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March 20, 1997
IPN-97-041

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Subject: Indian Point 3 Nuclear Power Plant
Docket No. 50-286
License No. DPR-64
Response to Request For Additional Information
Resolution of Unresolved Safety Issue A-46

References:

1. NRC letter, G. F. Wunder to W. J. Cahill, Jr., NYPA, "Request for Additional Information (RAI) on the Resolution of Unresolved Safety Issue A-46, Indian Point Nuclear Generation Unit No. 3 (TAC No. M69454)," dated December 16, 1996.

2. NYPA letter, W. J. Cahill, Jr. to NRC, "Summary Reports for Resolution of Unresolved Safety Issue A-46, Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors," dated November 16, 1995.

Dear Sir:

The enclosure to this letter provides a response to the Request for Additional Information (RAI) received with the Reference 1 letter. The RAI was sent in response to the Authority's submittal of the Indian Point 3 Summary Report regarding Unresolved Safety Issue A-46 (Reference 2). This issue deals with the seismic adequacy of mechanical and electrical equipment in operating reactors.

The Authority is making no new commitments in this letter. If you have any questions, please contact Ms. C. D. Faison.

Very truly yours,

J. Knubel

J. Knubel
Senior Vice President &
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Enclosure/Attachments/cc: next page

Enclosure:	Response to Request for Additional Information on the Resolution of Unresolved Safety Issue A-46 - Indian Point Nuclear Generating Unit No. 3.
Attach. 1:	Appendix C Response Spectra
Attach. 2:	Certificate of Achievement
Attach. 3:	Calculations
Attach. 4:	Calculations
Attach. 5:	Calculations

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Enclosure to IPN-97-041

Response to Request for Additional Information on the Resolution of Unresolved Safety Issue A-46

Indian Point 3 Nuclear Power Plant
Docket No. 50-286

RESPONSE TO
REQUEST FOR ADDITIONAL INFORMATION
ON THE RESOLUTION OF UNRESOLVED SAFETY ISSUE A-46
INDIAN POINT NUCLEAR GENERATING STATION UNIT NO. 3

Question 1

Indicate whether the seismic margin assessment (SMA) methodology, as described in the EPRI Report NP-6041, has been, or will be, used for the resolution of outliers at Indian Point Unit 3. It should be noted that while the SMA methodology discussed in the EPRI NP-6041 may be acceptable for the Individual Plant Examination for External Events (IPEEE) program, the evaluation performed and approved for the IPEEE program should not be considered automatically acceptable for the USI A-46 program.

Since this methodology is known to yield analytical results which are not as conservative as those which could be obtained by following the GIP guidelines, its application to the USI A-46 program is generally not acceptable to the NRC. Describe the extent to which the SMA methodology is used in the program and, for each deviation from the GIP-2 guidelines where the margin methodology is utilized, identify the nature and the extent of the deviation, and provide the justification for its use.

Response 1

The Refueling Water Storage Tank (RWST) and the Primary Water Storage Tank (PWST) have been identified as USI A-46 outliers. These outliers have been resolved analytically as described in References 1 and 2. The calculations in these references use the computational methodology for vertical tanks described in Appendix H of EPRI NP-6041 (Reference 5), rather than that described in Section 7 of the Generic Implementation Procedure (GIP), Revision 2 (Reference 4). As discussed below, the two methodologies produce essentially the same results as long as certain differences in the assumptions are taken into account.

The differences between the GIP and the NP-6041 methodologies for vertical tanks are discussed in Reference 3 (pages 2-23 through 2-32). Reference 3 is the source of the procedure in GIP. Reference 3 notes that the two procedures give the same results if the following differences are removed:

- When calculating the buckling capacity of the tank shell, NP-6041 applies a safety factor of 0.90, GIP applies a safety factor of 0.72.

- When calculating the base shear capacity of the tank, NP-6041 uses a friction coefficient of 0.70, GIP uses a friction coefficient of 0.55.

- When calculating the overturning moment capacity of the tank, NP-6041 includes the "hold-down" effect of the tank's shell and fluid, GIP does not.

There are two other potential differences not explicitly discussed in Reference 3:

- For the impulsive mode, NP-6041 allows up to 5% damping. GIP specifies 4% damping.

- For calculating the effect of concrete embedment and edge distance on the capacity of cast-in-place bolts, NP-6041 specifies the methodology contained in ACI 349 Appendix B (Reference 5). GIP uses the same methodology but applies a factor of safety of between 1.5 and 2.

NYPA calculations (References 1 & 2) used the GIP buckling factor of 0.72, the GIP friction coefficient of 0.55, the GIP impulsive mode damping value of 4%, and the GIP cast-in-place bolt capacities. Two capacities were calculated for each tank: one ignoring the hold-down effect of the fluid, and one including the hold-down effect of the fluid. Both tanks are shown to be adequate ignoring the fluid hold-down effect. Including the fluid hold-down effect increases the capacity of the RWST by about 5%, and the PWST by about 20%. The hold-down effect of the tank shell was included in all cases, but this effect is generally less significant than the fluid hold down effect, so removing it would not change the conclusions reached in these calculations.

Calculations for both tanks, which show that the tanks are adequate, are attached (Attachments 4 and 5).

Question 2

Referring to the in-structure response spectra provided in your 120-day-response to the NRC's request in Supplement No. 1 to Generic Letter (GL) 87-02, dated May 22, 1992, the following information is requested:

a. *Identify structure(s) which have in-structure response spectra (5% critical damping) for elevations within 40 feet above the effective grade, which are higher in amplitude than 1.5 times the SQUG Bounding Spectrum.*

b. *With respect to the comparison of equipment seismic capacity and seismic demand, indicate which method in Table 4-1 of GIP-2 was used to evaluate the seismic adequacy for equipment installed on the corresponding floors in the structure(s)* *identified in Item (a) above. If you have elected to use method A in Table 4-1 of the GIP-2, provide a technical justification for not using the in-structure response spectra provided in your 120-day-response. It appears that some A-46 licensees are making an incorrect comparison between their plants's safe shutdown earthquake (SSE) ground motion response spectrum and the SQUG Bounding Spectrum. The SSE ground motion response spectrum for most nuclear power plants is defined at the plant foundation level. The SQUG Bounding Spectrum is defined at the free field ground surface. For plants founded on deep soil or rock, there may not be a significant difference between the ground motion amplitudes at the foundation level and those at the ground surface. However, for sites where a structure is founded on shallow soil, the amplification of the ground motion from the foundation level to the ground surface may be significant.*

c. *For the structure(s) identified in Item (a) above, provide the in-structure response spectra designated according to the height above effective grade. If the in-structure response spectra identified in the 120-day-response to Supplement No. 1 to Generic Letter 87-02 was not used, provide the response spectra that were actually used to verify the seismic adequacy of equipment within the structures identified in Item(a) above. Also, provide a comparison of these spectra to 1.5 times the Bounding Spectrum.*

Response 2a and 2c

The NRC has accepted the in-structure response spectra provided in our 120-day-response as "conservative design" spectra for the purpose of comparing seismic capacity to seismic demand at Indian Point 3 (Reference 7). A graphical comparison of this "conservative design" spectra and the 1.5 times the SQUG Bounding Spectrum was provided in Appendix C of the Seismic Evaluation Report (Reference 8), previously submitted to NRC. Appendix C from this report is attached (Attachment 1).

A discussion of this comparison is included on page 9 of the same report and is repeated here.

"The 5% damping ground response spectra was enveloped by the Bounding Spectra and the In-structure Response Spectra were enveloped by 1.5Xs Bounding Spectrum (ABS) in all directions with the exception of the 70′-0″ elevation of the Diesel Generator Building, the 127′-6″ elevation of the Inner Containment Pressurizer Shield Wall, and the 78′-0″ elevation of the Auxiliary Boiler Feedwater Pump Building (AFPB). No SSEL equipment was found to be installed at the 70′-0″ elevation of the DieselGenerator/Control Building or the 127′-6″ elevation of the Inner Containment Pressurizer Shield Wall locations. The response spectra for the 78′-0″ elevation of the AFPB was taken from the Shield Wall Building (SWB) which was the most conservative. The SWB peak is 1.24g's at a frequency of 2.9Hz to 3.35Hz. The peak for 1.5Xs the Bounding Spectra is 1.2g's for this frequency range, therefore, the response spectra for the 78′-0″ elevation of the AFPB was judged to be enveloped by 1.5Xs the Bounding Spectra. The seismic demand (CRS) compared to the seismic capacity (ABS) was, therefore, used exclusively for the seismic walkdown evaluations."

The effective grade and 40 feet above grade elevations for the three buildings stated in the above discussion are as shown in Table 1 below.

Building	Effective Grade Elevation*	40′ Above Effective Grade Elevation
Diesel Generator Building	15′-0″	55′-0″
Auxiliary Feed Pump Building	18′-0″	58′-0″
Containment	46′-0″	86′-0″

* Effective grade elevations are taken from Reference 8, page 4

As seen from the above table and the comparison discussion, there are no structures at Indian Point 3 with SSEL equipment which have in-structure response spectra (5% critical damping) for elevations within 40 feet above the effective grade, that are higher in amplitude than 1.5 times the SQUG Bounding Spectrum.

Response 2b

At Indian Point 3, Method B in Table 4-1 of GIP-2 was used for the comparison of equipment seismic capacity and seismic demand to evaluate the seismic adequacy of all SSEL equipment. This is documented on the Seismic Evaluation Walkdown Sheets (SEWS) and summarized on the Screening Verification Data Sheets (SVDS) provided in Appendix D of the Seismic Evaluation Report (Reference 8). The notation "CRS" shown in the "Demd. Spec." column of the SVDS is in accordance with the definitions as provided on page 4-65 of the GIP (CRS = Conservative, Design In-Structure Response Spectra).

Question 3

Provide the status and the schedule for resolution of all unresolved mechanical, electrical, and structural components outliers identified in Table 1, "Outlier Summary," of the attached Seismic Evaluation Report, as well as the unresolved relay outliers identified in Attachment H. The licensee is also requested to provide its justification in support of the proposed schedule considering any potential impact on plant safety.

Response 3

The Authority has made significant progress in resolving the identified outliers. At this time, the Authority has resolved 21 of the 45 outliers identified in Table 1, "Outlier Summary" of the Seismic Evaluation Report (Reference 8). Of the remaining 24 outliers, two outliers; namely, items 15 and 31 from Table 1 will be resolved during the upcoming refueling outage scheduled for April/May 1997. The relay outliers as identified in Attachment H of the Seismic Evaluation Report still remain unresolved, since NYPA is in the process of obtaining/determining the seismic capacity of these relays.

The unresolved outliers have been prioritized by the Authority's Reactor Engineering/Nuclear Systems Analysis (RE/NSA) Group in descending order of core damage frequency contribution. The RE/NSA Group has determined that the resolution of the outliers should be prioritized in the following order:

Item*	Equipment Description	Consequence
38	480V Switchgear 31 and 32	Station blackout - loss of AC power
1	Diesel Generator 30 Gal Air Receiver Tanks	Failure of all EDGs to start - station blackout
25	Diesel Generator 32 & 33 Control Panels	Possible trip of EDG 32 and 33. Loss of buses 5A and 6A loads. Station blackout of all EDG ventilation
22	31 & 33 Auxiliary Control Panels	Possible trip of EDG 31 and 33 and resulting station blackout. Loss of buses 2A, 3A, and 5A loads. Only one essential service water pump available. Questionable EDG cooling.
7	Battery Bank 33	Loss of station battery 33. 125 DC power panel 33 will be powered by charger 33 which is fed from MCC 36C.
	All remaining outliers	These outliers have no major contribution to the IP3 core damage frequency.

* These item numbers are taken from Table 1, "Outlier Summary" of Reference 8

The resolution of the outliers will be prioritized in the order stated above, to the extent permitted by plant conditions. The Authority believes that most of the outliers can be resolved during plant operation.

All remaining outliers will be resolved during plant operation in 1997 through 1999 and the refueling outage in 1999. Resolution of all outliers will be completed prior to startup from refueling outage Reload 10/Cycle 11. Outliers will be resolved by either modification, replacement, testing, or analysis. During these analyses and testing, additional modifications beyond those anticipated may be identified and the above stated schedule may change. The Authority will inform the NRC if a schedule change becomes necessary.

Question 4

In the Peer Review Report, concerns were raised concerning the use of devices similar to "Sigma Meters" for level indication, due to its potential sensitivity to vibration. It was indicated that a further review of the circuit diagrams by the licensee would be needed. Discuss the implementation status of this item, and provide its planned completion schedule, if not already completed.

Response 4

A concern regarding "Sigma Type" meters was identified by the peer reviewers during the walkdown. The resolution of this concern is discussed in the Peer Review Report (Appendix B of Reference 7) which states:

" Atometrics was asked to review the circuit diagrams to insure that, if devices of this type were present, their malfunction would not cause an unwanted action during or after an earthquake".

Atometrics had agreed to this action and made those involved with the relay reviews aware of the concerns regarding these types of meters. No meters of this type were identified during the relay review (circuit screening) portion of this project.

A review of Atometrics files did not reveal any documentation or correspondance regarding the identification of any "Sigma Type" meters. All contacts within the circuits associated with the equipment listed on the SSEL requiring relay review are listed in the Relay List, Appendix B of the relay evaluation report (Reference 9). These contacts were evaluated in the Relay Screening and Evaluation Forms, Appendix C of reference 9. Any outliers were listed in the List of Relay Corrective Actions, Appendix G of reference 9. Therefore, it is concluded that there are no "Sigma Type" meters installed in circuits associated with any equipment listed on the SSEL.

Question 5

In Attachment A, to the Seismic Evaluation Report, "Resume and Training Records of Seismic Review Team Personnel, " there is no evidence or certificate provided to demonstrate that Mr. Mara Lakis has completed the necessary SQUG training courses on the seismic adequacy verification of nuclear power plant equipment. Provide the evidence to support his qualification for participating in the USI A-46 implementation program.

Response 5

The SQUG Certificate of Achievement certifying that Mrs. Mara Lakis has completed the SQUG Walkdown Screening and Seismic Evaluation Training Course held on November 9 - 13, 1992 is attached (Attachment 2).

Question 6

It is stated on page 5 of the Seismic Evaluation Report that "The turbine building is a seismic Class III structure modified in accordance with the design basis earthquake criteria to preclude collapse or other damage to nearby Class I structures." Provide the definition for the seismicClass III structure. State how the turbine building was physically modified from its original costruction. Provide the basis for concluding that the Turbine Building will not collapse or cause damage to nearby Category I structures during the design basis earthquake.

Response 6

The definition of Seismic Design Classifications is provided in Section 16.1.1 of the Indian Point 3 FSAR (Reference 10) as follows:

"Class I

Those structures and components, including instruments and controls, whose failure might cause or increase the severity of a Loss-of-Coolant Accident or result in an uncontrolled release of radioactivity causing more than 10 rem to the thyroid or 10 rem whole body to the average adult beyond the nearest site boundary. Also, those structures and components vital to safe shutdown and isolation of the reactor.

Class II

Those structures and components which are important to reactor operation but not essential to safe shutdown and isolation of the reactor, and whose failure could result in the release of radioactivity causing more than 1.0 rem to the tyroid or 0.5 rem whole body dose to the average adult beyond the nearest site boundary.

Class III

Those structures and components which are not directly related to reactor operation and containment."

Based on these definitions the "Turbine Structure" is classified as Class III in section 16.1.2 of the IP3 FSAR.

Section 16.4.2 of the FSAR in part states that: "The Turbine Building was analyzed, using a multidegree of freedom modal dynamic analysis, for the Design Basis Earthquake (0.15g maximum ground acceleration) and the building as constructed is capable of carrying the load without failure." Also, section 1.2.2 (Page 1.2-7) of the FSAR in part states that: "The Turbine Building is a Seismic Class III structure modified in accordance with the design basis eartquake criteria to preclude collapse or other damage to nearby Class I structures."

Background on the Design of the Indian Point 2 (IP2) and Indian Point 3 (IP3) Turbine Buildings

The Turbine Buildings of IP2 and IP3 are very similar to each other. The IP2 Turbine Building originally was designed in the mid 60's. The revision 0 versions of the IP3 Turbine Building drawings were issued for construction on 4/19/68 and were almost identical to the latest revision of the IP2 drawings. The IP2 design calculations were the basis for the original IP3 drawings.

In 1970, E. D'Appolonia Consulting Engineers Inc. performed a response spectrum analysis of the IP2 Turbine Building using the design basis earthquake (DBE) (Reference 11). The analysis included horizontal earthquake in the east-west and north-south directions. Vertical earthquake was also considered by adding a 0.13g component to the dead loads.

The results of this analysis was used to evaluate the structural frames. The evaluation showed that the 0.9 f_y combined load stress allowable was not violated except locally in the flange of columns where cross bracing framed in eccentric to other joint members. In addition, certain cross bracing required modification to eliminate potential buckling under compressive stress. The stresses in the framing members were reduced to allowable values by the addition of flange cover plates and doubling up the areas of cross bracing (References 11, 12, 13). The modifications were noted in the IP2 design calculations (Reference 14). The affected IP2 design drawings were revised (References 15, 16).

In 1971, E. D'Appolonia Consulting Engineers Inc. performed a seismic analysis of the IP3 Turbine Building column lines A, F, 9, and 10 only. It was noted that the seismic analysis performed for the IP2 Turbine Building was applicable to all other column lines of the IP3 Turbine Building (References 17, 18). Subsequently, United Engineers & Constructors (UE&C) performed an evaluation of the IP3 Turbine Building using the results of the seismic analysis of the IP2 and IP3 Turbine Buildings (Reference 19). This evaluation included seismic and tornado loads. It provides a comparison of both loading conditions and the necessary modifications to the original design of the IP3 Turbine Building. The evaluation concluded that all modifications performed on the IP2 Turbine Building were also applicable to the IP3 Turbine Building in order to assure that stresses remained below the allowable stress of 0.9 f_y.

The corresponding IP3 Turbine Building structural drawings were revised and re-issued on 4/12/72 to incorporate all the modifications (doubling up of the cross bracing, adding cover plates, reinforcing connections, etc.) required as a result of the seismic analyses of the IP2 and IP3 Turbine Buildings. For example; Revision 1 of drawing 9321-F-12563 (Reference 20) and revision 4 of drawing 9321-F-12573 (Reference 21) were issued to reinforce diagonal bracing in column lines A and F, respectively.

Safety Factor Against Collapse

In 1980, Structural Mechanics Associates (SMA) performed a margin evaluation of the IP2 Turbine Building. The results of this evaluation are documented in a report titled " Conditional Probabilities of Seismic Induced Failure for Structures and Components for IP2 and IP3" (Reference 22). This report addresses the probability of failure of IP2 and IP3 structures during the DBE and specifies the factors of safety against failure. Based on this report, the median ground acceleration necesary to produce failure of the IP2 Turbine Building is estimated to be around 1.4g. Therefore, it was concluded that the Turbine Building was structurally adequate for the DBE and that it has a factor of safety of 9.1 against failure. It is noted that although this report does not specifically address the IP3 Turbine Building, the conclusion reached for the IP2 Turbine Building is also applicable to the IP3 Turbine Building because, as previously stated the IP2 and IP3 Turbine Buildings are similar in design and construction.

Question 7

It is stated on page 10 of the Seismic Evaluation Report that "All outliers were reviewed to determine compliance with design documentation, and when deviations were found the plant procedures were followed to identify and resolve the noted conditions. None of the outliers were found to violate the design basis." Provide a statement as to whether "design documentation" and "design basis " mean the same thing; if not, provide the definition for each. If design documentation and design basis mean the same thing, explain why it is possible that the outliers were found to deviate from design documentation but also not to violate the design basis. If the definitions you used for design basis and licensing basis differ from those in Part 50 and Part 54 of the CFR, respectively, please provide your definitions.

Response 7

"Design documentation" and "design basis" do not mean the same thing as illustrated below.

The outliers shown in Table 1 of the Seismic Evaluation Report (Reference 8) can be categorized as follows:

I. The item is an outlier because it does not meet the GIP requirements, but meets original design basis documentation (design drawings). Most of the outliers at IP3 fall into this category.

Examples of this category are:

1. Condensate Storage Tank (Item 14)
2. Primary Water Storage Tank (Item 28)
3. Refueling Water Storage Tank (Item 36)

All of these tanks meet the original design requirements as shown on the design drawings, but are outliers due to GIP requirements.

II. The item is an outlier because it does not meet the GIP requirements, and there is a discrepancy between design drawings and the as-built condition.

Examples of this category are:

1. Missing End Rail for Battery 34 (Item 8). For this item, as per plant procedures, Deviation Event Report (DER) 94-0367 was written to document the discrepancy. An engineering evaluation was performed and the as-built condition was found to be acceptable. Since, this discrepancy did not cause an inoperable condition, the design basis was not violated. Subsequently, a modification was performed to reinstall the end rail.

2. Bolt tightness checks revealed loose anchors for charging pump 31, 32, and 33 suction stabilizer separators (Item 2). For this item, as per plant procedures, DER 94-0671 was written to document the discrepancy. An engineering evaluation was performed and the as-built condition was found to be acceptable. Since, this discrepancy did not cause an inoperable condition, the design basis was not violated. Subsequently, a modification was performed to replace these anchors.

3. Similarly, DER 94-0464 was written to document a discrepancy of the welding in the back of Supervisory Panel/Panel SAF (Item 37). The as-built condition was found to be

acceptable for operation, and subsequently a modification was performed to install the missing anchorage.

4. Unistrut nuts in lower unit of 480V/120V SOLA Transformer for 1B-33 and 33A were improperly installed (Item 11). For this item, as per plant procedures, Plant Identified Deficiency (PID) 12604 was written. Subsequently, the nuts were reinstalled properly.

5. Service water nuclear header pressure transmitter U-bolt was loose (Item 27). As per plant procedures PID 12603 was written and the U-bolt was tightened.

The statement, as taken from page 10 of the Seismic Evaluation Report,

> "All outliers were reviewed to determine compliance with design documentation, and when deviations were found the plant procedures were followed to identify and resolve the noted conditions. None of the outliers were found to violate the design basis."

is a blanket statement covering both categories of outliers as stated above. As shown from the above categorization, NYPA believes that none of the outliers violated the design basis. Design documentation, in most cases, was the design drawings which were reviewed during the walkdowns. Any discrepancies identified during the SQUG walkdowns where the function of the component could be compromised, were fixed to resolve this condition.

Question 8

It is stated on page 22 that the Condensate Storage Tank anchorage stiffener plate did not meet GIP criteria, and the issue was resolved by using GIP guidance and EPRI NP-5228, Vol. IV and was documented in calculation 18904-IP3-015. State which portions (sections) of the GIP and NP-5228 were used. Submit the relevant portions of calculation 18904-IP3015 for review.

Response 8

Calculation 18904-IP3-SQ017 (Reference 23) performed to evaluate the condensate storage tank is attached (Attachment 3). On page 22 of the "Seismic Evaluation Report" (Reference 8), this calculation number was misstated as 18904-IP3-015.

GIP (page 7-18) and EPRI NP-5228 Vol. 4 (page 2-37) specify the following three requirements for the anchorage stiffener plates:

1) $k / j < 95 / (f_y)^{1/2}$, k = stiffener depth, j = stiffener thickness
2) $j > 0.04 (h - c)$ and $j > 0.5''$, $(h - c)$ = stiffener height
3) $P_u / 2kj < 21$ ksi

The first requirement is from Section 1.9.1.2 of the AISC Manual for Steel Construction (Reference 24). If this condition is met, then the stiffener plate will yield before it buckles. It is based on the theoretical buckling capacity of a rectangular plate subjected to uniform compression and simply supported along one of the edges parallel to the compressive load. The theoretical buckling stress for this condition can be found in "Roark's Formulas for Stress Strain" (Reference 25), Table 35, paragraph 1d. For the case of a long plate (in Roark's notation, a/b >> 1):

$$\sigma_{cr} \approx 0.4 (E / (1 - \nu^2)) (j / k)^2$$

Set $\sigma_{cr} = f_y$, E = 29000 ksi, $\nu = 0.3$, and this formula can be rewritten as:

$$k / j = 110 /(f_y)^{1/2}$$

The AISC uses a more conservative value of 95 rather than the 110 computed above.

The second requirement also guarantees that the stiffener plate will yield before it buckles. It is based on the theoretical buckling capacity of a rectangular plate subjected to uniform compression, free on the two edges parallel to the compressive load, and simply supported on the other two edges. The theoretical buckling stress for this condition is the well known Euler buckling stress:

$$\sigma_{cr} = \pi^2 E / (l / r)^2$$

Substitute $\sigma_{cr} = 36$ ksi, E = 29000 ksi, $l = h - c$, and $r = 0.289j$ (weak axis radius of gyration for a rectangular cross-section), and this formula can be rewritten as:

$$j = 0.04 (h - c)$$

The third requirement guarantees that the actual stress is less than 60% of the yield stress.

For the Condensate Storage Tank (from page 15 of 18904-IP3-SQ017):

$$k = 3.75'', j = 0.5'', h - c = 20'', \text{ and } P_u = 65 \text{ kips.}$$

These parameters meet the first and third requirements, but the second requirement specifies that $j \geq 0.8''$, compared to the actual 0.5''.

Neither GIP nor NP-5228 specifies precisely how to deal with this situation. One approach is to recompute the buckling stress using the actual stiffener width:

$$\sigma_{cr} = \pi^2 E / (l / r)^2 = \pi^2 (29000) / (20 / 0.289 / 0.5)^2 = 15 \text{ ksi},$$

reduce the bolt load so that the stress in the plate is equal to this value:

$$P_u = (15)(2)(0.5)(3.75) = 56 \text{ kips},$$

(18904-IP3-SQ017 actually uses P_u = 53.6 kips) and use the GIP procedure for computing the tank moment capacity assuming a brittle anchorage. As shown on page 17 of 18904-IP3-SQ017, this produces a capacity of 26,164 k-ft, which is greater than the demand of 20,344 k-ft, and the tank is shown adequate.

This approach is considered very conservative for the following reason. The stiffener is a plate that is simply supported on three sides. The first GIP requirement checks buckling assuming that the plate is simply supported on one of the three sides. The second GIP requirement checks buckling assuming that the plate is simply supported on two of the three sides. Both checks are conservative (which is more conservative depends on the actual stiffener dimensions). Because they are both conservative, only one of the two conditions - not both - need be met to conclude that the stiffener will not buckle before it yields. GIP states that both conditions must be met, but NP-5228 (which is the technical basis for the GIP procedure) is not that explicit. It states that the first condition must be met and meeting the second and third conditions add conservatism.

The Condensate Storage Tank meets the first and third GIP requirements. Per the above discussion, this is sufficient to show that the stiffeners will not buckle. Consequently, the bolt load does not need to be reduced and the GIP procedure for a ductile anchorage can be used. This would increase the tank capacity to approximately 42,800 k-ft, about twice the demand (This capacity is calculated as: 0.09/0.0667 x 20/16.5 x 26,164).

Based on calculation 18904-IP3-SQ017 and the above discussion, the condensate storage tank is structurally adequate.

Question 9

It is stated on pages 24 and 25 that the anchorage of the Primary Water Storage Tank and the Refueling Water Storage Tank did not meet GIP criteria and further engineering evaluation was required. Provide the evaluation results and supporting calculations if the evaluation has been completed.

Response 9

The evaluations are contained in the calculations stated below, which are attached. These calculations show that both tanks are adequate. Note that these calculations are also discussed in the response to Question #1 of this Request for Additional Information.

A. Stevenson & Associates, "Refueling Water Storage Tank RWST-31", Calculation 96C2915-C001, Rev 0 (Attachment 4).

B. Stevenson & Associates, "Primary Water Storage Tank PWST-21", Calculation 96C2915-C002, Rev 0 (Attachment 5).

REFERENCES

1. NYPA Calculations by Stevenson & Associates, "Refueling Water Storage Tank RWST-31", Calculation 96C2915-C001, Rev 0.

2. NYPA Calculations by Stevenson & Associates, "Primary Water Storage Tank PWST-31", Calculation 96C2915-C002, Rev 0.

3. EPRI NP-5228-SL, "Seismic Verification of Nuclear Plant Equipment Anchorage (Revision 1) Volume 4: Guidelines on Tanks and Heat Exchangers", Revision 1, June 1991.

4. SQUG Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment, Rev. 2, 2/14/92.

5. EPRI NP-6041-SL, A Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1), August 1991.

6. ACI 349-1983, American Concrete Institute, Concrete Requirements for Nuclear Safety Related Structures.

7. NRC Letter, Docket No. 50-286, Response to Supplement No. 1 to Generic Letter (GL) 87-02 that Transmits Supplemental Safety Evaluation Report No. 2 (SSER No. 2) on Seismic Qualification Utility Group (SQUG) Generic Implementation Procedure, Revision 2, as Corrected February 14, 1992 (GIP) - Indian Point Nuclear Generating Station Unit No. 3 (TAC No. M69454), dated November 18, 1992, NYPA Records Management Services No. 268583.

8. Atometrics Report No. 18904-01 "Seismic Evaluation Report Verification of the Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors in Response to NRC Generic Letter 87-02/Unresolved Safety Issue (USI) A-46 for the Indian Point Nuclear Generating Station Unit No. 3", 10/23/95.

9. Atometrics Report No. 18904-00 "Safe Shutdown Equipment Selection and Relay/Contact Evaluations for the Seismic Verification of Equipment in Response to Unresolved Safety Issue (USI) A-46 for the Indian Point Nuclear Generating Station Unit No. 3", 10/10/95.

10. Indian Point 3 FSAR

11. E. D'Appolonia Consulting Engineers, Inc., "Final Report, Earthquake Analysis of the Turbine Building Unit No. 2 Indian Point", Volumes 1 and 2, Project No. 70-166, June 1970, Pittsburg, PA.

12. Westinghouse Letter IPP-3545, from W.S. Lapay to D.H. Rhoads of UE&C, Turbine Hall Structural Analysis, 9/18/ 1970.

13. Westinghouse Letter IPP-3583, from W.S. Lapay to D.H. Rhoads of UE&C, Turbine Hall Structural Analysis, 10/16/ 1970.

14. Calculation Book No. 2, Turbine Building - Steel Framing - Seismic, Indian Point Unit 2, Con Edison Company of New York, prepared by United Engineers & Constructors, 11/20/1970.

15. UE&C Drawing 9321-F-1256, Rev.5, IP2, Turbine Building Wall Framing Elevation at Col. Line A.

16. UE&C Drawing 9321-F-1257, Rev.8, IP2, Turbine Building Wall Framing Elevation at Col. Line F.

17. Westinghouse Letter IPP-3873, Indian Point Project, Turbine Hall Structural Analysis, July 1971.

18. UE&C Letter APD No. 14099, Indian Point Generating Station, Unit No. 3, Turbine Building Seismic Analysis, 4/1/71.

19. UE&C Calculation, IP3 Turbine Building - Bracings - Tornado Design, 10/28/71.

20. UE&C Drawing 9321-F-12563, Rev. 1 (current revision 4), IP3, Turbine Building Wall Framing Elevation at Col. Line A.

21. UE&C Drawing 9321-F-12573, Rev. 4 (current revision 6), IP3, Turbine Building Wall Framing Elevation at Col. Line F.

22. Structural Mechanics Associates, " Conditional Probability of Seismic Induced Failure for Structures and Components for Indian Point Generating Station Unit 2 and 3", SMA 1290.01, prepared for Pickard, Lowe and Garrick, Inc., October 1980.

23. Atometrics Calculation No. 18904-IP3-SQ017, Rev. 0, 10/23/95.

24. AISC Manual of Steel Construction, 8th Edition.

25. Roark's Formulas for Stress and Strain, W.C. Young, 6th Edition.

Attachment 1 to IPN-97-041

Response to Request for Additional Information on the Resolution of Unresolved Safety Issue A-46

Indian Point 3 Nuclear Power Plant
Docket No. 50-286

APPENDIX C

RESPONSE SPECTRA

APPENDIX C

VERIFICATION OF SEISMIC ADEQUACY OF MECHANICAL AND ELECTRICAL EQUIPMENT IN OPERATING REACTORS IN RESPONSE TO USI A-46

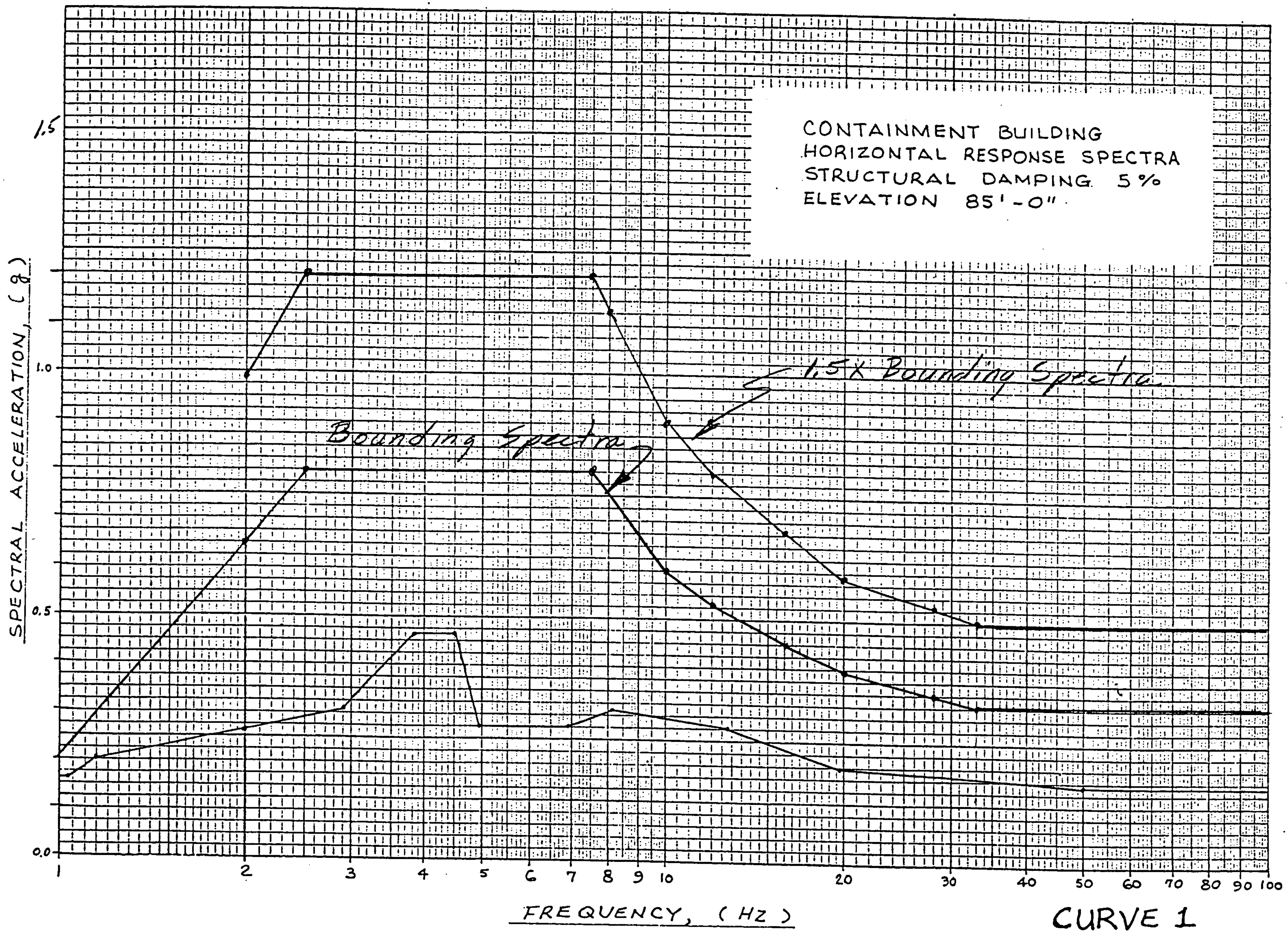
RESPONSE SPECTRA CURVES

CURVE 1	Containment Building - Elevation 85′ 0"
CURVE 2	Containment Building - Elevation 106′ 0"
CURVE 3	Containment Building - Elevation 127′ 0"
CURVE 4	Inner Containment Pressurizer Shield Wall - Elevation 127′ 6"
CURVE 5	Primary Auxiliary Building - Elevation 55′ 0"
CURVE 6	Primary Auxiliary Building - Elevation 73′ 0"
CURVE 7	Primary Auxiliary Building - Elevation 90′ 0"
CURVE 8	Control and Diesel Generator Building - Elevation 15′ 0"
CURVE 9	Control and Diesel Generator Building - Elevation 32′ 0"
CURVE 10	Control and Diesel Generator Building - Elevation 48′ 0"
CURVE 11	Control and Diesel Generator Building - Elevation 70′ 0"
CURVE 12	Intake Structure - Elevation 15′ 0"
CURVE 13	Electrical Tunnel, Pipe Penetration/Pipe Tunnel - Elevation 35′ 0"
CURVE 14	Electrical Tunnel, Pipe Penetration/Pipe Tunnel - Elevation 51′ 0"
CURVE 15	Auxiliary Boiler Feedwater Pump Building - Elevation 42′ 0"
CURVE 16	Auxiliary Boiler Feedwater Pump Building - Elevation 54′ 0"
CURVE 17	Auxiliary Boiler Feedwater Pump Building - Elevation 66′ 0"

APPENDIX C

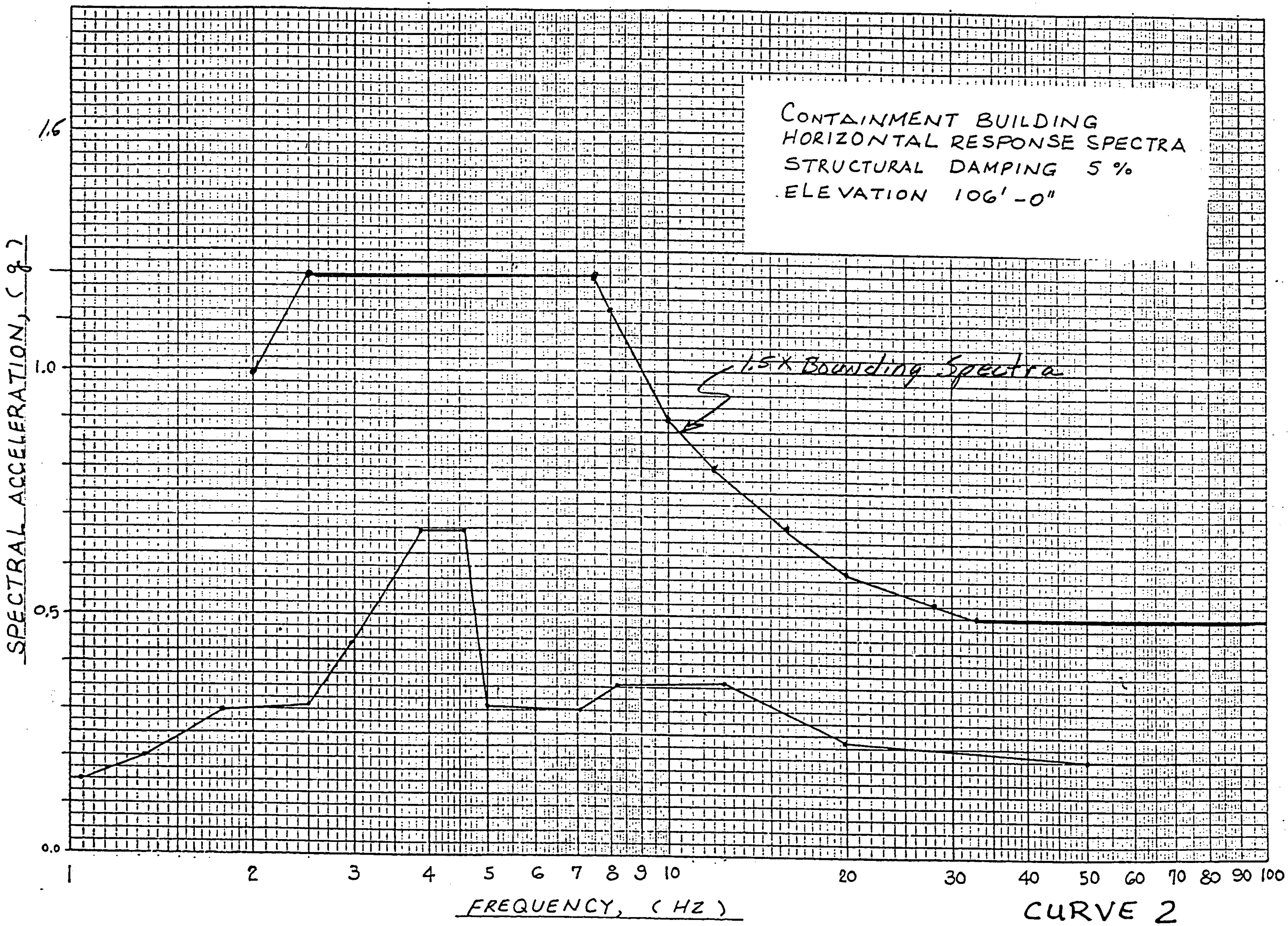
RESPONSE SPECTRA CURVES

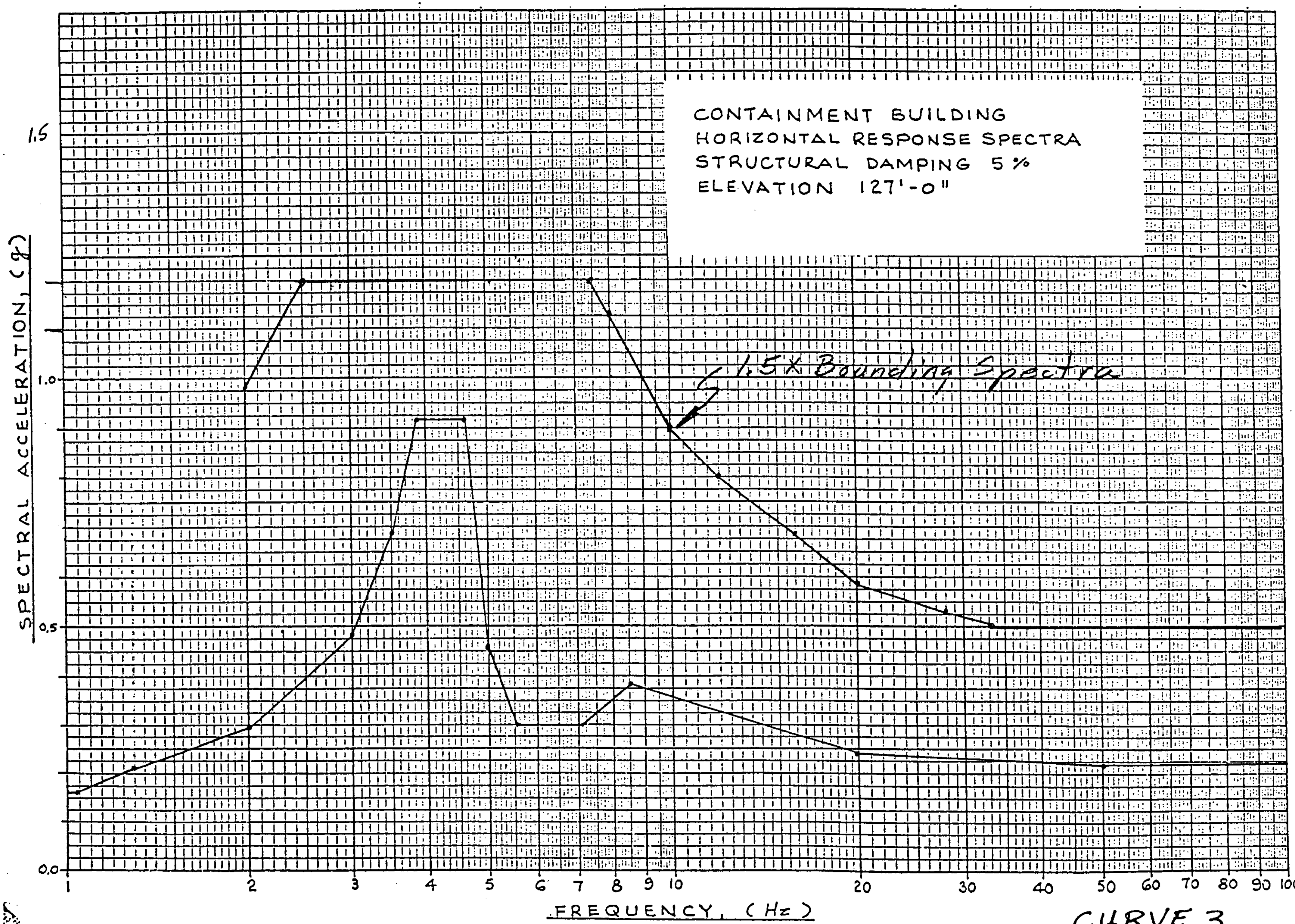
CURVE 18	Auxiliary Boiler Feedwater Pump Building - Elevation 78′ 0"
CURVE 19	Diesel Generator Fuel Oil Tank - Elevation 32′ 0"
CURVE 20	IP-3 Horizontal Ground Response Spectra
CURVE 21	Fan House Building - Elevation 89′ 0"



CONTAINMENT BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 85'-0"
1.5x Bounding Spectra
Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

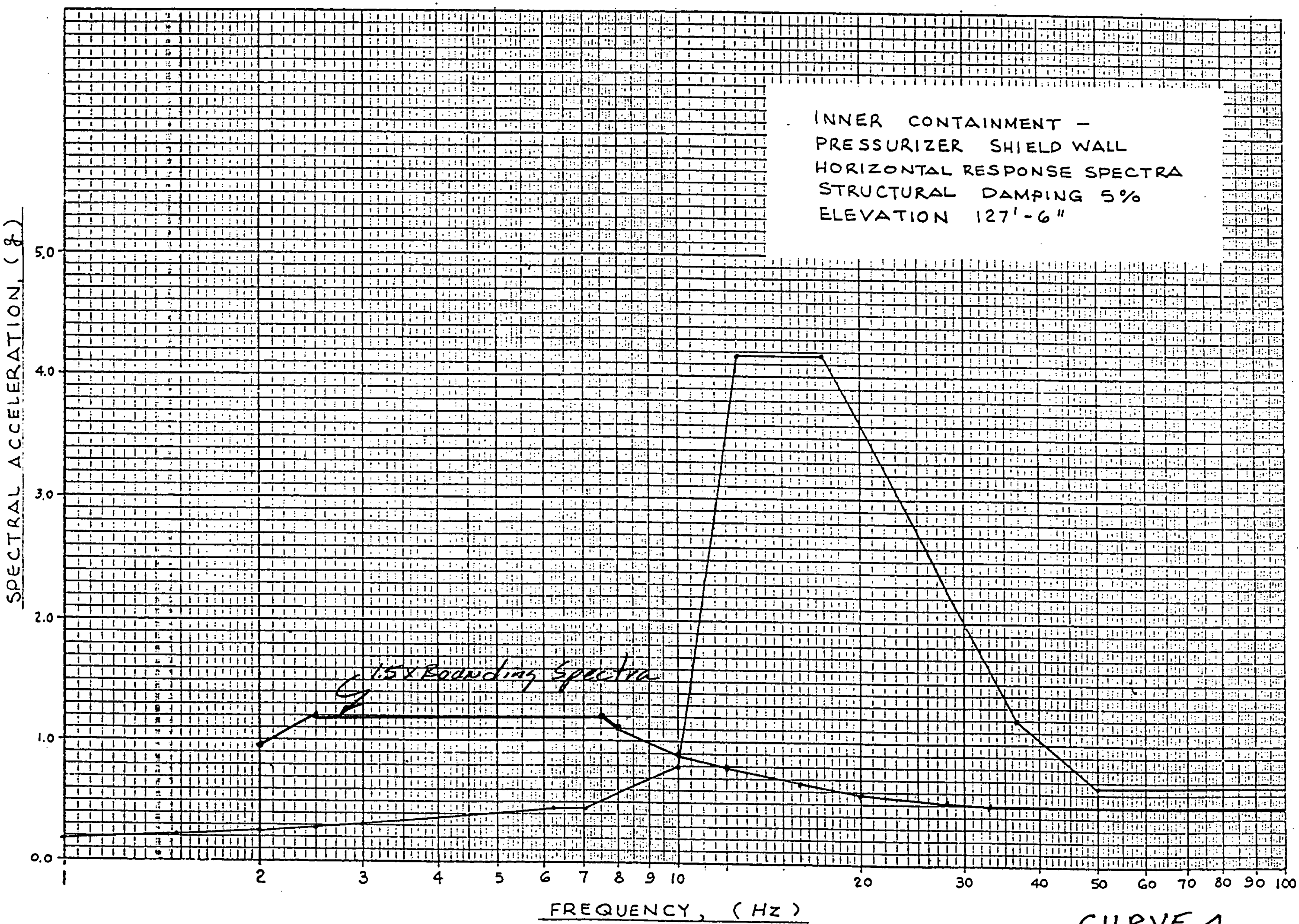
CURVE 1


CONTAINMENT BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5 %
ELEVATION 106'-0"
1.5 X Bounding Spectra
1.6
1.0
0.5
0.0
SPECTRAL ACCELERATION, (g)
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (HZ)
CURVE 2



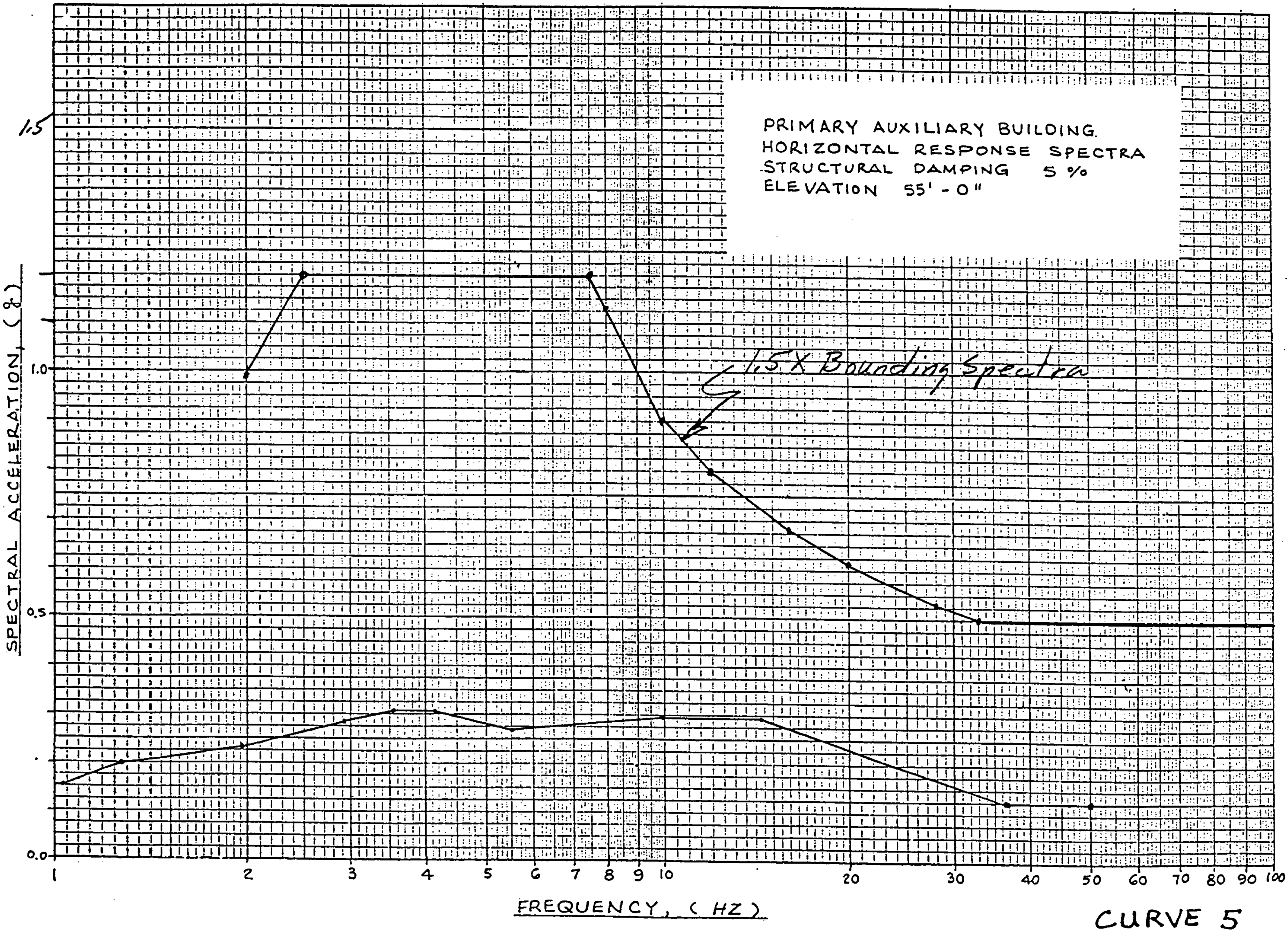
CONTAINMENT BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 127'-0"
1.5x Bounding Spectra
1.5
1.0
0.5
0.0
SPECTRAL ACCELERATION, (g)
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

CURVE 3

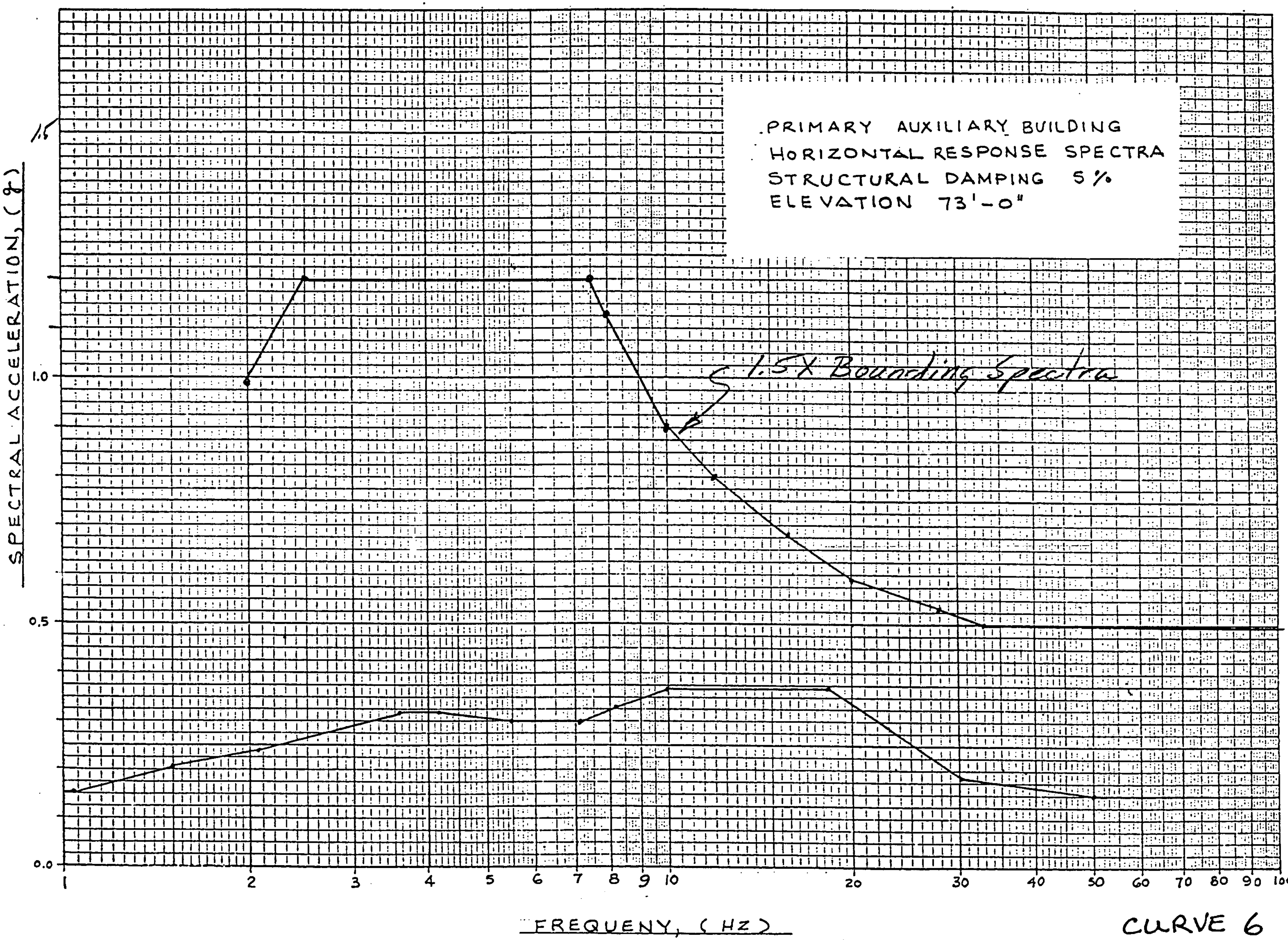


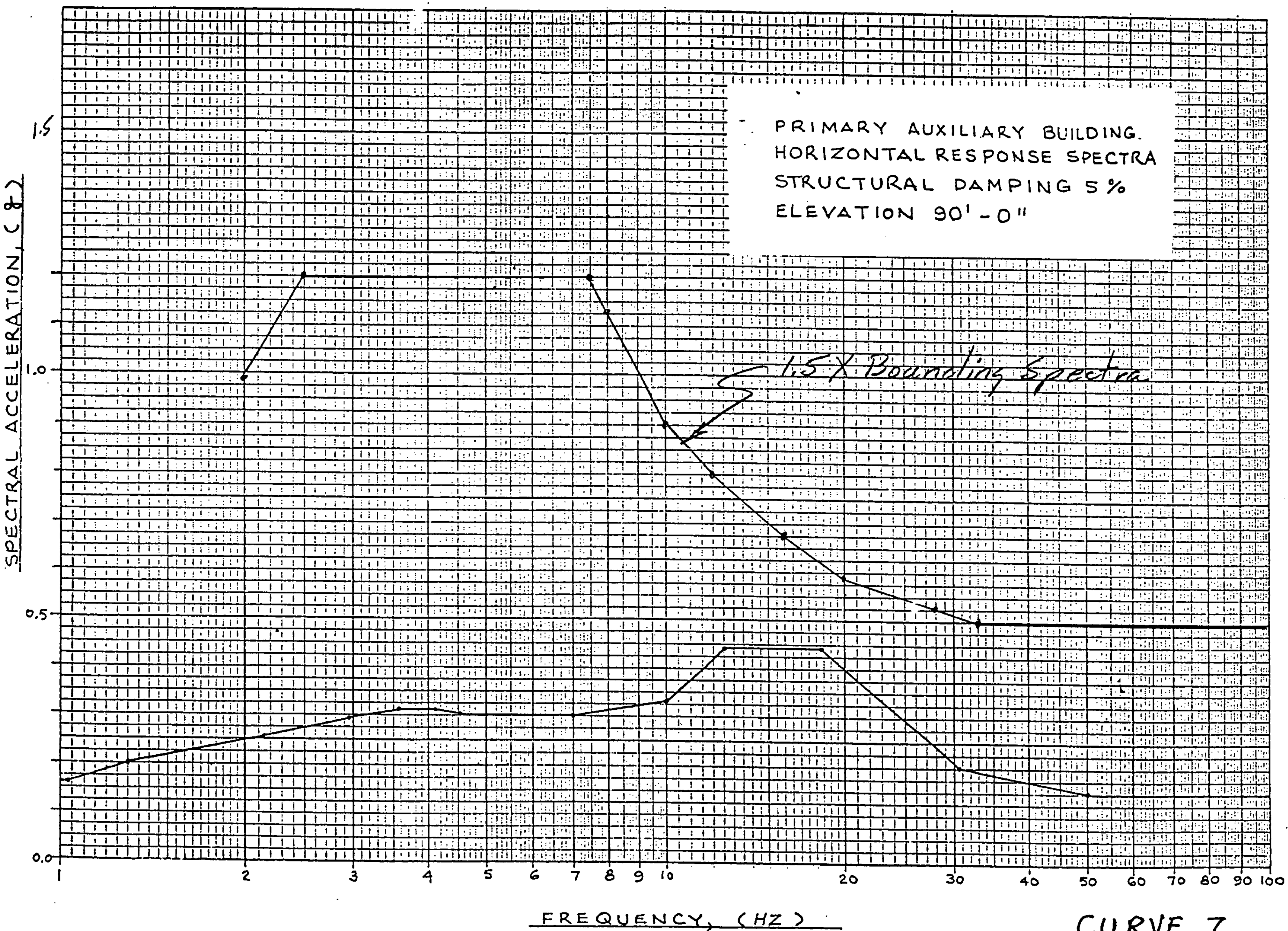
INNER CONTAINMENT –
PRESSURIZER SHIELD WALL
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 127'-6"
1.5X Bounding Spectra
SPECTRAL ACCELERATION, (g)
5.0
4.0
3.0
2.0
1.0
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

CURVE 4

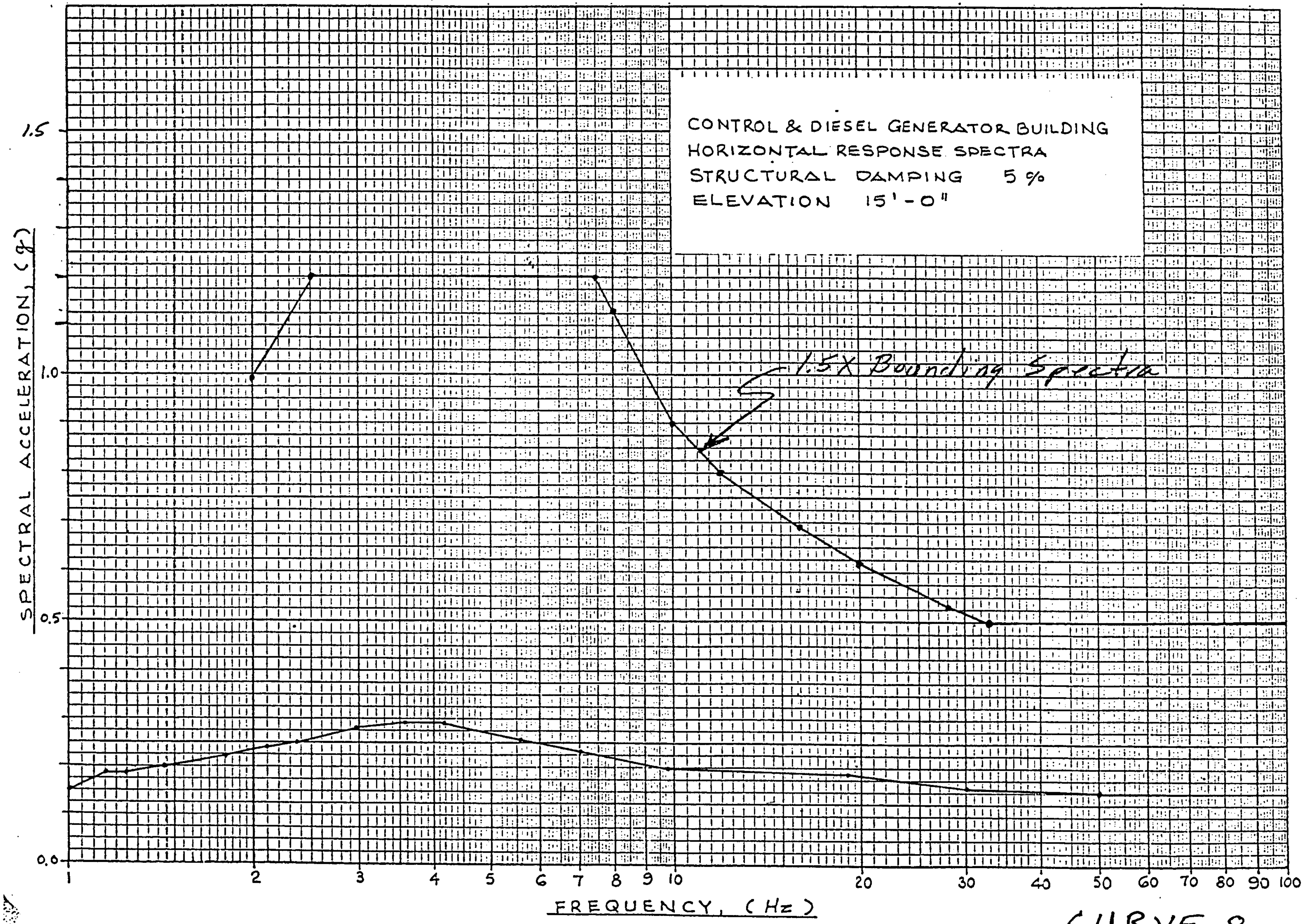

PRIMARY AUXILIARY BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5 %
ELEVATION 55' - 0"
1.5 X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (HZ)

CURVE 5

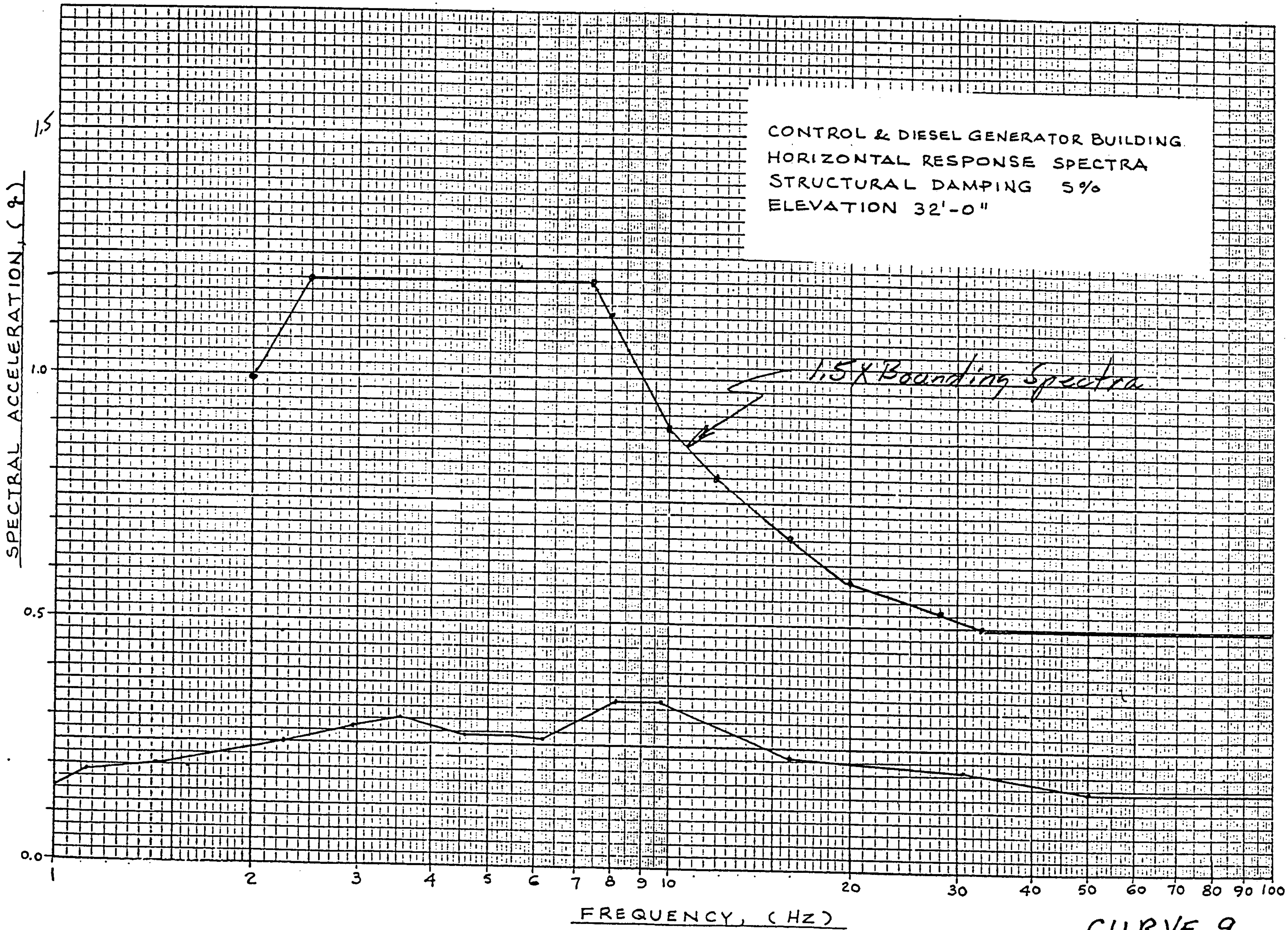

PRIMARY AUXILIARY BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 73'-0"
1.5X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENY, (HZ)
CURVE 6


PRIMARY AUXILIARY BUILDING.
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 90'-0"
1.5 X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (HZ)

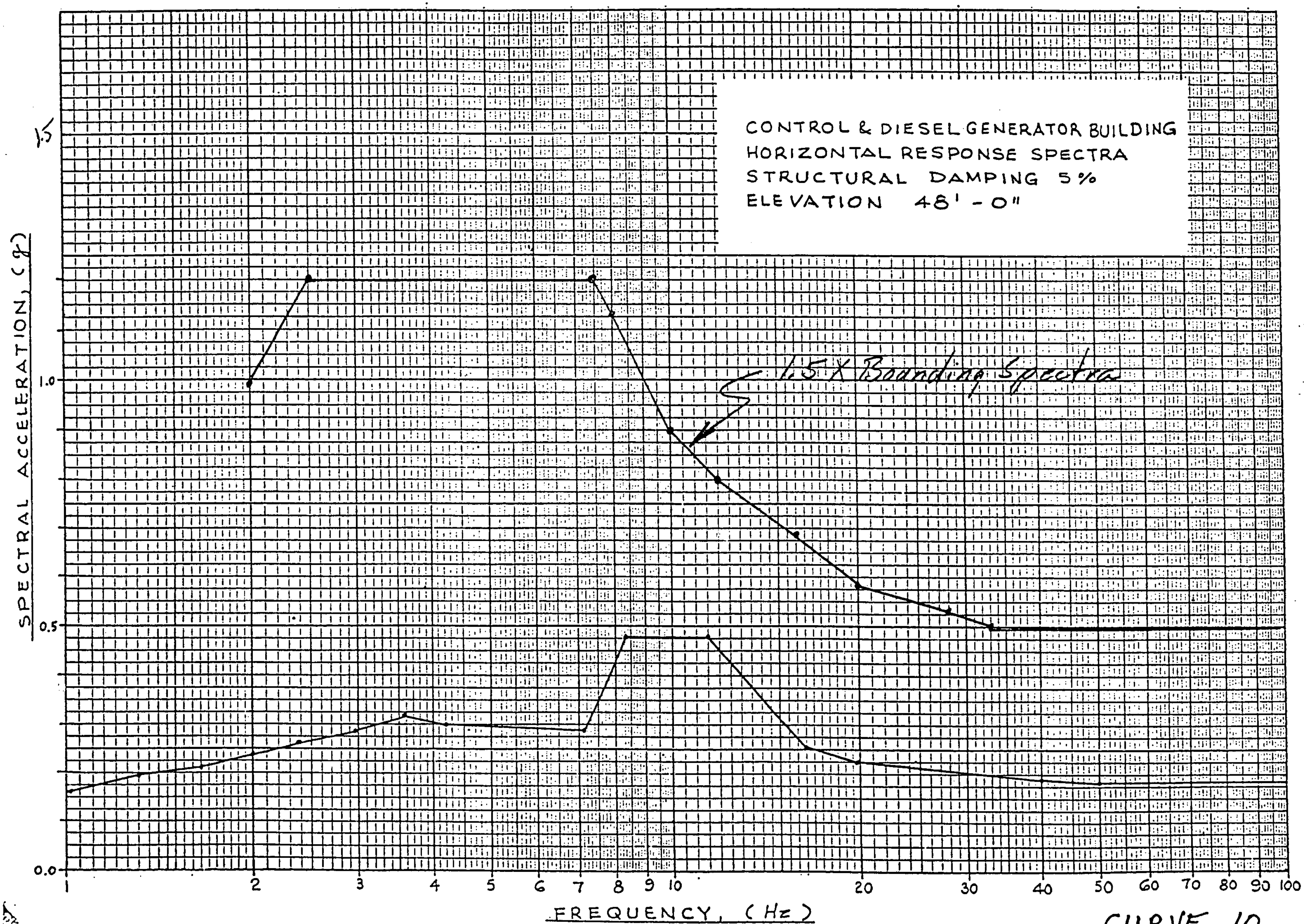
CURVE 7


CONTROL & DIESEL GENERATOR BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5 %
ELEVATION 15'-0"
1.5X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

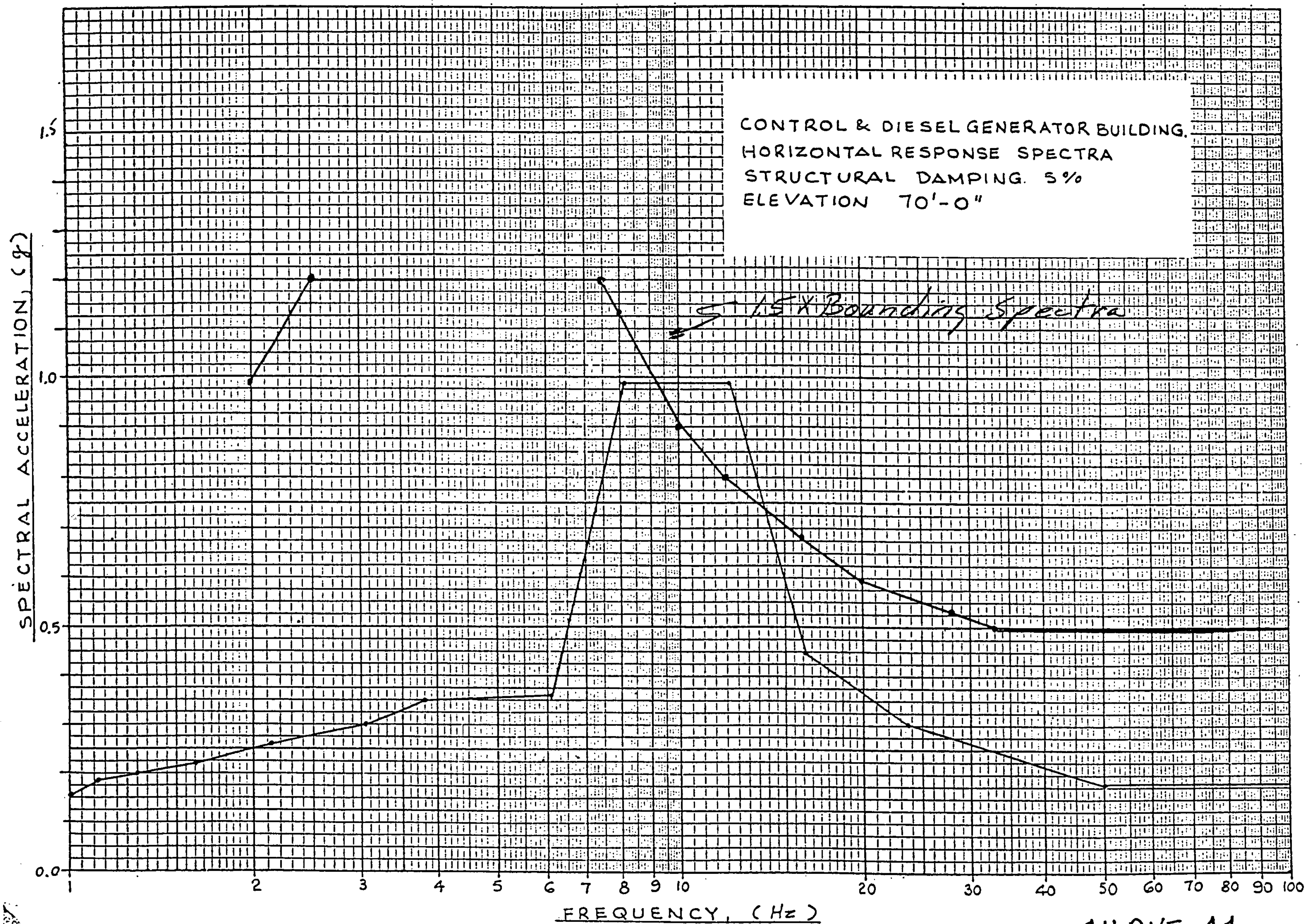
CURVE 8


CONTROL & DIESEL GENERATOR BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 32'-0"
1.5X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

CURVE 9

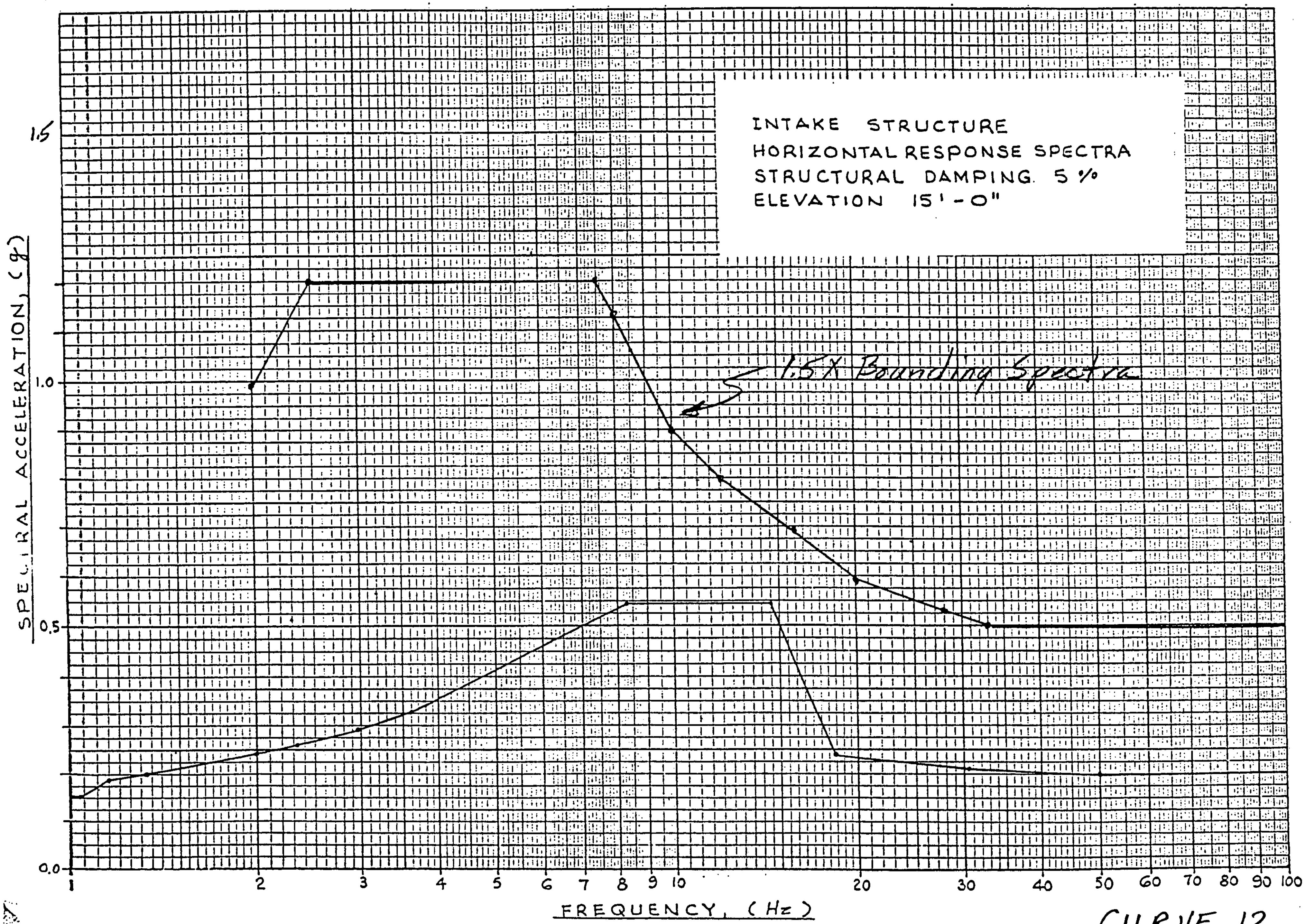

CONTROL & DIESEL GENERATOR BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 48' - 0"
1.5 X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

CURVE 10



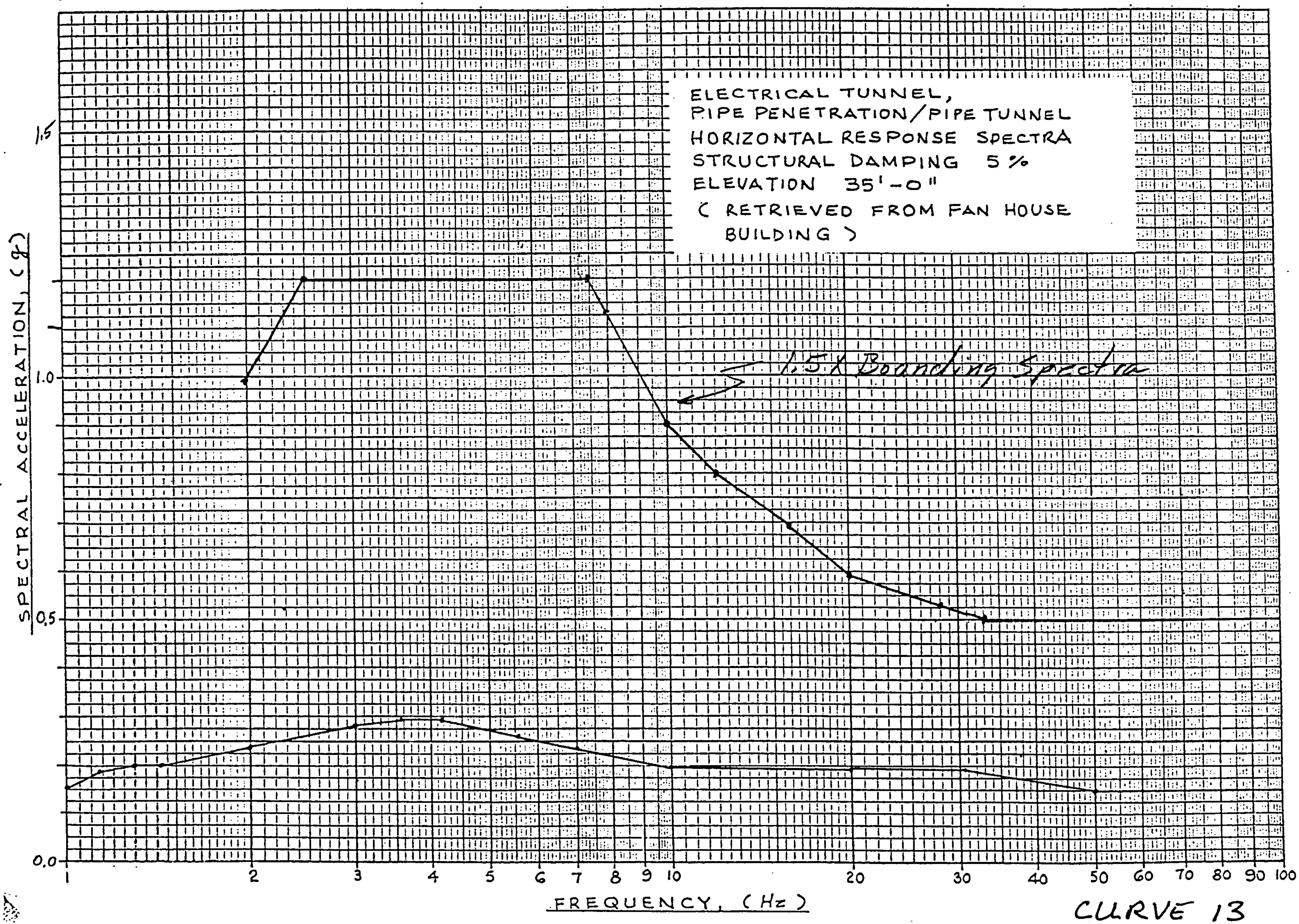
CONTROL & DIESEL GENERATOR BUILDING.
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 70'-0"
1.5 X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

CURVE 11

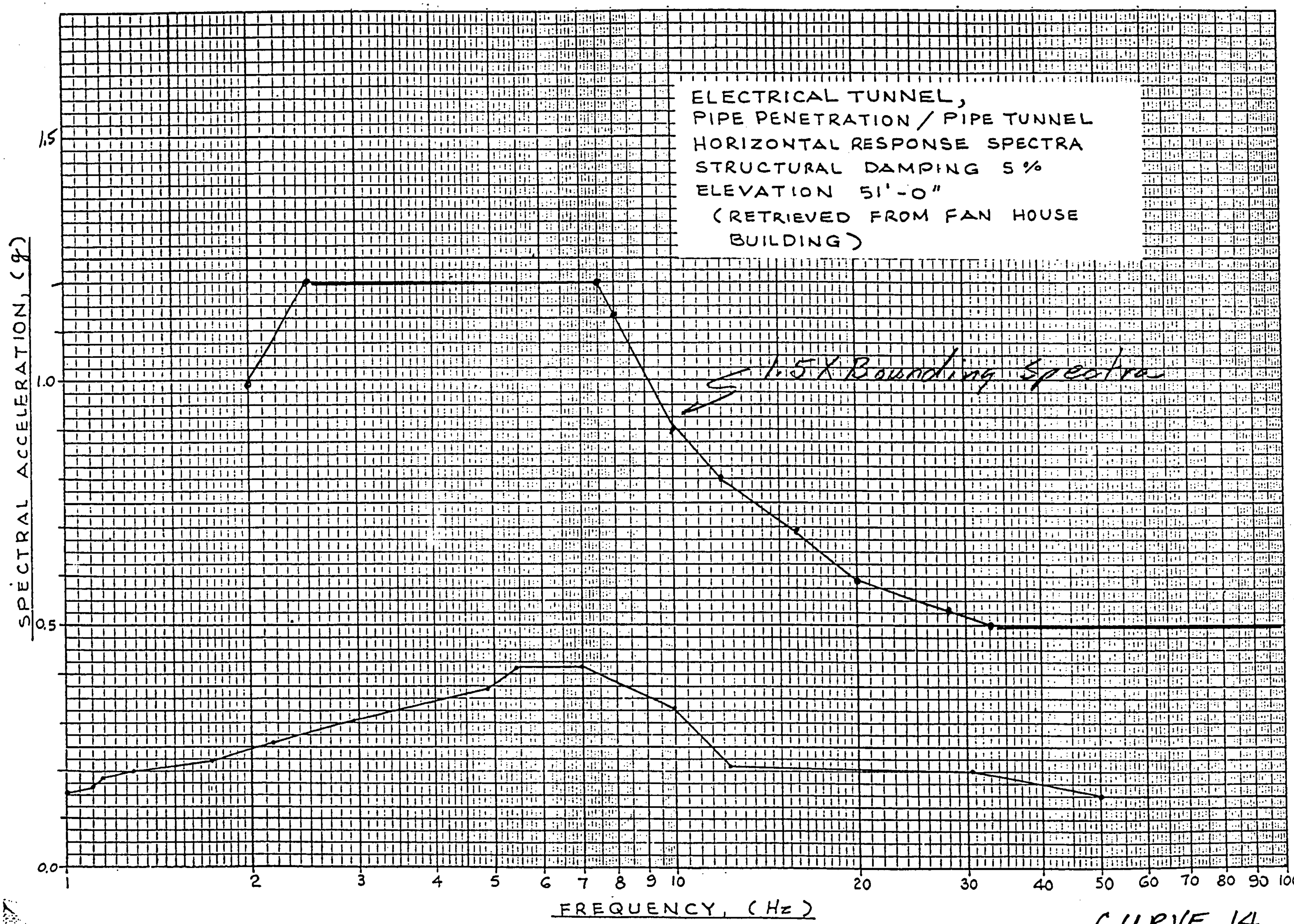


INTAKE STRUCTURE
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 15'-0"
1.5X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

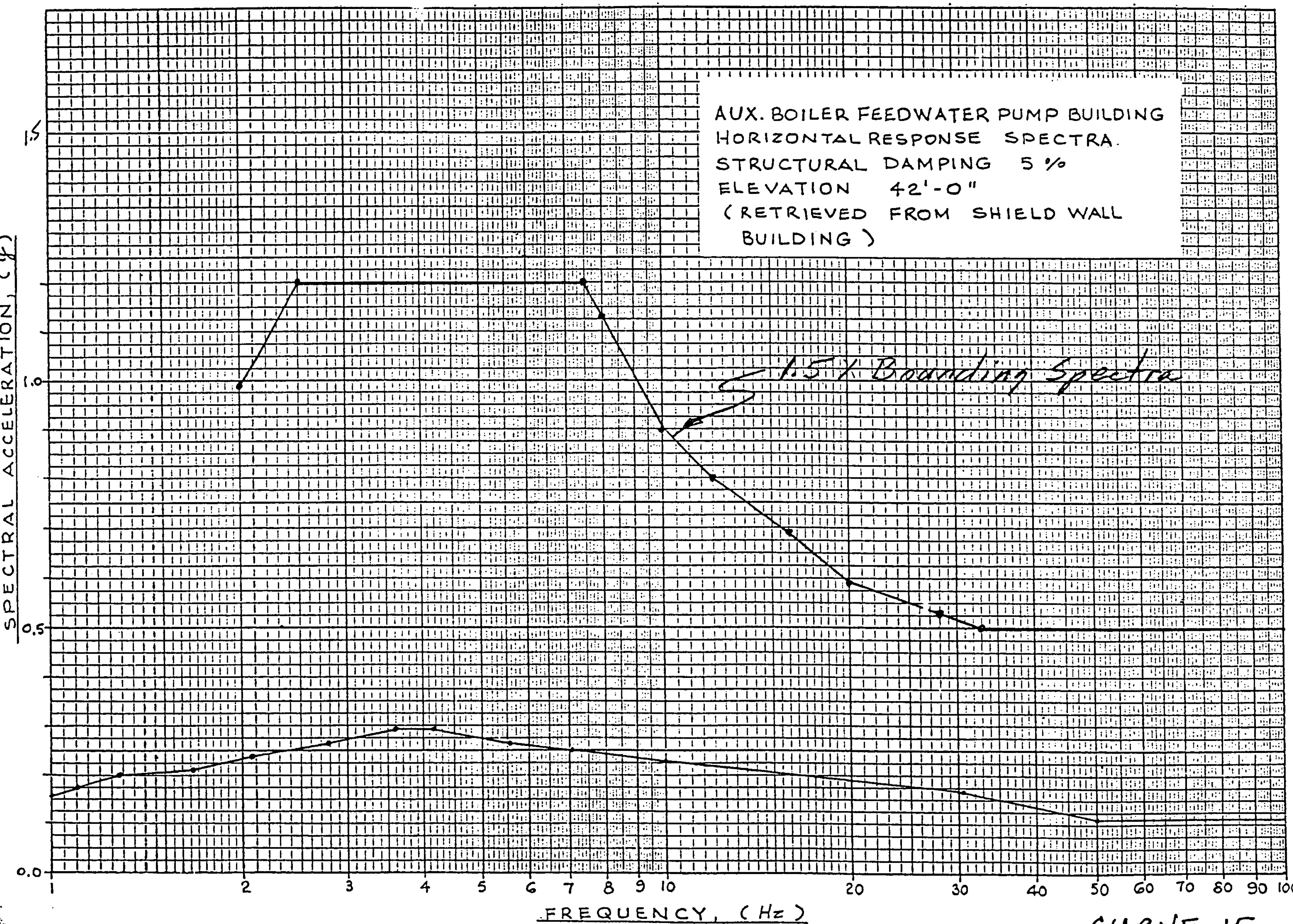
CURVE 12


ELECTRICAL TUNNEL,
PIPE PENETRATION/PIPE TUNNEL
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 35'-0"
(RETRIEVED FROM FAN HOUSE BUILDING)
1.5 x Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

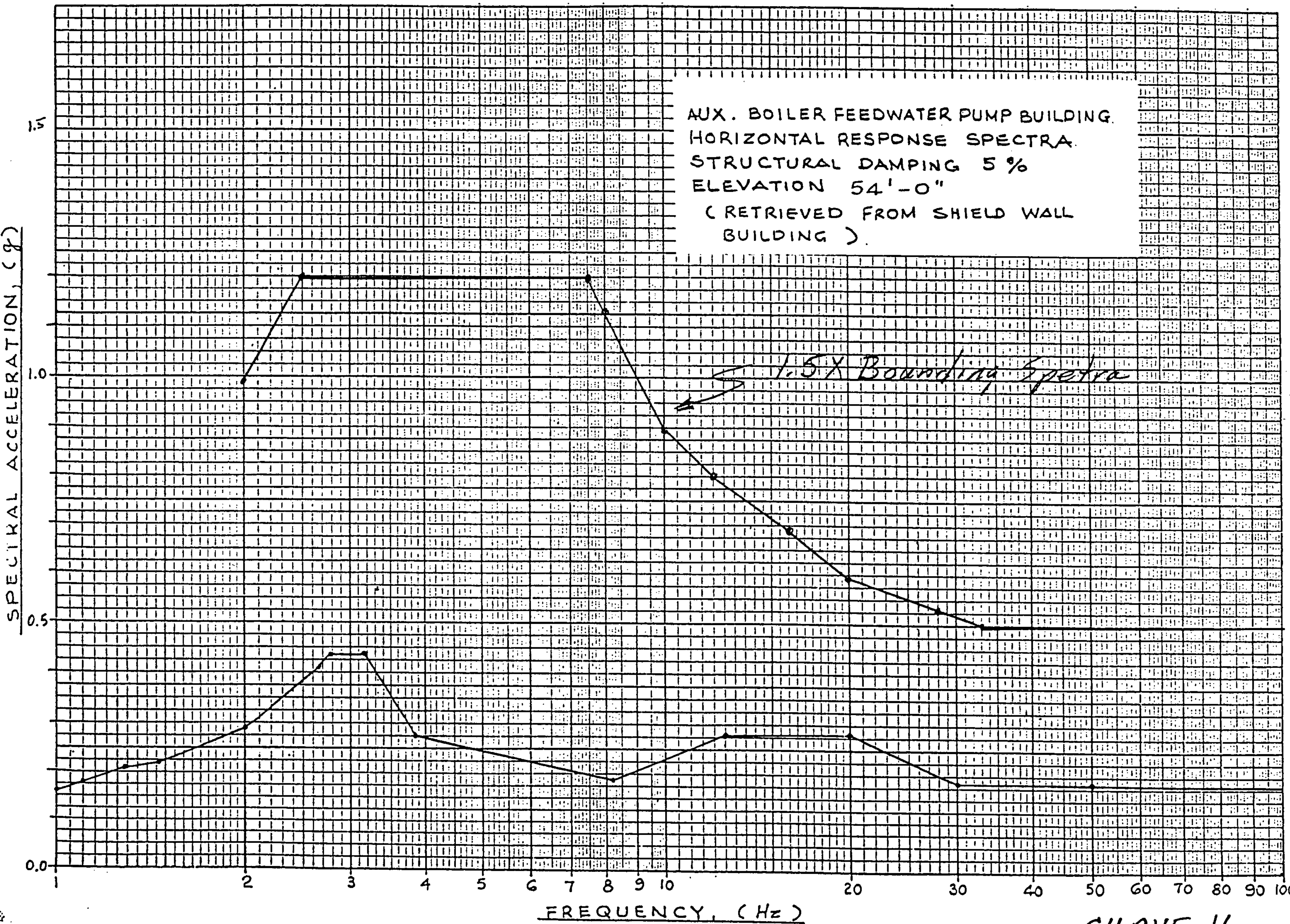
CURVE 13


ELECTRICAL TUNNEL,
PIPE PENETRATION / PIPE TUNNEL
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 51'-0"
(RETRIEVED FROM FAN HOUSE BUILDING)
1.5 X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

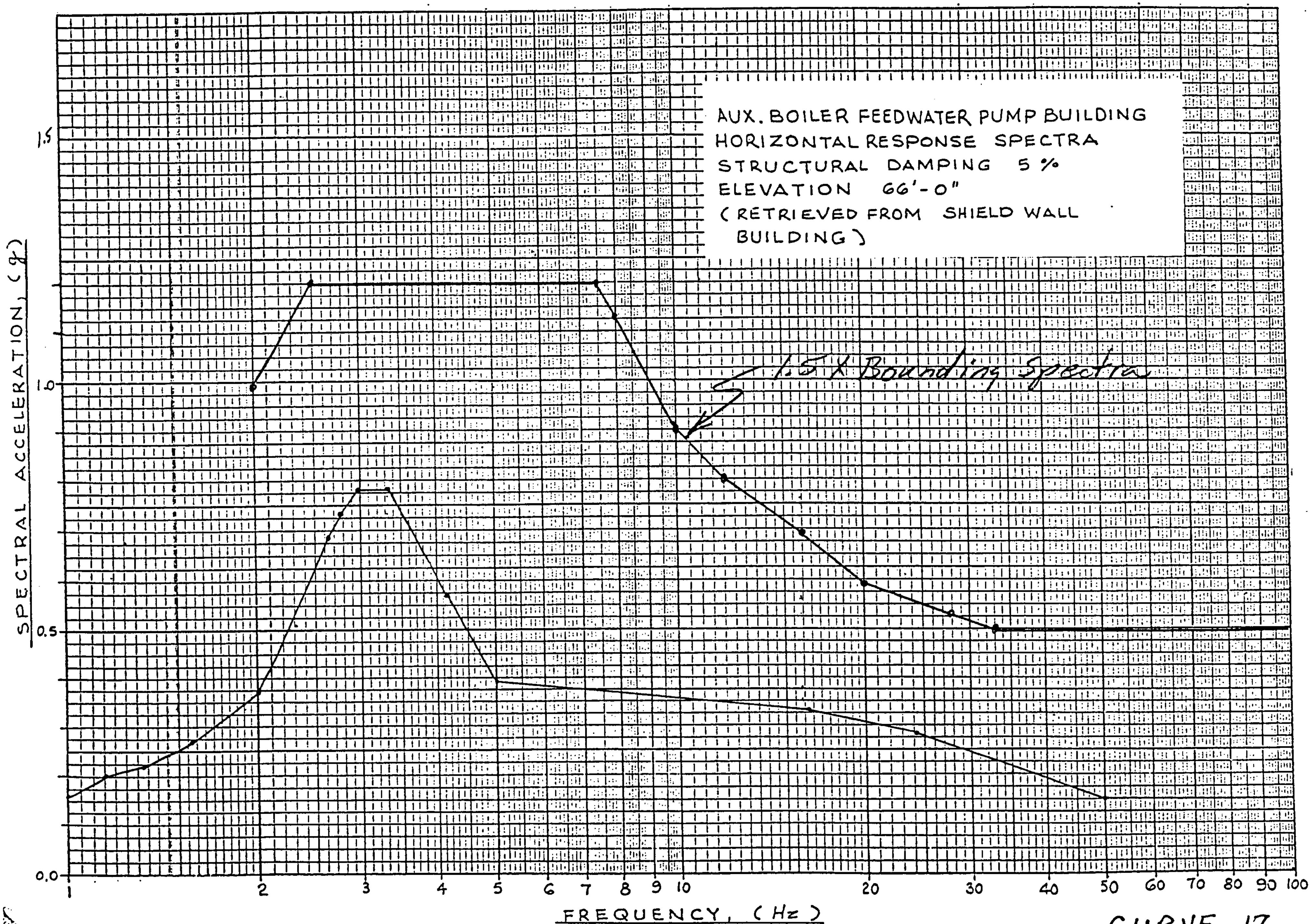
CURVE 14


AUX. BOILER FEEDWATER PUMP BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5 %
ELEVATION 42'-0"
(RETRIEVED FROM SHIELD WALL BUILDING)
1.5% Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

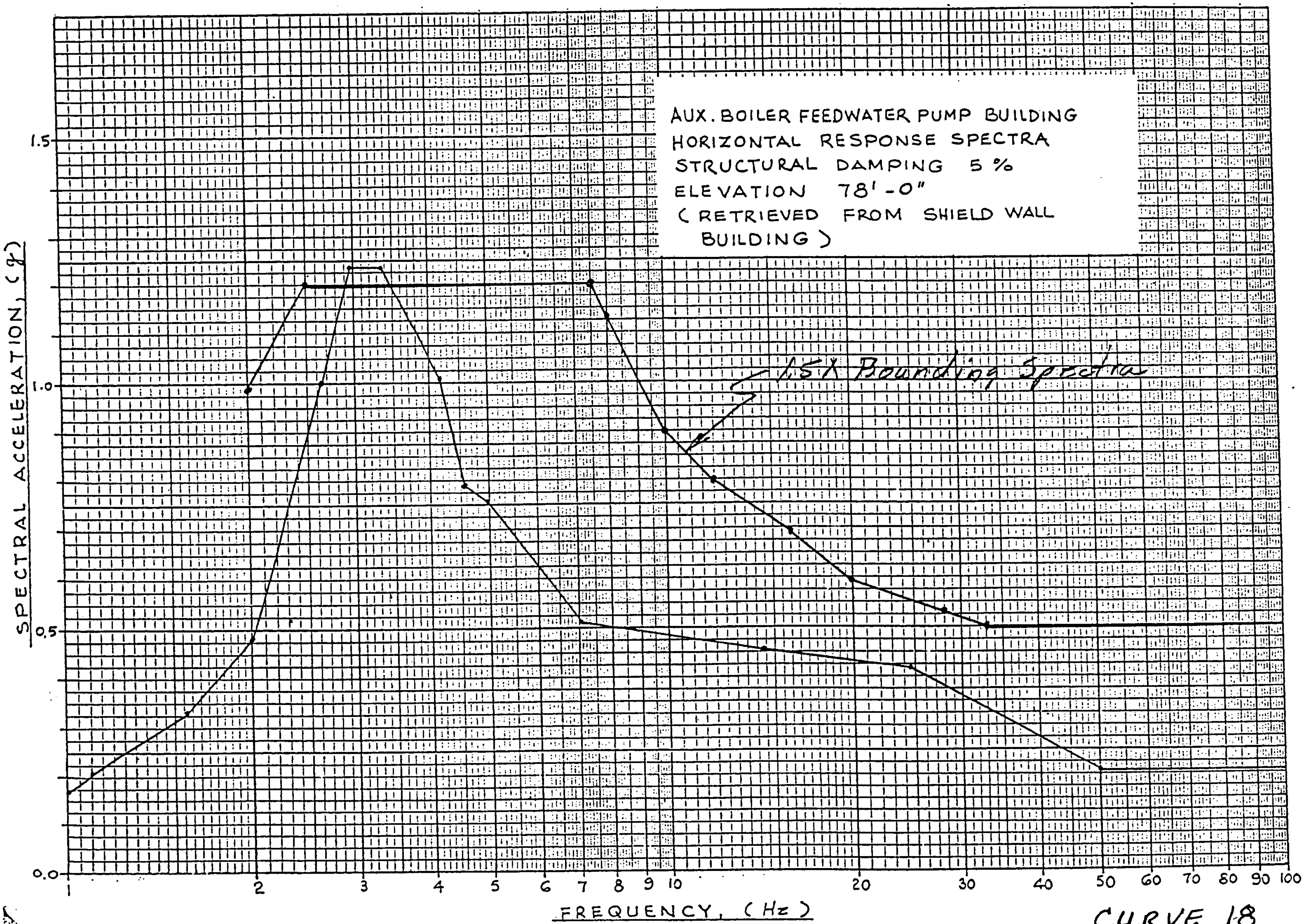
CURVE 15


AUX. BOILER FEEDWATER PUMP BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5 %
ELEVATION 54'-0"
(RETRIEVED FROM SHIELD WALL BUILDING)
1.5X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

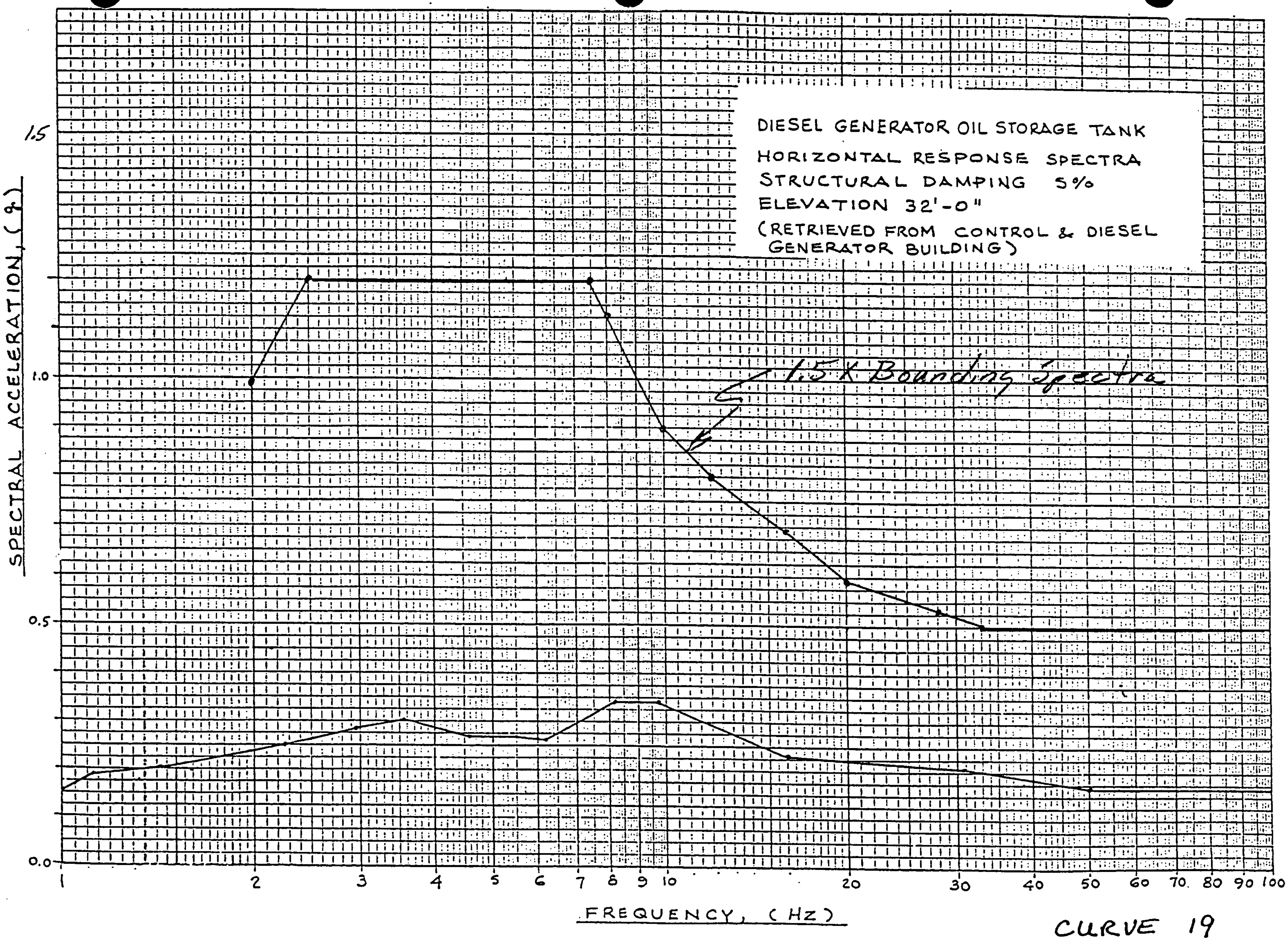
CURVE 16


AUX. BOILER FEEDWATER PUMP BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5 %
ELEVATION 66'-0"
(RETRIEVED FROM SHIELD WALL BUILDING)
1.5 x Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

CURVE 17

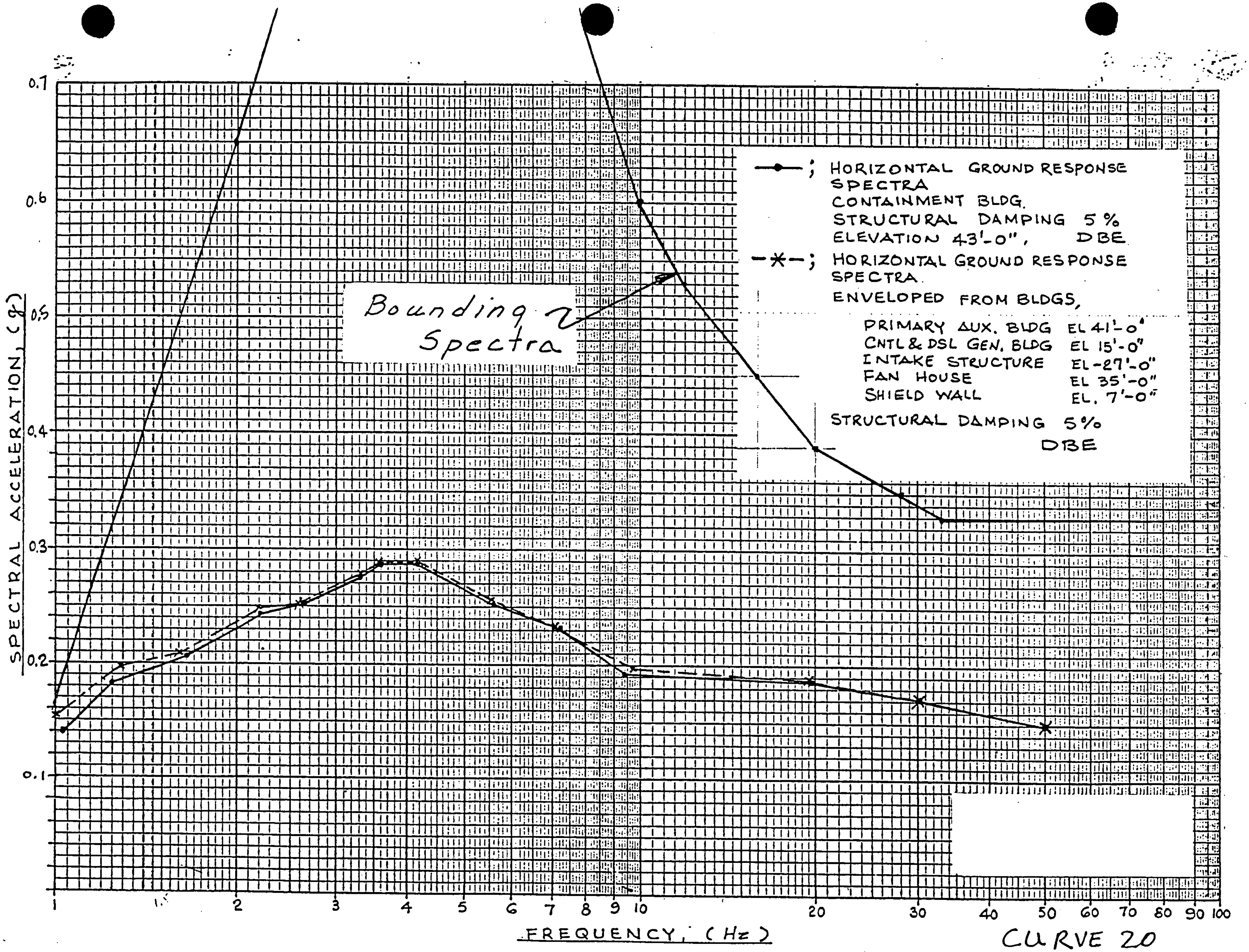

AUX. BOILER FEEDWATER PUMP BUILDING
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5 %
ELEVATION 78'-0"
(RETRIEVED FROM SHIELD WALL BUILDING)
1.5 X Bounding Spectra
SPECTRAL ACCELERATION, (g)
0.0
0.5
1.0
1.5
FREQUENCY, (Hz)
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100

CURVE 18



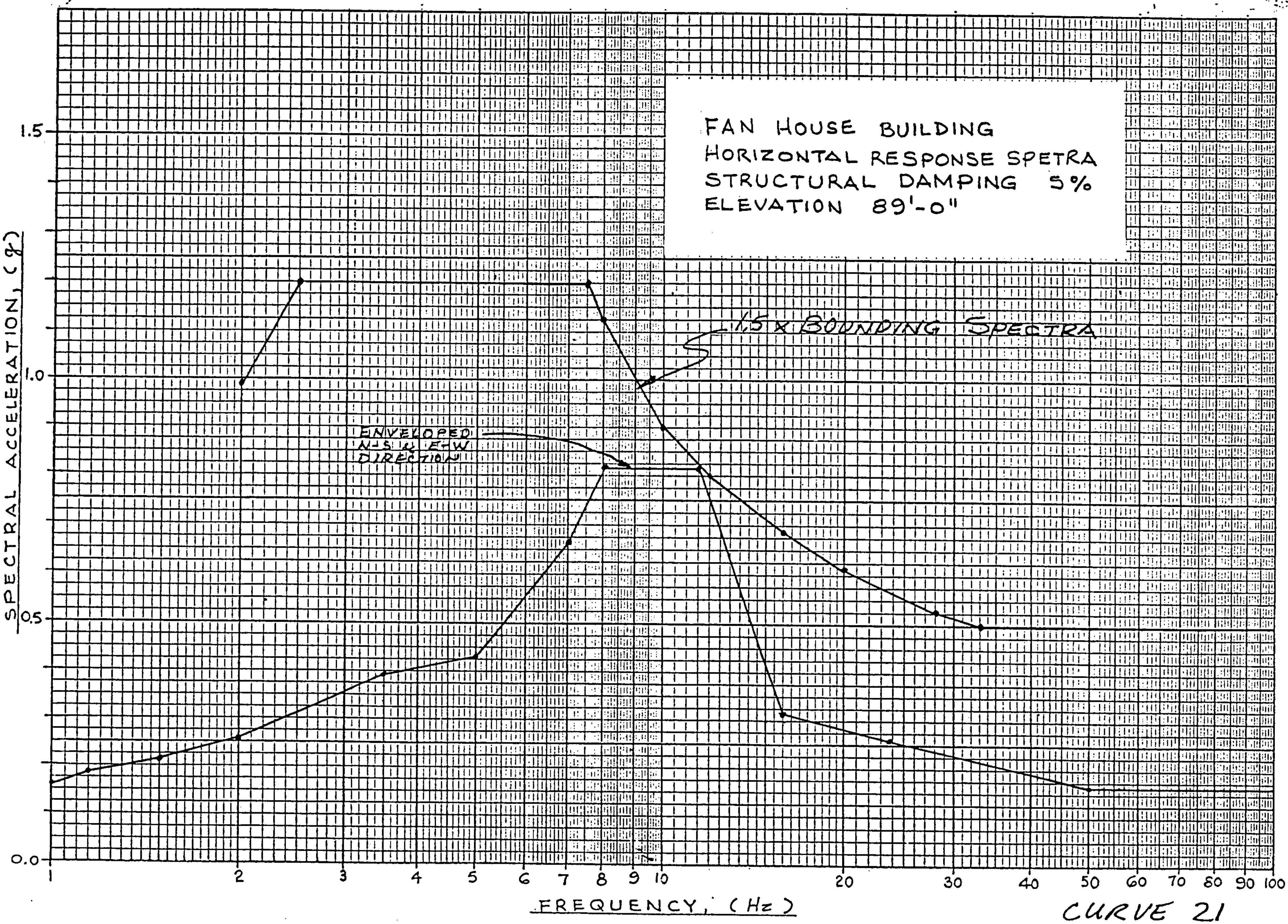
DIESEL GENERATOR OIL STORAGE TANK
HORIZONTAL RESPONSE SPECTRA
STRUCTURAL DAMPING 5%
ELEVATION 32'-0"
(RETRIEVED FROM CONTROL & DIESEL GENERATOR BUILDING)
1.5 X Bounding Spectra
SPECTRAL ACCELERATION, (g)
1.5
1.0
0.5
0.0
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)

CURVE 19



0.7
0.6
0.5
0.4
0.3
0.2
0.1
SPECTRAL ACCELERATION, (g)
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
FREQUENCY, (Hz)
Bounding Spectra
; HORIZONTAL GROUND RESPONSE SPECTRA
CONTAINMENT BLDG.
STRUCTURAL DAMPING 5%
ELEVATION 43'-0", DBE
; HORIZONTAL GROUND RESPONSE SPECTRA
ENVELOPED FROM BLDGS,
PRIMARY AUX. BLDG EL 41'-0"
CNTL & DSL GEN. BLDG EL 15'-0"
INTAKE STRUCTURE EL -27'-0"
FAN HOUSE EL 35'-0"
SHIELD WALL EL. 7'-0"
STRUCTURAL DAMPING 5%
DBE

CURVE 20


FAN HOUSE BUILDING
HORIZONTAL RESPONSE SPETRA
STRUCTURAL DAMPING 5%
ELEVATION 89'-0"
1.5 x BOUNDING SPECTRA
ENVELOPED N-S & E-W DIRECTION
SPECTRAL ACCELERATION, (g)
FREQUENCY, (Hz)
0.0
0.5
1.0
1.5
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
CURVE 21

Attachment 2 to IPN-97-041

Response to Request for Additional Information on the Resolution of Unresolved Safety Issue A-46

Indian Point 3 Nuclear Power Plant
Docket No. 50-286

SQUG

Certificate of Achievement

This is to Certify that

Mara Lakis

has Completed the SQUG Walkdown Screening
and Seismic Evaluation Training Course
Held November 9-13, 1992

Neil P. Smith, Commonwealth Edison
SQUG Chairman

David A. Freed, MPR Associates
SQUG Training Coordinator

Robert P. Kassawara, EPRI
SQUG Program Manager