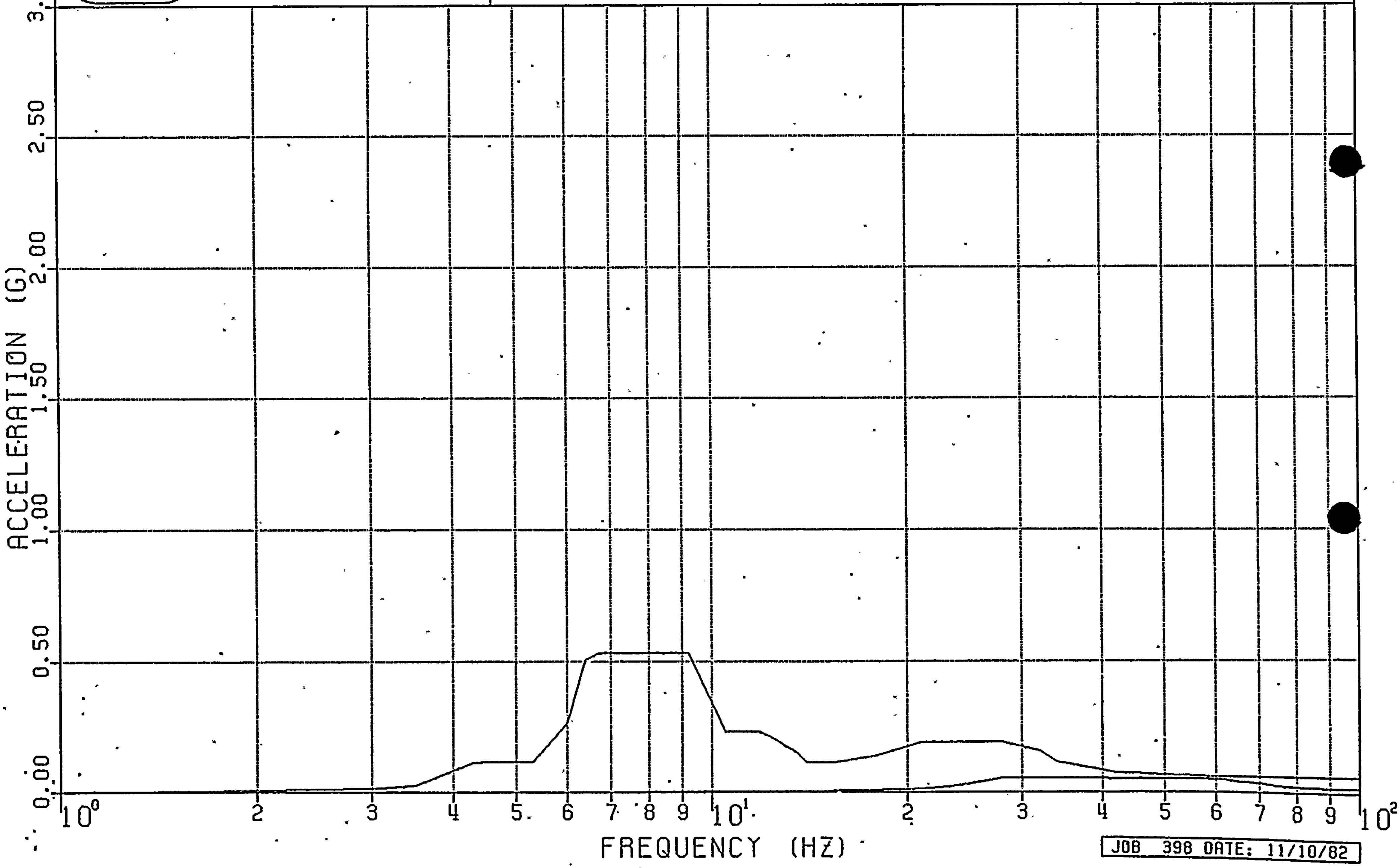
CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 238)
RADIAL DIRECTION - 2% DAMPING

12



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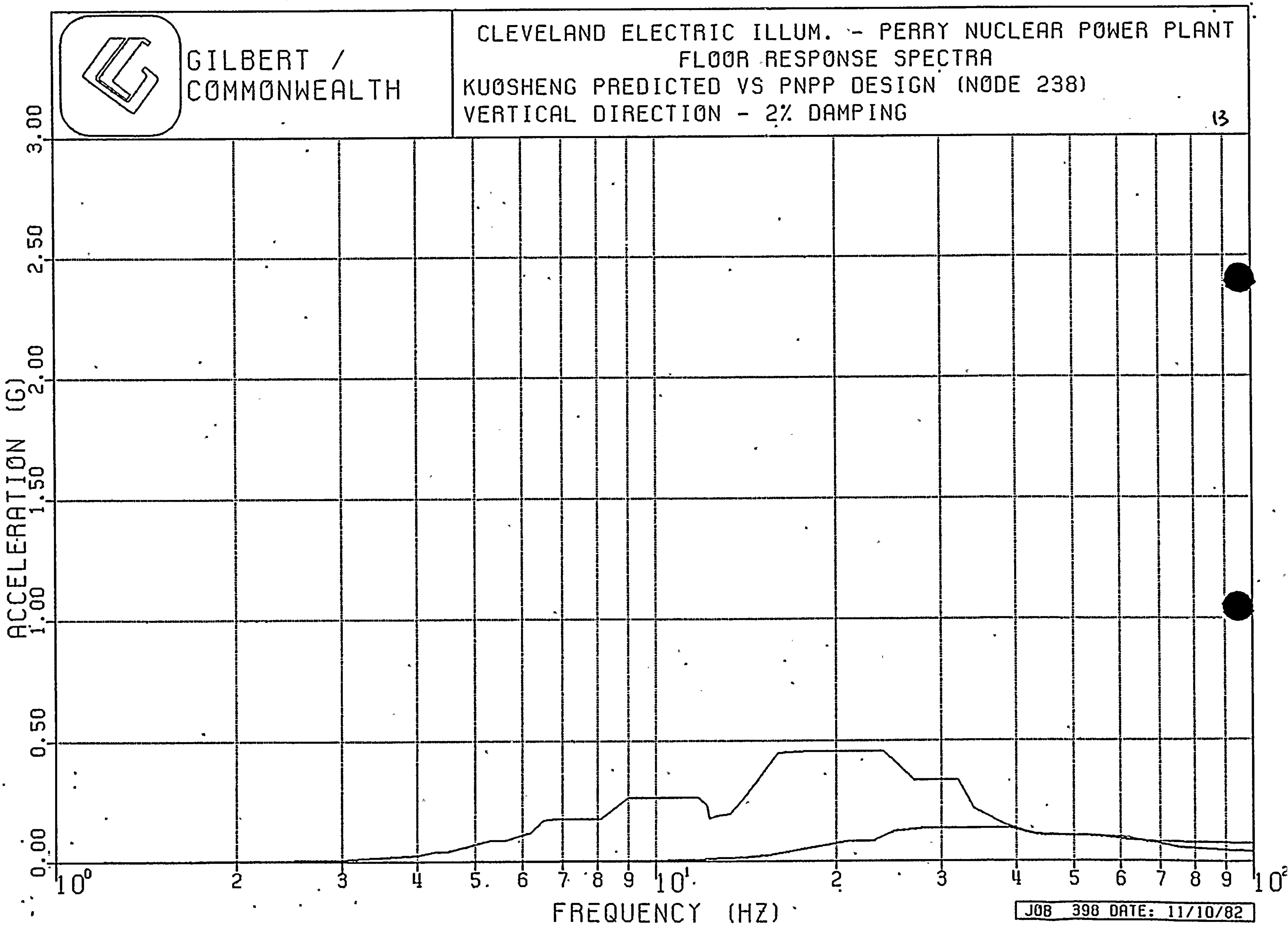
GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 238)
VERTICAL DIRECTION - 2% DAMPING
13
ACCELERATION (G)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
FREQUENCY (HZ)
10^0
2
3
4
5
6
7
8
9
10^1
2
3
4
5
6
7
8
9
10^2
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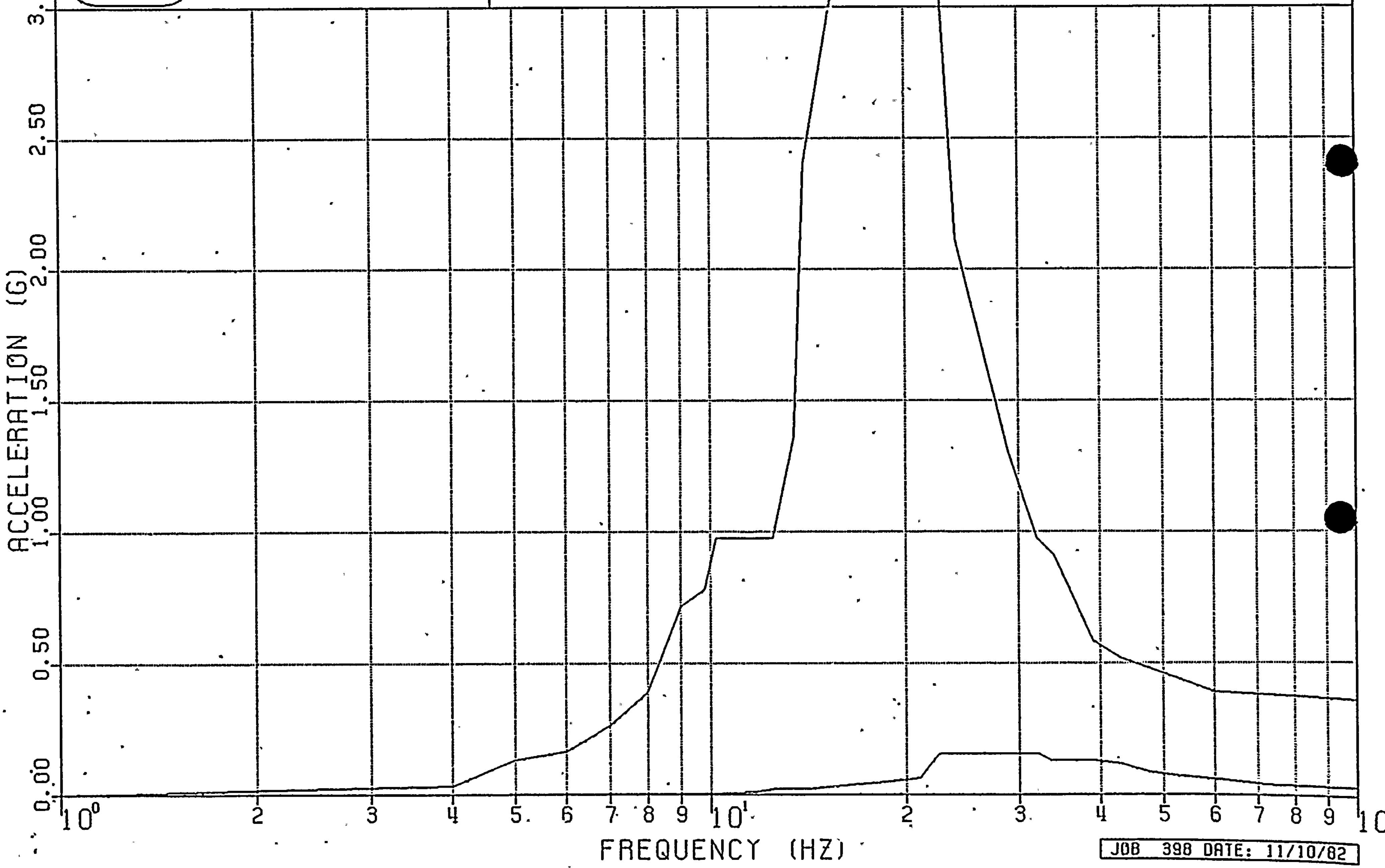
CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 263)
RADIAL DIRECTON - 2% DAMPING

14



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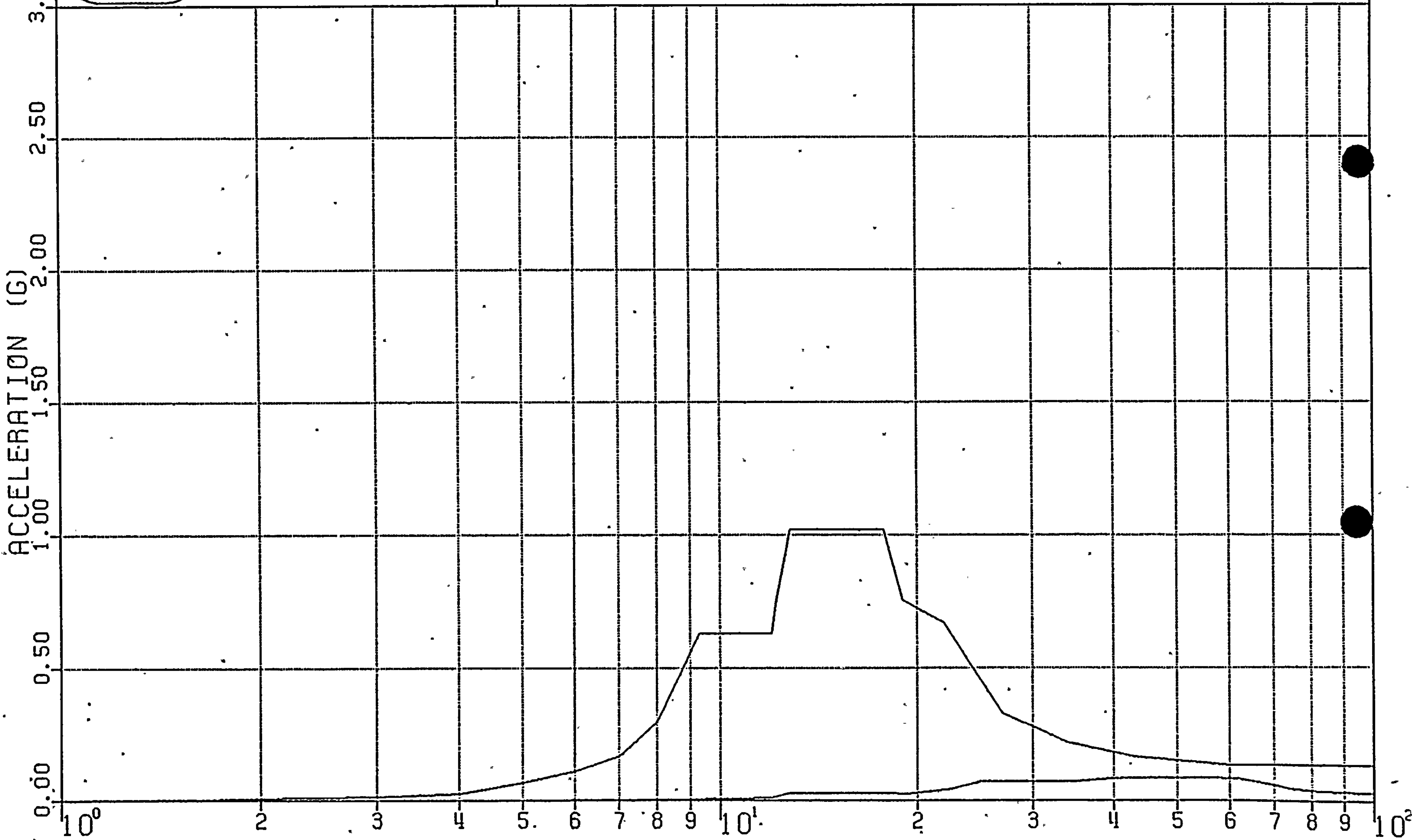
CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
KUOSHENG PREDICTED VS PNPP DESIGN (NODE 263)
VERTICAL DIRECTION - 2% DAMPING

15



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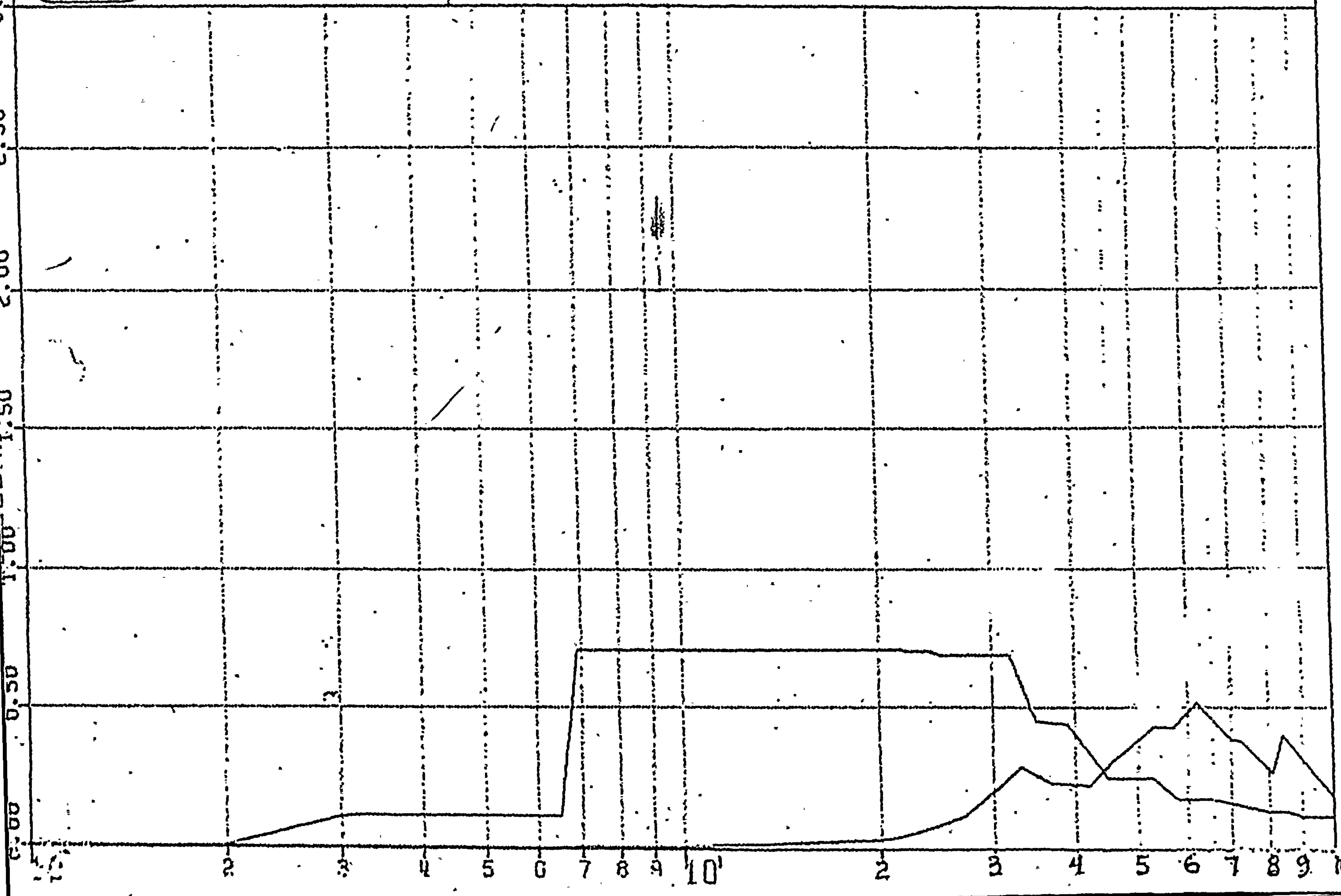
GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(JT. 154 - FACTORED) VS (PNPP DESIGN 88-154)
RADIAL DIRECTION - 2% DAMPING

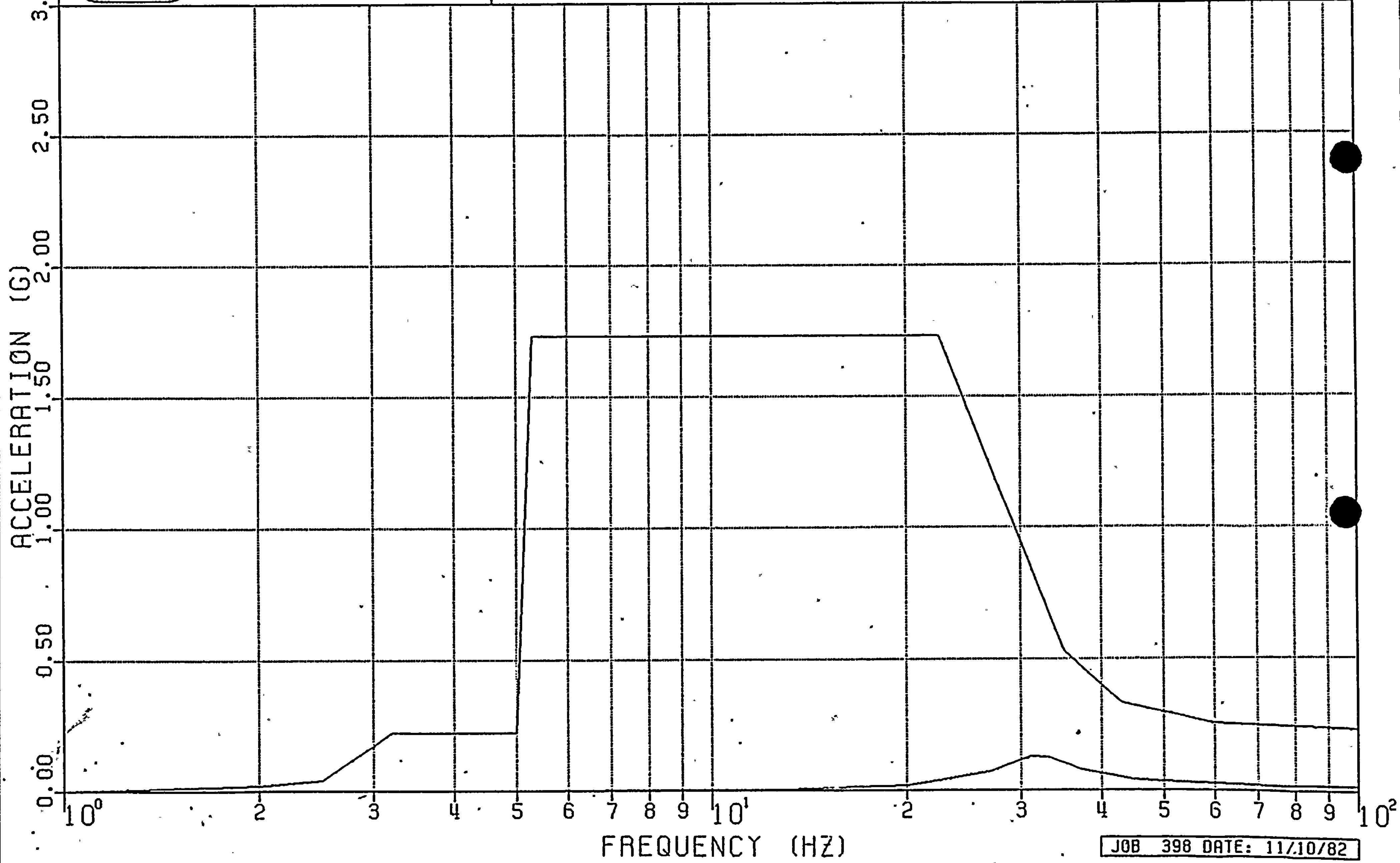
16



GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(F) (NODE 198) NARROW BAND
RADIAL DIRECTION - 2% DAMPING

17



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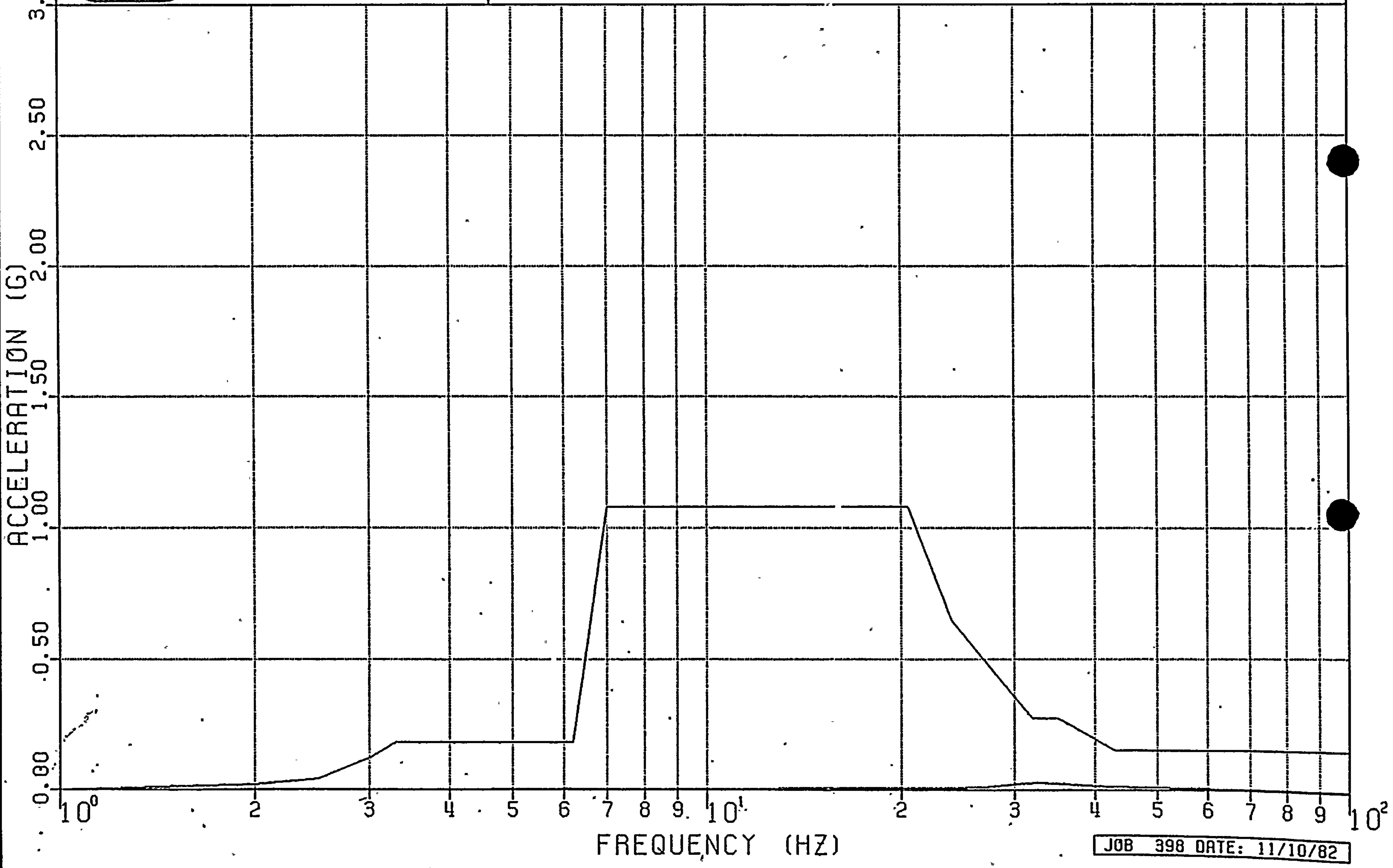
GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(F) (NODE 217) NARROW BAND
RADIAL DIRECTION - 2% DAMPING

18



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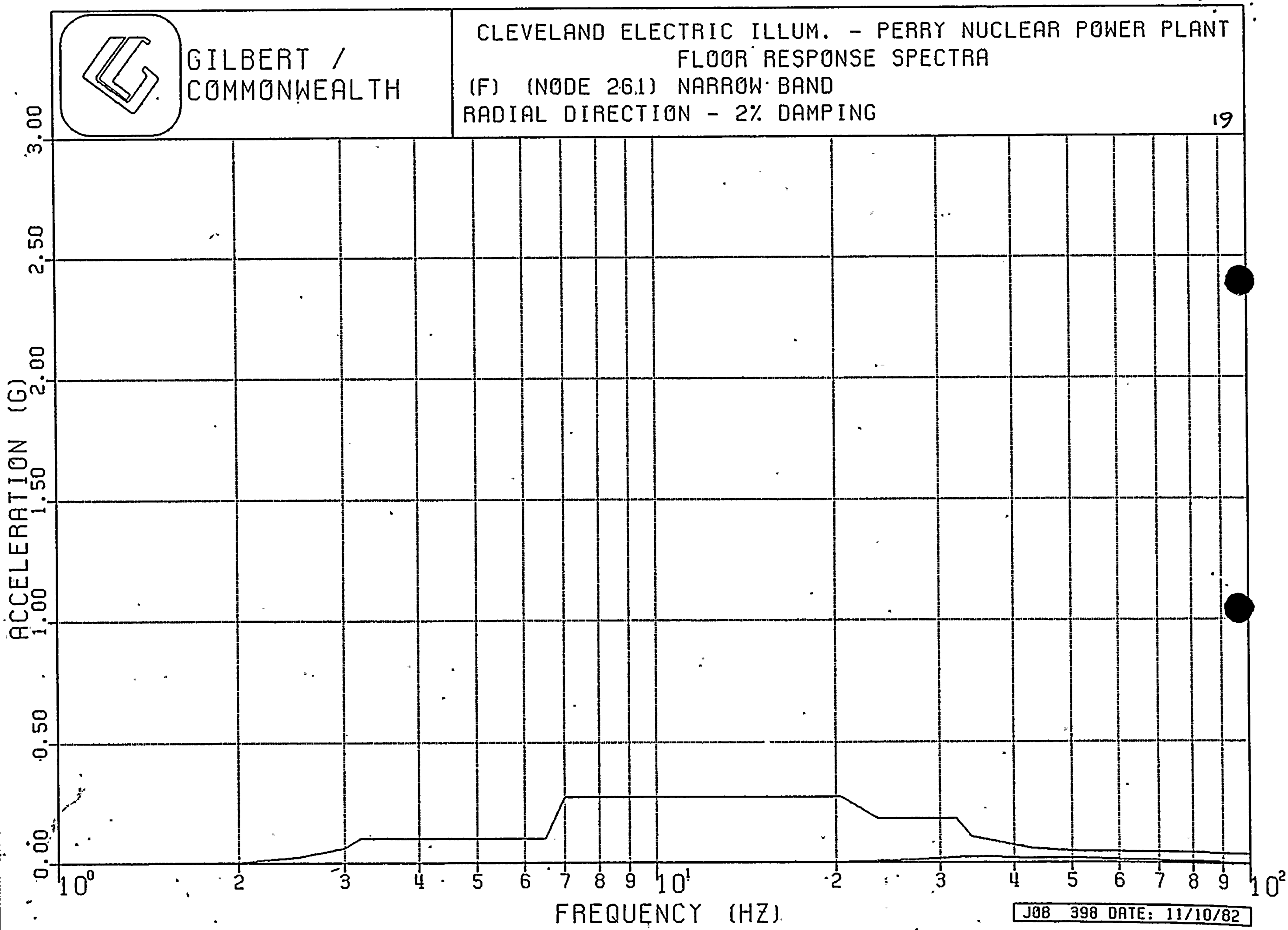
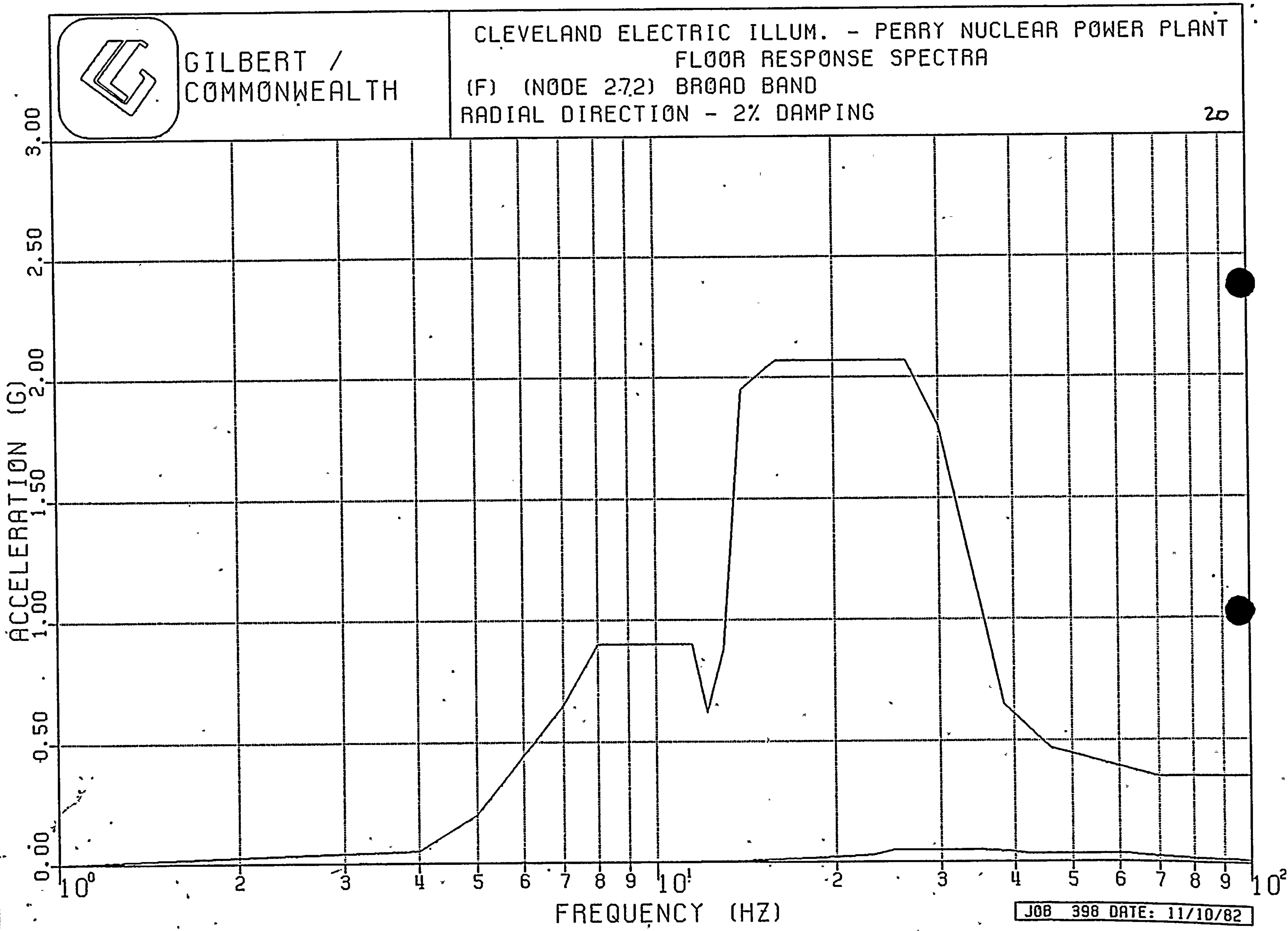


GILBERT / COMMONWEALTH
CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(F) (NODE 261) NARROW BAND
RADIAL DIRECTION - 2% DAMPING
19
ACCELERATION (G)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
10^0
2
3
4
5
6
7
8
9
10^1
2
3
4
5
6
7
8
9
10^2
FREQUENCY (HZ)
JOB 398 DATE: 11/10/82

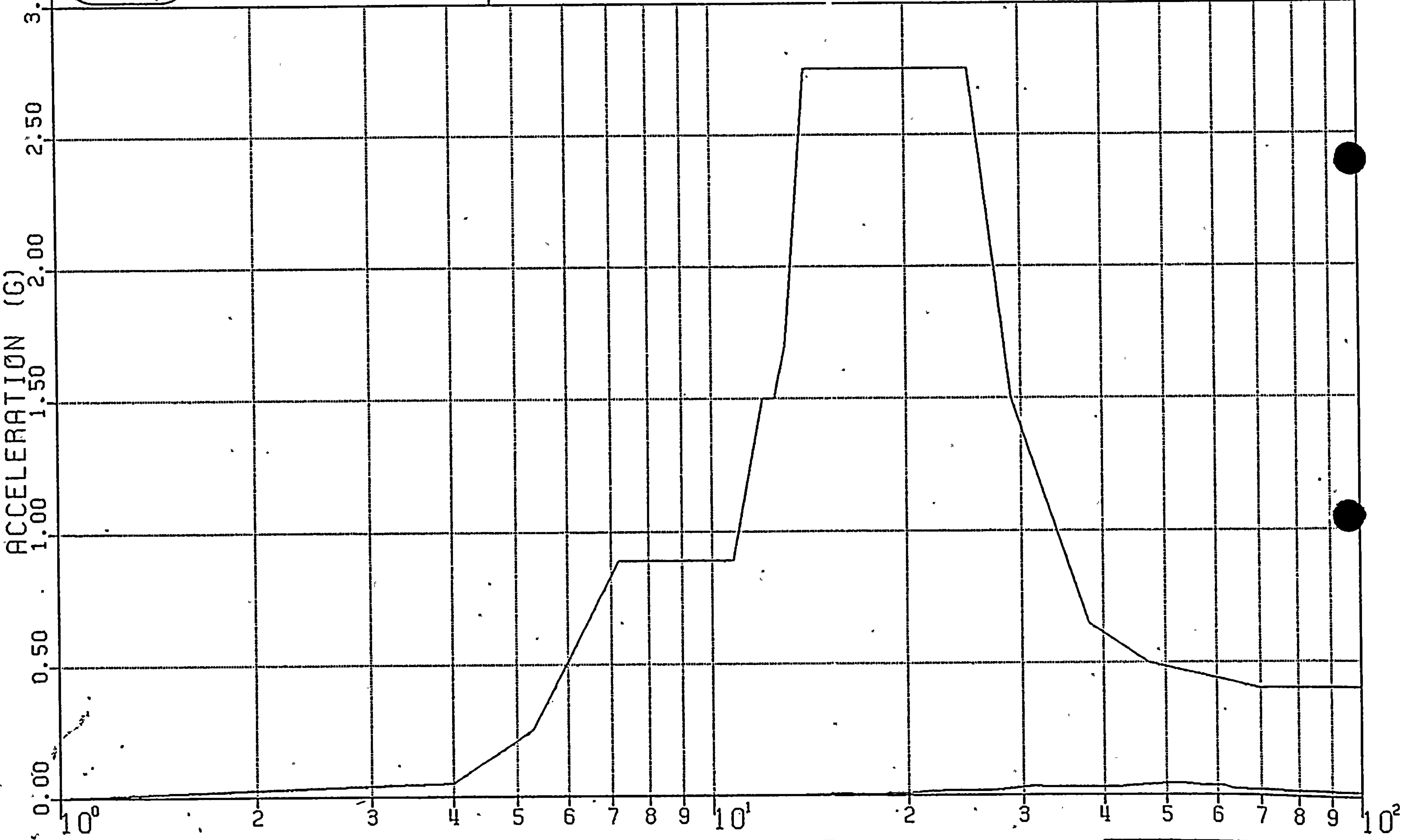


GILBERT /
COMMONWEALTH
CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(F) (NODE 272) BROAD BAND
RADIAL DIRECTION - 2% DAMPING
20
ACCELERATION (G)
0.00
0.50
1.00
1.50
2.00
2.50
3.00
10^0
2
3
4
5
6
7
8
9
10^1
2
3
4
5
6
7
8
9
10^2
FREQUENCY (HZ)
JOB 398 DATE: 11/10/82

GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(F) (NODE 299) NARROW BAND
RADIAL DIRECTION - 2% DAMPING

21

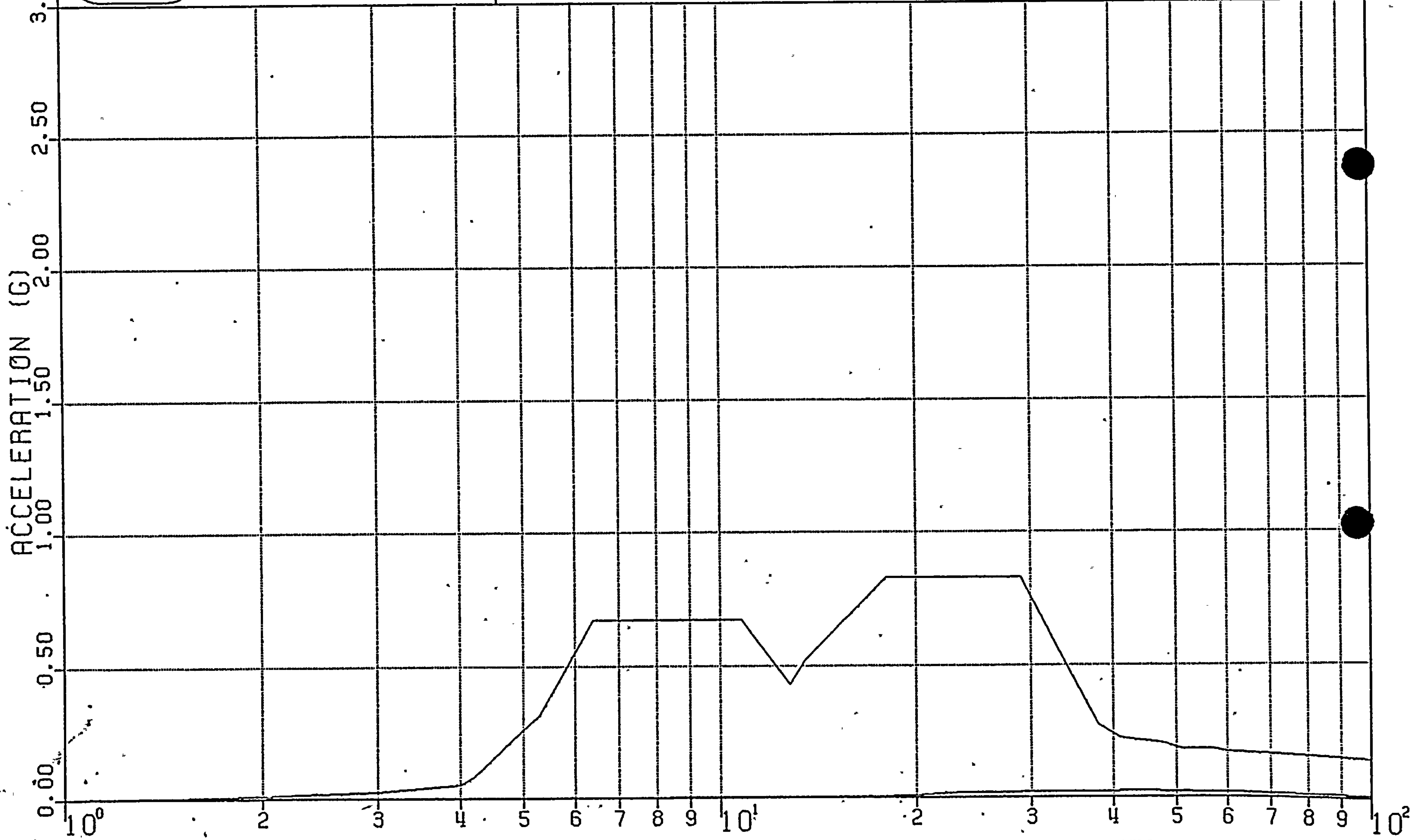


JOB 398 DATE: 11/10/82

GILBERT / COMMONWEALTH

CLEVELAND ELECTRIC ILLUM. - PERRY NUCLEAR POWER PLANT
FLOOR RESPONSE SPECTRA
(F) (NODE 316) NARROW BAND
RADIAL DIRECTION - 2% DAMPING

22



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ATTACHMENT 3

Revised Response to Containment Systems
Branch Concern - Question 4

Question 4: Explain how test data was extrapolated to design conditions and the influence such an extrapolation would have on the comparisons when applied to the Perry Nuclear Power Plant.

Response: The Kuosheng non-leaky valve test data were extrapolated to design conditions by using the GE methodology as presented on GESSAR Appendix 3B. The most important parameter in this extrapolation was the influence of SRV steam flowrate.

A detailed discussion of the development of the extrapolation factor is presented in Appendix D of the Kuosheng Final Report. The values of the extrapolation factors for first actuations were 1.26 and 1.19 for positive and negative pressures, respectively. The extrapolation factors for consecutive actuations were 1.31 and 1.18 for positive and negative pressures, respectively.

As shown in Table 3 of the August 13, 1982 NRC presentation, the predicted maximum pool pressures using the General Electric methodology are similar for Kuosheng and Perry (i.e., 0.537 Bars vs. 0.595 Bars). Therefore a correction factor based on the ratio 0.595/0.537 = 1.11 should be applied to the Kuosheng test data to predict pool pressures at the same test conditions. The Perry pool pressures at design conditions could also be predicted from the Kuosheng test data by increasing the extrapolation factors listed above by 11%. This would yield extrapolation factors for Perry first actuations of 1.40 and 1.32 for positive and negative pressures respectively. The factors for consecutive actuations would be 1.45 and 1.31 for positive or negative pressures, respectively.

It should be noted that an alternate method for extrapolation of the Kuosheng test results to reflect Perry pressures at design conditions is possible. This method would take the predicted Kuosheng pool pressures at design conditions and add the difference in the predicted pressures at design conditions between Perry and Kuosheng. The attached table provides a comparison of the two methods using the highest single valve, first actuation, non-leaky valve pool pressures as listed in Table 7.13 of the Kuosheng Final Report.

The comparison shows that increasing the applicable Kuosheng extrapolation factors by 11% produces a slightly higher peak pool pressure than the alternate method for all cases when the measured pool pressure is greater than 6.0 psid.

Comparison of Methods for Extrapolation of Kuosheng Test Data to Perry Design Conditions

Method 1

	(1)		(2)		
Perry Pressure & Design Conditions =	4.46	x	1.4	=	6.24 psid
	5.90	x	1.4	=	8.26 psid
	3.80	x	1.4	=	5.32 psid
	6.59	x	1.4	-	9.22 psid

Method 2

	(1)				(3)		
Perry Pressure & Design Conditions =	4.46	x	1.26	+	.84	=	6.46 psid
	5.90	x	1.26	+	.84	=	8.27 psid
	3.80	x	1.26	+	.84	=	5.63 psid
	6.59	x	1.26	+	.84	=	9.14 psid

Notes:

1) Pressure taken from Table 7.13 of the Kuosheng Final Report

2) 1.4 = 1.26 (Extrapolation Factor for First Actuation Positive Pressure) times 1.11

3) Perry PRDI (0.595 Bars) - Kuosheng PRDI (0.537 Bars)
= 0.058 x 14.5
= 0.84 psid

ATTACHMENT 4

PERRY NUCLEAR POWER PLANT

NOVEMBER 22, 1982 MEETING ON

SAFETY RELIEF VALVE

HYDRODYNAMIC LOADS

PROPOSED

- AGENDA -

- INTRODUCTION/PNPP SUBMITTALS ON SRV TEST

- PRESENTATION OF ANALYSIS OF KUOSHENG TEST DATA IN PNPP CONTAINMENT MODEL

  - Selection of Test Data/Methodology

  - Comparison of PNPP Predicted vs. Kuosheng Measured

  - Comparison of PNPP Design vs. PNPP Predicted

  - Program to Address Exceedances

- SUMMARY/CONCLUSIONS