VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

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Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY
SURRY POWER STATION UNITS 1 AND 2
GENERIC LETTER 87-02 – UNRESOLVED SAFETY ISSUE (USI) A-46
REQUEST FOR ADDITIONAL INFORMATION

In a letter dated November 26, 1997 (Serial No. 97-664), Virginia Electric and Power Company provided a plant-specific summary report in response to Generic Letter 87-02 that addressed the seismic qualification program for mechanical and electrical equipment at Surry Power Station relative to the resolution of USI A-46. In a letter dated September 11, 1998, the NRC requested additional information to facilitate the completion of its review. Our response to the ten questions included in the NRC request is provided in the enclosure.

As noted in the above referenced letter, we are still planning to 1) disposition the outliers, as defined by GIP-2 and that have not been resolved to date, by the end of the Surry Unit 2 refueling outage currently scheduled to commence in September 2000, and 2) notify the NRC when the planned actions for resolution of USI A-46 have been completed.

If you have further questions or require additional information, please contact us.

Very truly yours,

David A. Christian

D. A. Christian
Vice President - Nuclear Operations

Enclosures

A025

Existing commitments noted in this letter:

1. Outliers, as defined by GIP-2, that have not been resolved to date will be completed by the end of the Surry Unit 2 refueling outage currently scheduled to commence in September 2000.

2. Virginia Electric and Power Company will notify the NRC when the planned actions for resolution of USI A-46 have been completed.

cc: U.S. Nuclear Regulatory Commission
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Mr. R. A. Musser
NRC Senior Resident Inspector
Surry Power Station

50-280 VEPC SURRY 1

RESPONSE TO NRC RAI RE UNRESOLVED SAFETY ISSUE (USI) A-46

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- NOTICE -

ENCLOSURE 1

Response to NRC Request for Additional Information
Generic Letter 87-02

Surry Power Station Units 1 and 2

ENCLOSURE 1

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION
GENERIC LETTER 87-02
SURRY POWER STATION UNITS 1 AND 2

NRC Question No. 1

In Section 10, "Significant and Programmatic Deviations from the GIP," of the referenced submittal, the seismic margin methodology described in the EPRI report NP-6041, including the use of High-Confidence-of-Low-Probability of Failure (HCLPF) capacity, was used to verify the seismic adequacy of some equipment items, including tanks and heat exchangers. The conservatism of the above methodology is not certain when compared to the GIP-2 guidelines. Its application is, therefore, not endorsed by the NRC for the analysis of safety-related systems and components, including the resolution of USI A-46 mechanical, electrical and structural component outliers. You are requested to reevaluate the portion of your USI A-46 program where such methodology has been employed, to ensure that the method of evaluation conforms to the GIP-2 guidelines or is otherwise acceptable to the staff.

Virginia Power Response:

Background:

In our letter to the NRC dated September 18, 1992 (Serial No. 92-384), "120-day Response to Supplement 1 to Generic Letter 87-02," we noted that, "The USI A-46 program will be integrated with the seismic IPEEE program, forming a single cost effective program, and minimizing unnecessary duplication of examination and review effort." The staff, in its safety evaluation report dated November 20, 1992 (Serial No. 92-763), did not disagree that the two programs could be integrated, and stated that, "The staff interprets your response as a commitment to the entire GIP-2....and therefore considers it acceptable."

Comments/Evaluation:

The staff's interpretation in the SER was correct in that we have performed our USI A-46 evaluations in accordance with the GIP-2 methodology, with a few minor exceptions that were noted in past correspondence to the NRC and in the summary report submitted to the staff in November 1997. However, we did integrate elements of the USI A-46 program, such as walkdowns, with the IPEEE (seismic) program. Another element, which was followed in a few instances, was to avoid duplication of analyses, if justified. When a USI A-46 analysis of a component demonstrated that there was a sufficiently large factor of safety, that component was screened out from further IPEEE evaluation. Conversely, if an IPEEE calculation was done first and the component's capacity was determined to be very high, then, based on engineering judgment of the results, we may not have performed an explicit USI A-46 calculation. Cases in this category were rare and were typically applicable only to equipment anchorage calculations. Exceptions include the Emergency Condensate Storage Tanks (ECST), which are discussed below, and the Refueling Water Storage Tanks (RWST), which are discussed in our response to Question 9.

An example where only an IPEEE anchorage calculation was performed is the Charging Pump Seal Cooling Surge Tanks. The calculation for this tank has been revised as part of our response to Question 9 below and is enclosed for the staff's review. Consistent with our initial review and the judgement of our consultant, who prepared the original calculation, it is evident from this revision that the tank has substantial safety margin in its anchorage when using the GIP-2 methodology and criteria.

Emergency Condensate Storage Tanks (1/2-CN-TK-1):

For the ECST, a calculation was initially performed in accordance with the methodology provided in GIP-2. It showed that the overturning capacity of the tank was unacceptable. Based on this determination, the tank was identified as an outlier. To resolve this outlier, a re-assessment of the overturning capacity of the tank was performed that included consideration of the fluid hold-down forces. The hold-down forces resulting from fluid pressure acting on the tank bottom contribute significantly to the overturning capacity of the tank. The GIP methodology does not have any provision or guidelines to allow the consideration of the fluid hold-down forces. Therefore, the fluid hold-down forces were estimated using the method discussed in EPRI Report NP-6041, Appendix H, which in turn appears to be based primarily on the following three references:

1. W. Flugge, Stresses in Shells, Springer-Verlag, 1960.

2. G. C. Manos, "Earthquake Tank Wall Stability of Unanchored Tanks", Journal of Structural Engineering, Vol. 112, No. 8, ASCE, August 1986, pp 1863-1880.

3. M. A. Haroun and H. S. Badawi, "Nonlinear Axisymmetric Uplift of Circular Plates", Dynamics of Structures, ASCE, August 1987, pp 77-89.

In this method, a slightly conservative linear expression between the fluid hold-down forces and uplift displacement is used. An iterative procedure was utilized and the maximum elongation of the bolt/chair of anchorage was limited to 0.25". Two cases of permissible uplift elongation were analyzed. The case that provided the smaller moment capacity showed a factor of safety against overturning of 1.8. Thus, the ECST is adequate to withstand the design basis seismic loads.

The above procedure is technically sound and does not utilize any non-conservative or probabilistic aspects of the methodology that may be prescribed elsewhere in EPRI Report NP-6041.

Summary:

It is emphasized that for the vast majority of components, especially for large components, explicit calculations in accordance with the GIP-2 methodology were performed during the USI A-46 review. The evaluation methods and deviations from the

GIP methodology for the ECSTs, as described above, and for the RWSTs, as discussed in our response to Question 9 below, are justifiable and conservative. Other than these two tanks, no element of EPRI Report NP-6041 was used to verify the seismic adequacy of a USI A-46 equipment item that was less conservative than the GIP-2 methods.

Therefore, our approach meets the GIP-2 guidelines, and no further re-evaluation of the USI A-46 program is warranted. In addition, for the resolution of the outstanding USI A-46 outliers, we do not plan to use the probabilistic methods of IPEEE or the less conservative criteria of EPRI Report NP-6041, but will use evaluation methods that we believe are acceptable to the staff.

NRC Question No. 2

Provide the current status for the identified outliers and plant installation deficiencies, including, but not limited to, those listed in Table 11.2-1 of the referenced submittal.

Virginia Power Response:

The summary report submitted to the staff in November 1997 identified unresolved outliers related to electrical/mechanical equipment, relays, and cable and conduit raceway systems. The current status of the resolution of these outliers and/or plant installation deficiencies is provided below:

- Status of Outliers for Mechanical/Electrical Equipment and Essential Relays:

  Table 11.2-1, List of Outstanding Outliers and Issues, in the summary report submitted to the staff in November 1997 contained a list of issues that remained open at the time of the submittal. The current resolution status of each item is shown, in bold letters, in the Updated Table 11.2-1 below. Of the 14 items (related to 35 components) which were unresolved at the time of the submittal, 7 have been completely resolved, 3 are in progress, and 4 remain to be addressed.

- Status of Outliers for Cable and Conduit Raceway Systems:

  Several condulet covers were missing in the cable vault and tunnel area and in the Service Building and Turbine Building. Some anchor bolts were noted missing in base plate supports for conduits in the Turbine Building. To resolve these deficiencies, work requests were issued to the Station. Approximately half of these deficiencies have been corrected and verified to date. A verification will be performed upon completion of the work to ensure that the deficiencies are satisfactorily resolved.

As committed in the summary report, all the remaining outliers and installation deficiencies will be resolved no later than the end of the Surry Unit 2 outage, currently scheduled to commence in September 2000.

Updated Table 11.2-1
Resolution Status of Outstanding Outliers for
Mechanical/Electrical Equipment and Essential Relays

ITEM NO.	DESCRIPTION OF OUTLIER/ISSUE	EQUIPMENT MARK NUMBER	PREVIOUS RESOLUTION PLAN/ **CURRENT STATUS (BOLD)**
1	Cabinet contains essential relays and is not connected to the adjacent cabinet. The cabinet also has a low ruggedness relay (Westinghouse-SV).	3-EE-PNL-35	Field Change to Design Change Package 93-033-3 has been issued to bolt the cabinet to adjacent cabinet. Also, the low ruggedness relay is planned to be replaced via Station approved Design Change 95-017. **The cabinets have been bolted together per the Design Change. The SV relay in the cabinet (for EDG No. 3) was replaced by a seismically qualified Wilmar relay per the Design Change. This outlier/issue is closed.**
2	A low ruggedness relay (Westinghouse - SV) was found in these cabinets.	1-AP-CC-35-1 2-AP-CC-35-2	The low ruggedness relay is planned to be replaced via Station approved Design Change 95-017. **The low ruggedness SV relay was replaced by a seismically qualified Wilmar relay in cabinet 2-AP-CC-35-2 (EDG No. 2). For cabinet 1-AP-CC-35-1 (EDG No. 1), the SV relay is planned to be replaced in February 1999, during the Diesel outage. This outlier/issue is partially complete, and the remaining effort is in progress.**
3	MCC cabinet contains essential relays, is not connected to an adjacent cabinet, and the anchorage is to be enhanced.	1-EP-MCC-1J1-1A	Field Change to Design Change Package (DCP) 93-033-3 has been issued to bolt MCC cabinet to adjacent cabinet and to enhance MCC cabinet anchorage. **The cabinets were bolted together and the anchorage was modified per the DCP. This outlier/issue is closed.**

ITEM NO.	DESCRIPTION OF OUTLIER/ISSUE	EQUIPMENT MARK NUMBER	PREVIOUS RESOLUTION PLAN/ **CURRENT STATUS (BOLD)**
4	The nuts for some of the bolts connecting the transformer coils to the base channels are loose (up to 1/8"). Also, a tightness check was not performed for the transformer cabinet anchor bolts.	1-EP-TRAN-1H 1-EP-TRAN-1H1 1-EP-TRAN-1J 1-EP-TRAN-1J1 2-EP-TRAN-2H 2-EP-TRAN-2H1 2-EP-TRAN-2J	The nuts for the bolts connecting the transformer coils to the base channels will be tightened and a tightness check will be performed for the representative samples of the transformer cabinet anchor bolts. **The nuts for the bolts connecting the transformer coils to base channels have been tightened for all the transformers. A tightness check was performed for the anchor bolts of Unit 1 transformers. The accessible anchor bolts were found to be tight. Based on this, the inaccessibility of some of the anchor bolts in the Unit 2 transformers, and past results of bolt tightness checks of almost all USI A-46 components, it is concluded that both Unit 1 and Unit 2 transformer anchor bolts are adequate and need not be further reviewed. This outlier/issue is closed.**
5	The gaps between batteries do not have close-fitting, crush-resistance fillers.	1-SW-B-1A 1-SW-B-1B 1-SW-B-1C	A Field Change to DCP 93-033-3 will be issued to install the fillers. **This issue remains to be resolved.**
6	These dampers are class "0" items of equipment that are not covered by GIP.	1-VS-SAD-22A 1-VS-SAD-22B 1-VS-SAD-22C	Guidelines provided by SQUG for this type of equipment will be reviewed to assess their applicability and adequacy. **This issue remains to be resolved.**
7	This switchgear cabinet is missing base plug welds at some locations.	1-EP-SW-1H	The anchorage will be enhanced through a Field Change to DCP 93-033-3. **The missing plug welds were refurbished per the above DCP. This outlier/issue is closed.**
8	Further evaluation of the fan housing mounting is to be performed.	MOD-VS-58A MOD-VS-58B	Further walkdown and anchorage evaluation will be performed. **A walkdown and a subsequent evaluation were completed. The mounting is adequate. This outlier/issue is closed.**
9	These MCCs are back-to-back and tied together at the end cabinet bays	1-EP-MCC-1J1-2E 1-EP-MCC-1J1-2W 1-EP-MCC-1H1-2N	Further review of the cabinets' displacement will be performed. If required, the center bays will be bolted together to prevent

ITEM NO.	DESCRIPTION OF OUTLIER/ISSUE	EQUIPMENT MARK NUMBER	PREVIOUS RESOLUTION PLAN/ **CURRENT STATUS (BOLD)**
	only. A potential exists for seismic interaction of the center bays.	1-EP-MCC-1H1-2S 2-EP-MCC-2J1-2E 2-EP-MCC-2J1-2W 2-EP-MCC-2H1-2N 2-EP-MCC-2H1-2S	potential interaction. **The center bays of the MCCs for Unit 1 were bolted together per the Design Change. The Unit 2 MCCs will be bolted together in April 1999 (Unit 2 outage). This outlier/issue is partially complete, and the remaining effort is in progress.**
10	CH/BAST C Temperature elements have a potential of interaction with adjacent conduit supports and require anchorage evaluation.	1-CH-TIC-1103 1-CH-TIC-1166	Interaction concern will be verified through further walkdown and the anchorage evaluation will be performed. If required the anchorage will be enhanced. **A walkdown and a subsequent evaluation were completed. The anchorage is adequate. This outlier/issue is closed.**
11	The type of bolted connection (friction vs. bearing type) in the support frame is unknown.	1-CC-TK-1	Further evaluation of the bolt connection will be performed and if required, the connection will be modified. **An additional review was performed and it was found that the bolting connection is friction type, therefore it is not a concern. This outlier/issue is closed.**
12	Control Room (CR) ceiling panels may require reinforcement to prevent their falling during a SSE, and the potential to injure operators.	CR ceiling	CR ceiling panels will be reviewed. If required, they will be tied together with clips to prevent their falling during a SSE. **This issue remains to be resolved.**
13	Fuel oil level indicator sight tube is glass, which is a brittle material.	1-EE-TK-3 1-EE-TK-4 2-EE-TK-3	A Field Change to DCP 93-033-3 will be issued to replace indicator sight tubes. **This issue remains to be resolved.**
14	Housekeeping/Conduct of Maintenance issues.	In areas containing safe-shutdown components.	A procedure will be written and implemented at the station to address these issues. **A draft procedure has been prepared and is expected to be implemented in 1999. This outlier/issue is partially complete, and the remaining effort is in progress.**

NRC Question No. 3

In an attachment to the referenced submittal, the peer review walkdown report identified a number of concerns related to installation deficiencies. You are requested to elaborate on your actions to address and satisfactorily resolve the identified concerns.

Virginia Power Response:

The peer review walkdown report identified specific concerns and noted these concerns in Appendix C of the summary report submitted to the staff in November 1997. In some instances, the concerns were identified and noted by the reviewer because the Surry USI A-46 effort was in progress at the time of the peer review. However, each of the concerns noted in the peer reviewer's report has been reviewed and dispositioned as stated in section 9 of the summary report submitted to the staff in November 1997. In many cases, a subsequent walkdown, evaluation, analysis or work at the plant was performed to satisfactorily resolve the issue.

A brief description of the actions taken to resolve those peer review concerns, such as anchorage modification for MCCs which were completed prior to the summary report submittal date, is provided in section 11.1 of the summary report.

The major peer review issues that remained open as of November 1997 were listed together with other outliers in Table 11.2-1 of the summary report. A brief status of these issues, as well as the other outliers and plant installation deficiencies is provided in our response to Question No. 2 above (reference Updated Table 11.2-1). Some of the issues, such as the tightness of the nuts for the bolts connecting transformer coils to base channel, have been resolved since the transmittal of the summary report. Other issues, such as control room ceiling diffuser panels, gaps between battery cells, and housekeeping issues are in progress or yet to be addressed. However, all the outstanding peer review issues/installation deficiencies will be resolved no later than the end of the Surry Unit 2 outage, currently scheduled to commence in September 2000. Also, consistent with the requirements of the GIP, detailed documentation of the resolution of each issue is being retained in supporting data packages.

NRC Question No. 4

It is stated in the referenced submittal that for all buildings and elevations where (SSEL) equipment is located in the Surry plant, the in-structure response spectra (ISRS) are enveloped by the Reference Spectrum or the 1.5 x Bounding Spectrum of the GIP. You are requested to provide the ISRS at the highest elevations where SSEL equipment items are located in each building, and demonstrate their enveloping by the Reference Spectrum.

Virginia Power Response:

The structures and the highest elevations where Safe Shutdown Equipment List (SSEL) equipment items are located at Surry Power Station Units 1 and 2 are listed below.

These locations are also listed in the Screening Verification Data Sheets (SVDS), which were included in the summary report submitted to the staff in November 1997.

Structure	**Highest elevation of SSEL equipment**
Auxiliary Building	45'
Reactor Containment[1]	64'
Containment Spray Pump House	27'
Main Steam Valve House[2]	62'
Service Building[3]	45'
Safeguards Building	27'
Turbine Building[4]	64'
Emergency Service Water Pump Intake Structure[5]	22.9'
Fuel Oil Pump House[6]	16'

Comparisons of ISRS (envelope of both horizontal directions) at 5% spectral damping at the above locations and the 1.5 x Bounding Spectrum (Reference Spectrum) of the GIP are provided in Enclosure 2. This comparison demonstrates that the Reference Spectrum completely envelops the ISRS or meets the intent.

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1 Enveloping of ISRS of both the internal and the external structures is provided at this elevation.

2 Peaks are extrapolated from 1% damping ISRS to obtain 5% damping ISRS for comparison with the Reference Spectrum. A few valves are located at elev. 62', and a slight excursion near 2 hz. is judged to meet the intent of GIP.

3 The Emergency Diesel Generator Rooms are included in the model for the Service Building. It is also noted that the Reactor Trip Breakers are located in this building at elevation 45' within a compact structural hut. Although they are top braced to the hut at elevation 54', the ISRS at elevation 45' was judged to be applicable. This is the highest elevation in this building containing any SSEL equipment item.

4 No new analysis was done for the Turbine Building to generate ISRS. The conservative, design ISRS at all elevations in this building is based on the Taft earthquake input and was developed in the 1971 time frame for 1% spectral damping. From this, ISRS at 5% spectral damping was recently developed, and is compared with the 5% damped Reference Spectrum of the GIP. A slight exceedance near 2 hz is judged to meet the intent of the GIP.

5 No Housner basis design ISRS was developed for this structure. A study concluded that the ISRS is not larger than 1.2 times the ground spectrum at the highest elevation where SSEL components are located in this building.

6 This is a compact structure, and SSEL components are located below the grade level. Therefore, the ISRS is judged to be less than 1.2 times the ground response spectrum.

NRC Question No. 5

Section 4.4.1 of GIP-2 states that all accessible anchorages should be visually inspected. State whether you have visually inspected all accessible anchorages. If not, provide your reasons for not doing so.

Virginia Power Response:

All accessible anchorages were visually inspected.

NRC Question No. 6

State whether you have performed a tightness check on anchorages in accordance with GIP-2 provisions and what sampling method was used.

Virginia Power Response:

In accordance with GIP-2, the tightness check was accomplished by applying a torque to the anchor by hand until the anchor was "wrench tight." If the expansion anchor or nut rotated less than about ¼ turn, then the anchor was considered tight. Except for a very few anchor bolts, the tightness of the expansion anchor bolts was found to be adequate. The few expansion anchors that turned more than a ¼ turn prior to achieving "wrench tight" were noted on the SEWS.

Rather than using the sampling method provided in GIP-2, a tightness check was performed for almost all accessible expansion anchor bolts. The population of anchor bolts checked for tightness was sufficient to meet GIP-2 anchor bolt tightness check criteria and was able to assure proper anchor bolt installation.

NRC Question No. 7

State whether you have performed inspections for "Gap at Threaded Anchors" (check 6 of GIP-2), "Spacing between Anchors" (check 7 of GIP-2), "Edge Distance" (check 8 of GIP-2), "Concrete Strength and Condition" (check 9 of GIP-2), "Concrete Crack Locations and Sizes" (check 10 of GIP-2), "Essential Relays in Cabinets" (check 11 of GIP-2), "Base Stiffness and Prying Action" (check 12 of GIP-2), and "Embedment Steel and Pads" (check 14 of GIP-2). If yes, describe your inspection procedures and results of the inspection.

Virginia Power Response:

All of the above mentioned inspections were performed during the walkdown and review of the components on the SSEL. The inspection procedures used were based on the GIP-2 methodology. During the inspections, concerns or unusual attributes related to anchorage were noted on the SEWS. Typical anchorage concerns or unusual attributes noted were reduced spacing between anchors, reduced edge distance, and base stiffness and prying action. These concerns or unusual attributes were addressed in the anchorage evaluations. For example, anchor bolt capacities were reduced in accordance with GIP-2 to address reduced spacing between anchor bolts. In most of these cases, the component anchorage satisfied the GIP-2 screening guidelines. Components not satisfying the GIP-2 screening guidelines were listed as outliers. A summary of the outliers and their resolution relative to anchorage inspections and evaluations is provided below.

As noted in the SVDS forms (Appendix D of Summary Report), 823 components are listed on the SSEL which required a seismic review (SPS Unit 1 – 474 components; SPS Unit 2 – 349 components). Of the 823 components, an anchorage inspection and evaluation was required of approximately 500 components. The other components were in-line equipment such as valves or temperature elements for which there was no anchorage, hence, an anchorage review was not applicable. Of the 500 components, the anchorage for approximately 40 components did not pass the screening guidelines of GIP-2 and therefore were listed as outliers. The following is a list of typical reasons for component anchorages not passing the screening guidelines of GIP-2:

- Type of anchorage not covered by GIP-2.
- Cabinets do not have positive anchorage (i.e., friction relied upon).
- Missing anchor bolts.
- Multi-bay components which contain essential relays do not have anchorage in each section.
- Gap between base of equipment and surface of concrete in vicinity of anchors exceeds ¼".
- Appearance of corrosion or rust on anchorage.
- Inadequate installation.

The specific anchorage issues are detailed on the SEWS for the particular components.

To ensure adequate equipment anchorage, the anchorage for approximately half of the 40 components was or will be enhanced/modified. The anchorage for the remaining components were further reviewed and found acceptable. Most of the components for which anchorage enhancements were implemented were electrical cabinets or panels, which include MCCs and switchgear. In some of these components, the anchorage was questionable, but instead of attempting lengthy calculations to justify marginal conditions, relatively simple modifications were performed. Additionally, as part of the A-46 Program, adjacent non-SSEL components were reviewed for seismic interaction. As a result, the anchorage on several adjacent non-SSEL electrical cabinets was enhanced to ensure there would be no seismic interaction with SSEL components.

NRC Question No. 8

Identify all your large flat-bottom vertical tanks and heat exchangers and describe your procedures and criteria for verifying the adequacy of the tank shell buckling capacity (section 7.3.3.3 of GIP-2), anchorage capacity (sections 7.3.3 and 7.3.4 of GIP-2), and anchorage connection capacity (section 7.3.3.2 of GIP-2), and submit one sample calculation that demonstrates the adequacy of each of the above three capacities.

Virginia Power Response:

There are only four large flat-bottom vertical tanks in the Surry Units 1 and 2 safe-shutdown path – two emergency condensate storage tanks (ECST, 1/2-CN-TK-1) and two refueling water storage tanks (RWST, 1/2-CS-TK-1). There are no large flat bottom vertical heat exchangers in the Surry SSEL. The procedures and criteria used for the evaluation of these tanks are the same as those stated in section 7.3 of the GIP and the subsections stated above. Since these tanks were outliers, minor deviations to the GIP method for both the ECST and the RWST were used in our evaluations, as described in the response to Question No. 1 and Question No. 9, respectively. The USI A-46 calculation for the RWST is enclosed in response to Question No. 9. This calculation addresses and demonstrates the adequacy of the tank for each of the above three requested capacities.

A brief summary of tanks and heat exchangers was provided in section 7 of the summary report submitted to the staff in November 1997. As stated in this section, the review criteria used were in accordance with section II-7 of the GIP. Resolved outliers for tanks and heat exchangers were identified in section 11.1.2 of the summary report, and are further discussed in response to this request for additional information. No unresolved outlier related to tanks and heat exchangers remains. In addition, a listing and tabular summary of evaluation of the tanks and heat exchangers (class 21) in the USI A-46 program was provided in the SVDS. The SVDS were sorted by equipment class and enclosed in Appendix D of the summary report.

NRC Question No. 9

In reference to item No. 1, you are requested to verify the seismic adequacy of the charging pump seal cooling tanks and refueling water storage tanks by performing a deterministic analysis, in accordance with the GIP-2 methodology, and submit the analysis results for staff review.

Virginia Power Response:

Charging Pump Seal Cooling Surge Tanks:

The charging pump seal cooling surge tanks (1/2-CC-TK-3) are suspended tanks. Each tank is fabricated from 16" outer diameter, schedule 10 pipe and is about four feet in length. A previously performed calculation for the IPEEE (seismic) program showed that its High-Confidence-of-Low-Probability-of-Failure (HCLPF) capacity was much greater than 0.3g, expressed in terms of peak ground acceleration (pga). As requested by the staff, this calculation has been revised. The revision, which was performed in accordance with the deterministic USI A-46 methodology of the GIP, is provided as Enclosure 3. It demonstrates that the tank anchorage has substantial capacity to withstand the design basis earthquake loads based on the USI A-46 approved in-structure response spectra and the GIP-2 methodology.

Refueling Water Storage Tanks:

The refueling water storage tanks (RWST, 1/2-CS-TK-1) were evaluated per the deterministic method of GIP-2. The tanks were identified as outliers as required by the GIP due to inadequate freeboard for the sloshing mode. A further review of the calculation prepared for USI A-46 indicates that all the water in the tank (i.e., the entire weight of 3388 kips) was treated as impulsive water mass for the calculation of base shear and base overturning moment. This is conservative in comparison to using part of the water inertia load in the convective (sloshing) mode. The consequence of fluid sloshing against the tank roof was neglected for the following reasons: (a) since the sloshing height is small, the forces acting on the roof are expected to be small, (b) we are unaware of any documented failure of tank roofs in the seismic experience database due to sloshing forces, and, (c) even if the unlikely scenario of a structural failure of the tank roof in a seismic event occurs, the ability of the tank to contain water after an earthquake will not be impaired.

The calculation for the RWST, which was prepared in accordance with the GIP-2 methodology, is provided as Enclosure 4. The calculation shows that the tanks meet the GIP criteria, with the exception of the freeboard height. It is noted that a separate, independent calculation for this tank was also performed in the IPEEE (seismic) program, which also conservatively considered all the water in the tank in the impulsive mode. The calculated HCLPF capacity was 0.32g, which is more than twice the peak ground acceleration of Surry's DBE. It should be noted that the median capacity of the tank is expected to be more than twice as great.

Based on the above discussion and the attached USI A-46 calculation, it is concluded that the RWSTs have adequate capacity to withstand the design basis earthquake.

NRC Question No. 10

It is stated in the referenced submittal that buried tanks are not sensitive to seismic inertia effects and you used that argument to dispose of the outliers associated with the underground fuel oil storage tanks and emergency condensate make-up tanks. Provide sufficient technical bases to verify the adequacy of these tanks taking into account the effects of wave passage and the resulting soil pressure.

Virginia Power Response:

Two seismic evaluations were performed for the above two types of tanks and they are discussed below:

1. For seismic evaluation of the horizontal underground fuel oil storage tanks (1-EE-TK-2A/2B), see the enclosed calculation entitled "Surry Power Station Units 1 and 2, Underground Fuel Oil Storage Tanks" (Enclosure 5). As demonstrated in the enclosed calculation, the tanks are able to adequately withstand a seismic event.

2. For seismic evaluation of the horizontal emergency condensate make-up tanks (1/2-CN-TK-3), the following assessment is provided:

The material notes and design data of the tanks are provided on the drawing no. 11448-FV-33A, 100,000 GAL. EMERGENCY CONDENSATE MAKE-UP TANK 1-CN-TK-3 (Enclosure 6). The foundation of the tank site is provided on the drawing no. 11448-FC-12A, MISC. FOUNDATION SH1 (Enclosure 6). For the purpose of our seismic assessment, the following tank data is considered:

The outer diameter of the tank is 18'-0". It is 60'-4" in length and 5/8" thick. Four stiffeners are provided for every 11'-2" spacing along the longitudinal axis of the tank. The stiffeners are also provided at both heads. The tank shell and heads are made of ASTM A-285 GR C material. The weight of an empty tank is 119,000 lbs. and the weight of a full tank is 1,009,000 lbs.

One half of the tank is embedded in the ground without soil pressure from the top and it is expected that the effects of seismic wave imposed on the entire tank would be negligible. The tank is protected by a missile shield constructed of two feet thick reinforced concrete. The missile shield is intuitively rugged for the seismic loading and it would minimize tank deformation from a seismic wave, if any. Two-inch thick compressed material fills the space between the tank and the missile shield around the top-half of the tank. This material is extended into the ground for about four feet deep. This design allows for uniform distribution of the lateral and axial seismic inertia loads imposed on the tank wall to avoid any local deformations.

Five (5) pipelines are connected to the head section of the tank in the ground, six feet deep. There are one 6" inlet, two 6" outlets, one 8" outlet, and one 2" recirculation pipes. These pipes are schedule 40 and have a pipe turn/elbow within two feet from the connecting tank head. The pipelines have enough flexibility for the seismic movement.

Therefore, it is concluded that the seismic adequacy of the tanks has been demonstrated by the forgoing assessment. No further evaluation is necessary.

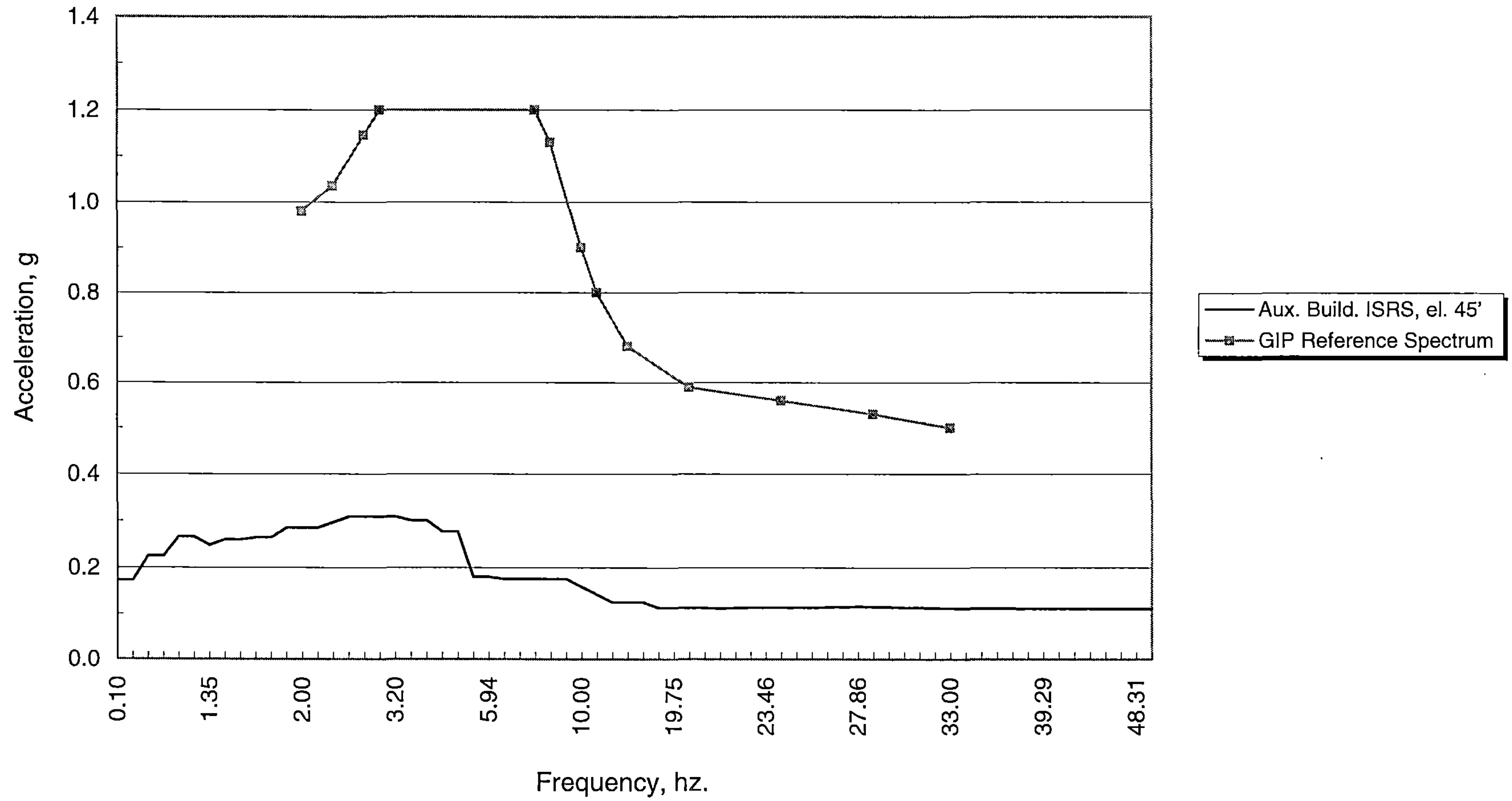
ENCLOSURE 2

Comparisons of In-Structure Response Spectra at 5% Spectral Damping and the 1.5 x Bounding Spectrum (Reference Spectrum) of the GIP

(Reference Response to NRC Question No. 4)

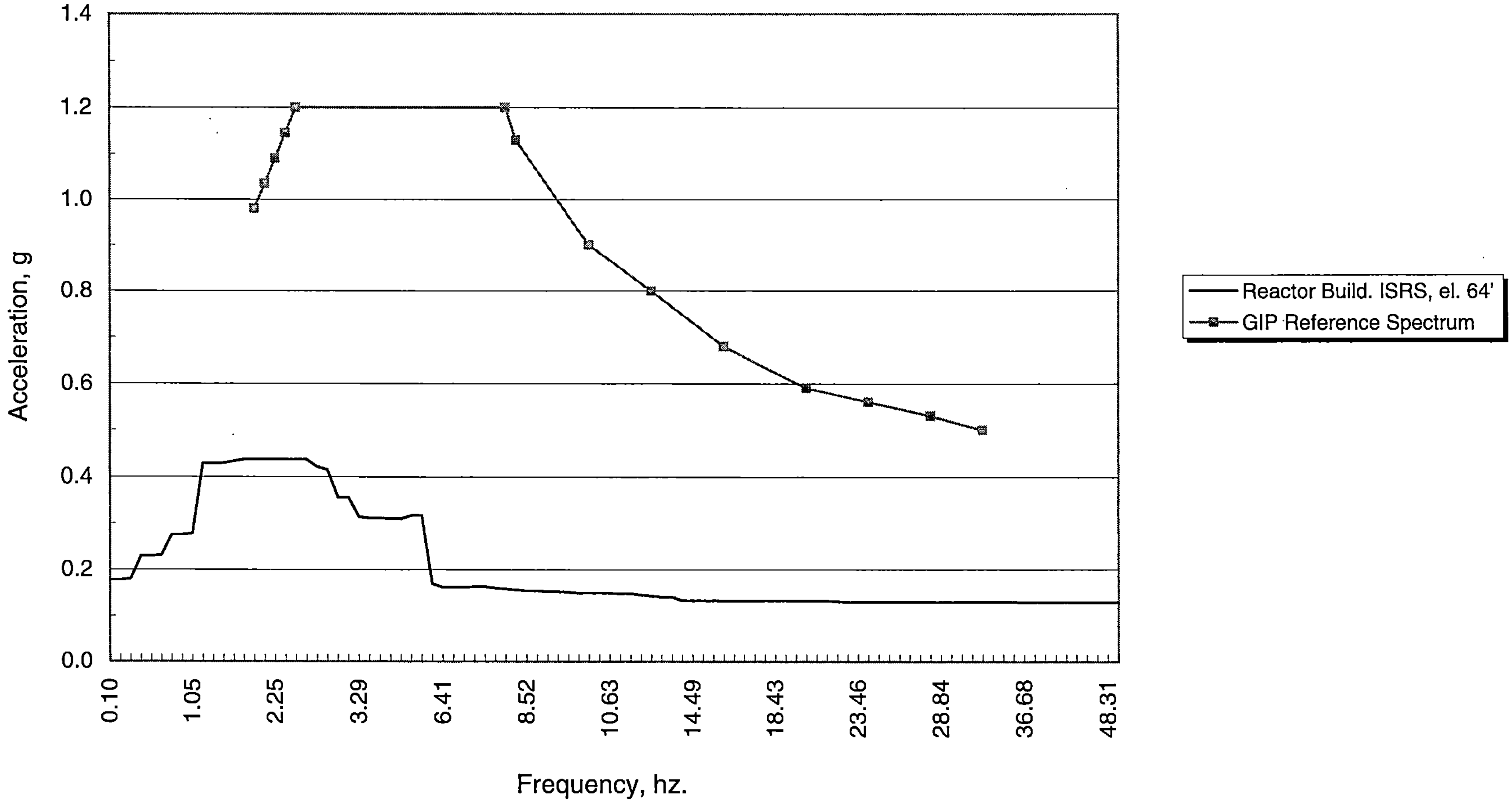
Surry Power Station Units 1 and 2

In-Structure Response Spectrum (ISRS) - Design Basis Earthquake
Auxiliary Bldg.- Elev. 45' - Horiz. Direction - 5% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



Prepared by: DB 10-8-98
Reviewed by: CJR 10-22-98

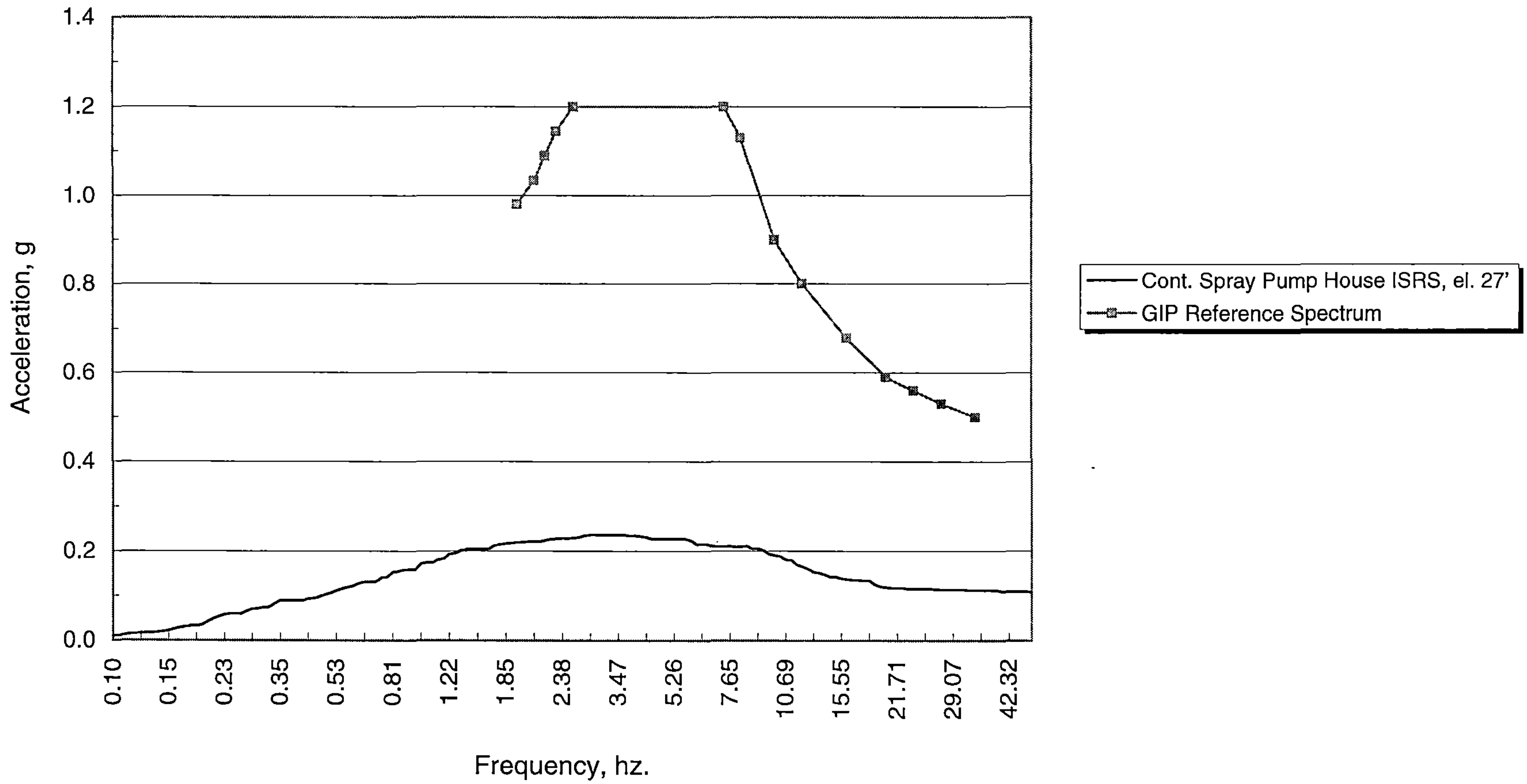
In-Structure Response Spectrum (ISRS) - Design Basis Earthquake
Reactor Building - Elev. 64' - Horiz. Direction - 5% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



Prepared by: DB 10-8-98
Reviewed by: CR 10-22-98

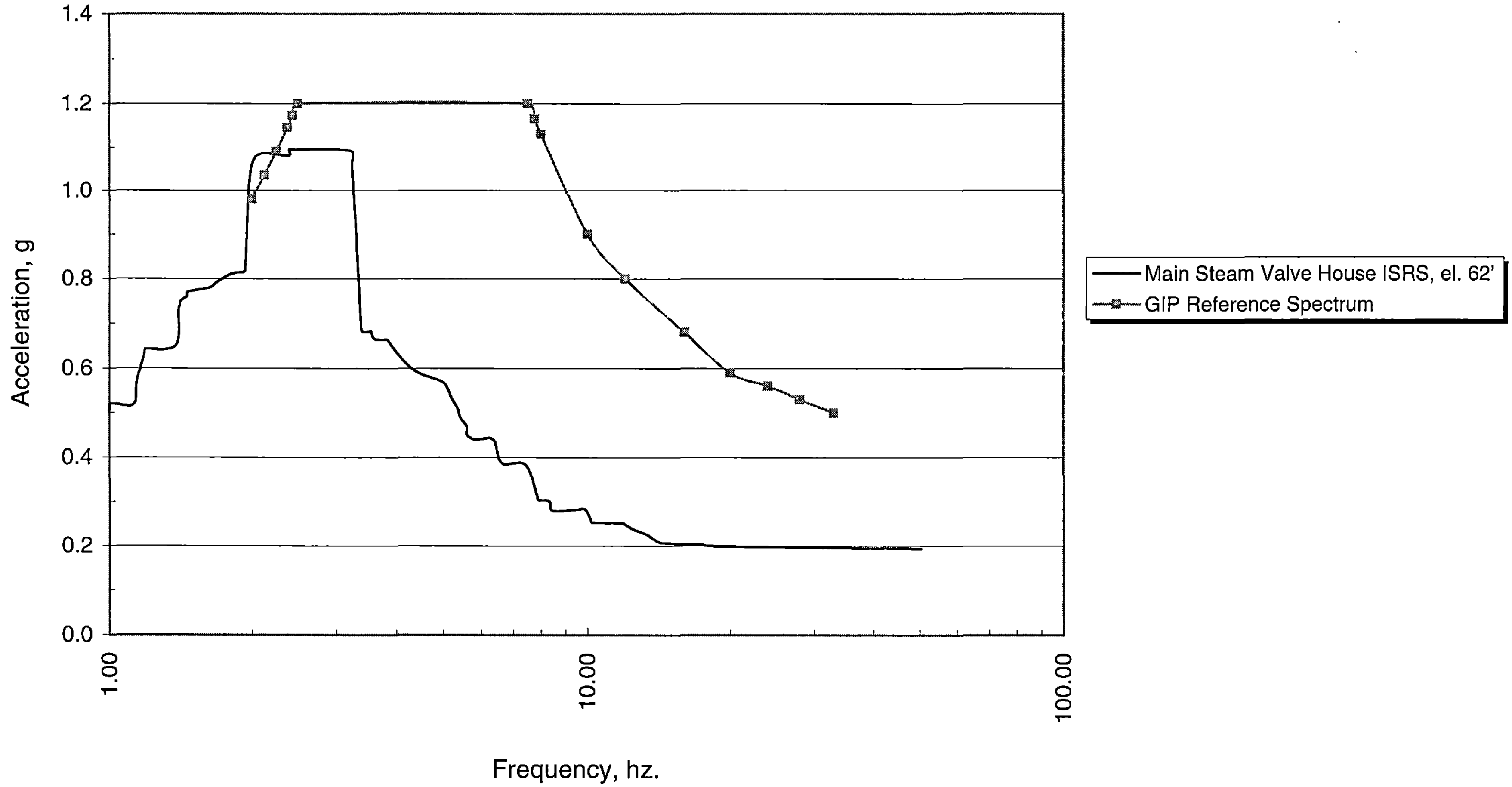
In-Structure Response Spectrum (ISRS) - Design Basis Earthquake Cont. Spray Pump House - Elev. 27' - Horiz. Direction - 5% Spectral Damping

SURRY POWER STATION UNITS 1 AND 2



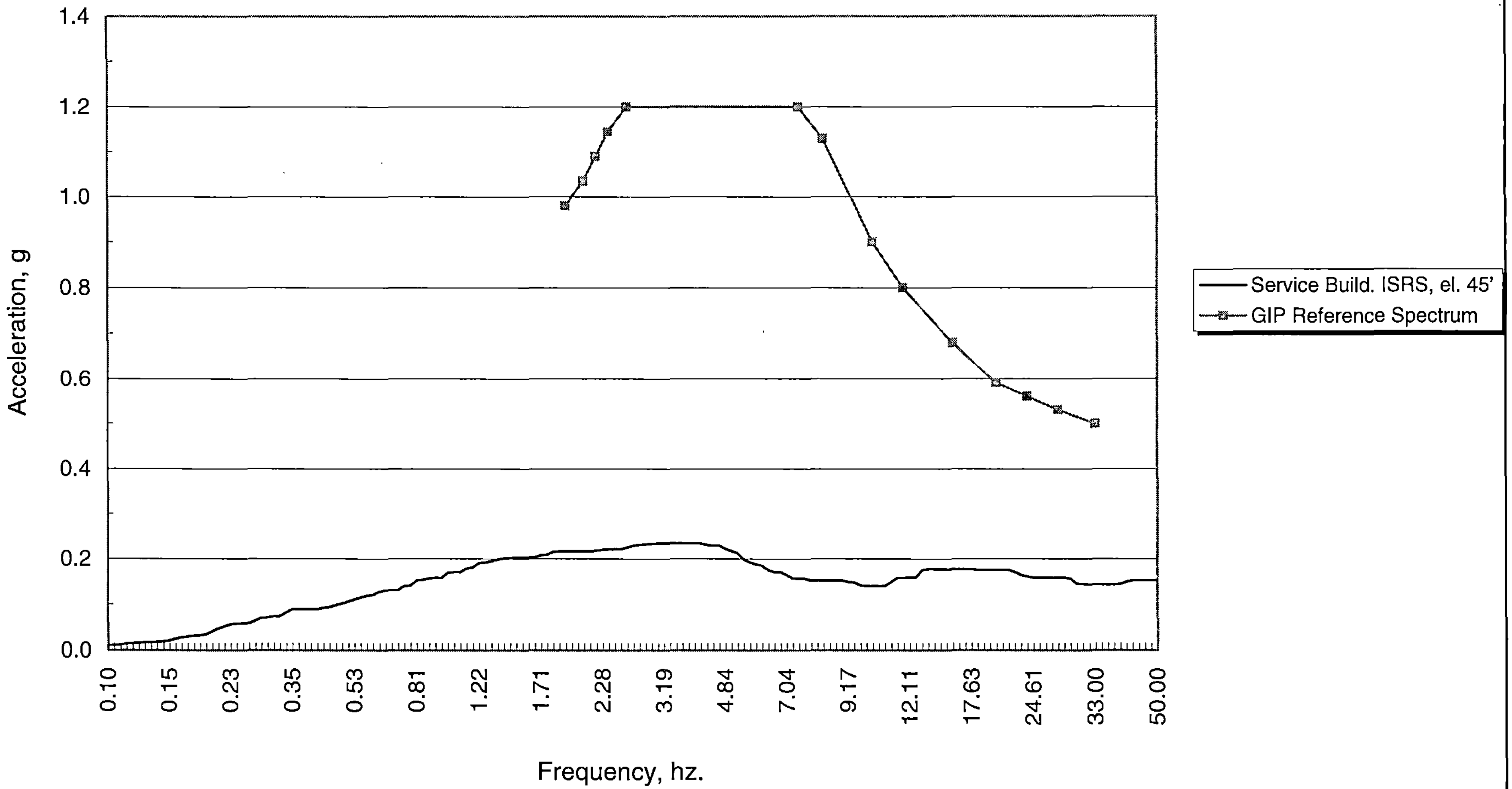
Prepared by: DB 10-8-98
Reviewed by: CHR 10-22-98

In-Structure Response Spectrum (ISRS) - Design Basis Earthquake
Main Steam Valve House - El. 62' - Horiz. Direction - 5% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



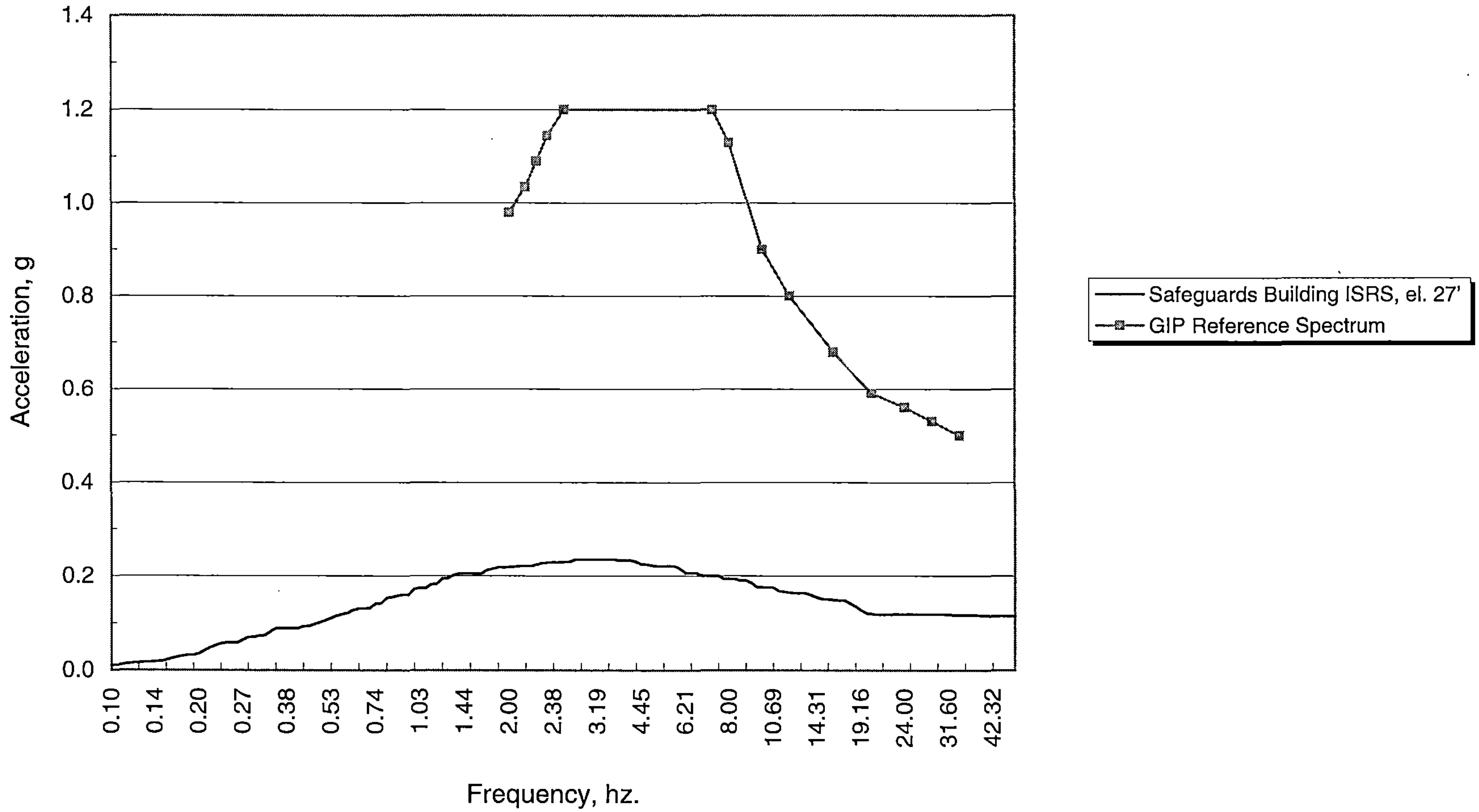
Prepared by: DB 10-8-98
Reviewed by: CHR 10-22-98

In-Structure Response Spectrum (ISRS) - Design Basis Earthquake
Service Bldg.- Elev. 45' - Horiz. Direction - 5% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



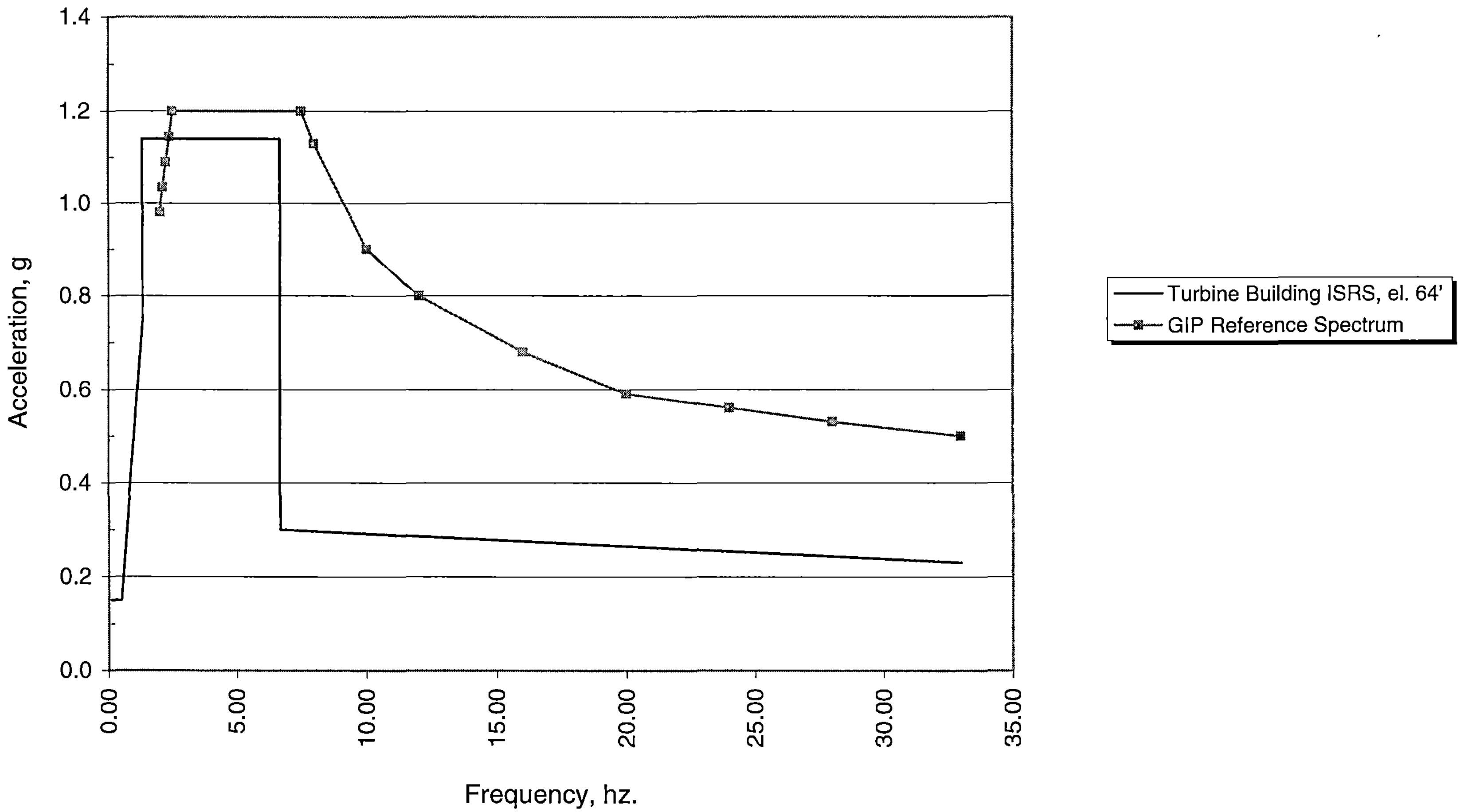
Prepared by: [signature] 10-8-98
Reviewed by: [signature] 10-22-98

In-Structure Response Spectrum (ISRS) - Design Basis Earthquake
Safeguards Building - Elev. 27' - Horiz. Direction - 5% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



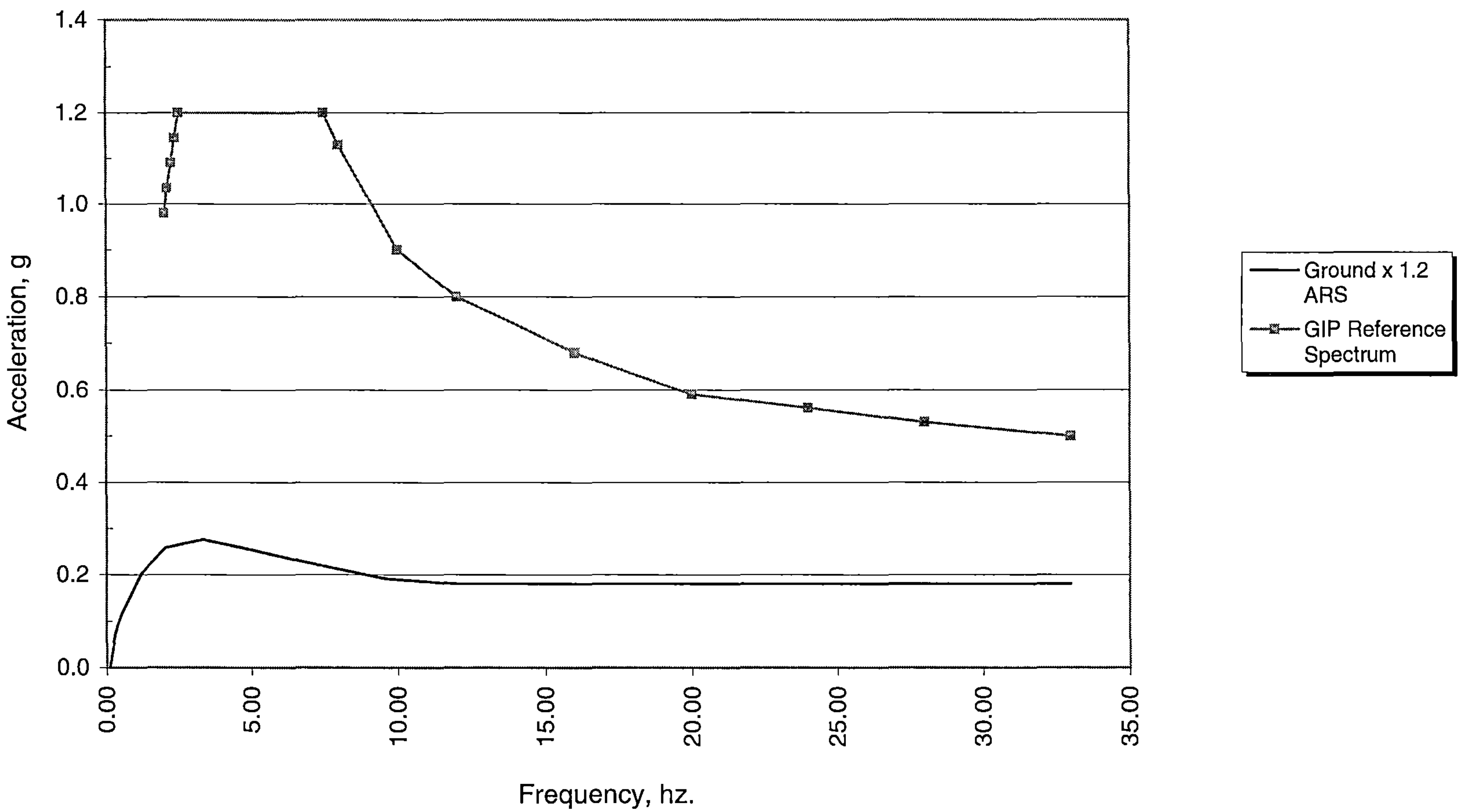
Prepared by: BB 10-8-98
Reviewed by: CHR 10-22-98

In-Structure Response Spectrum (ISRS) - Design Basis Earthquake
Turbine Building - Elev. 64' - Horizontal Direction - 5% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



Prepared by: DB 10-8-98
Reviewed by: CHR 10-22-98

Ground x 1.2 Response Spectrum - Design Basis Earthquake
(Applies to Emer. Serv. Water Pump Intake Struct. & Fuel Oil Pump House)
Horizontal Direction, 5% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



Prepared by: BB 10-8-98
Reviewed by: CJR 10-22-98

ENCLOSURE 3

USI A-46 Evaluation of Charging Pump Seal Cooling Surge Tanks

(Reference Response to NRC Question No. 9)

Surry Power Station Units 1 and 2

ENGINEERING WORK SHEET

Calc Number 250226-C-021	Rev. 1	Add.	Sheet: 1 of 3
Prepared By: DB *DB*			Date: 10-15-98
Reviewed By: CGR *CGR*			Date: 10-22-98
Other (If Applicable):			Date:

USI A-46 Evaluation of Charging Pump Seal Cooling Surge Tanks (1-CC-TK-3, 2-CC-TK-3):

This calculation is revised from the calculation performed in Reference 1. However, all applicable information from the calculation performed in Ref. 1 is repeated here for convenience and completeness.

Based on a review of the Screening Evaluation Work Sheet (SEWS) and the accompanying as built information (Attachment A), the suspended tank and its mounting configuration are judged to be relatively rigid. Torsional effect about the U-bolt bracket near the mid-length of the tank is expected to be minimal.

Critical elements in the load path are determined to be the shear capacity of the bracket anchor bolts and the pullout capacity of the overhead C6 channel section to the embedded concrete insert in the ceiling.

For seismic demand, conservatively use the peak acceleration values rather than ZPA's, from the 4% damped (damping per Ref. 2) design spectra at elev. 27' (floor spectra is actually taken at elev. 26'). The horizontal and vertical spectra at this elevation are provided in Attachment B. From the design basis spectra,

Horizontal acceleration, a_h = 0.32g

Vertical acceleration, a_v = 0.32g

Estimate tank weight, assuming flooded condition for 16" diameter Sch. 10 piping (Refer to Attach. A):

Length of tank, L = 2x11" + 27.25" = 49.25" (Attachment A)

W = (42.05 +81.8) x (49.25/12) = 508 lb. (Pipe weights per Ref. 3)

Therefore, the seismic loads are:

$F_h = F_v = 508 \times 0.32 = 163$ lb.

U-bolt adequacy:

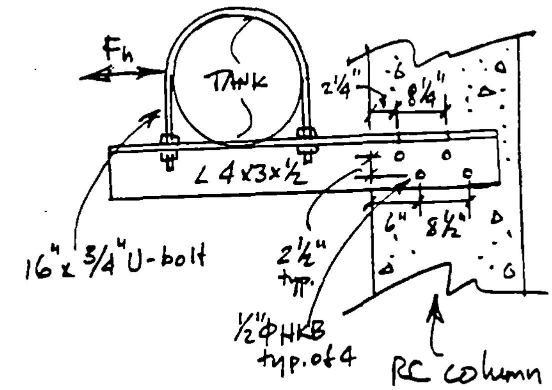
For lateral load F_h, the capacity of U-bolt = 790 lbs. (Ref. 7)

Thus, Factor of safety = 790/163 = 4.85

ENGINEERING WORK SHEET

Calc Number 250226-C-021	Rev. 1	Add.	Sheet: 2 of 3
Prepared By: DB *DB*			Date: 10-15-98
Reviewed By: CGR *CGR*			Date: 10-22-98
Other (If Applicable):			Date:

<u>Check bracket anchor bolt shear capacity due to seismic loads in the transverse direction per Appendix C of GIP (Ref. 2):</u>



4-1/2" dia HKB anchor bolts are used.

Bolt spacing = 2.5" >2D; $RS_s = 1.0$

Edge distance = 2.25" >4D but < 10D

$RE_s = (E/(10D))^{1.5}$, for 4D < E=2.25" < 10D

Thus, $RE_s = (2.25/(10x.5))^{1.5} = 0.30$

$V_{all} = 2.38 \times 0.3 = 0.718$ K

$V = 163/4 + V_{torsion}$

Calculate shear due to torsion ($V_{torsion}$):

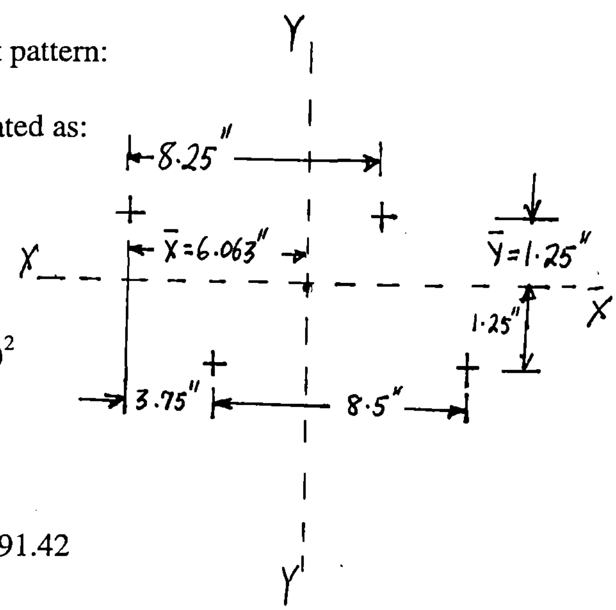
Calculate bolt pattern c.g, and polar moment of inertia of bolt pattern:

The c.g., based on the dimensions in Attachment A, is calculated as:

$\bar{X} = (12.25+8.25+3.75)/4 = 6.063$", and $\bar{Y} = 1.25$" Also,

$I_{xx} = 4 \times 1.25^2 = 6.25 \text{ in}^2$

$I_{yy} = 6.063^2 + (8.25- 6.063)^2 + (6.063-3.75)^2 + (12.25-6.063)^2$
$= 85.17 \text{ in}^2$



Thus, $J = I_{xx} + I_{yy} = 91.42 \text{ in}^2$

And $V_{torsion} = (8+4-0.625-1.25) \times 163 \times \text{SQRT}(6.063^2 + 1.25^2)/91.42$

i.e., $V_{torsion} = 10.125 \times 163 \times 6.2/91.42 = 112$ lb

Thus, $V_{total} = 163/4 + 112 = 153$ lb,

And $V_{total}/V_{all} = 153/718 = 0.213 << 1.0$,

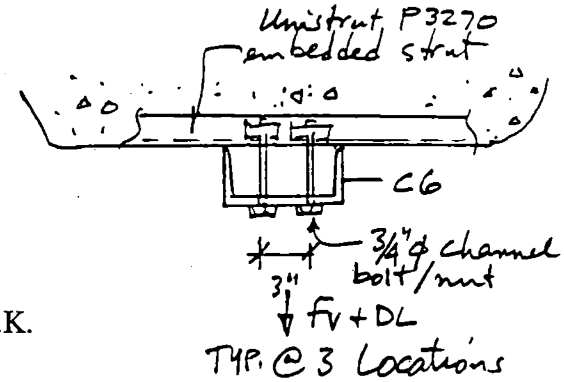
Safety factor = 4.69, O.K.

ENGINEERING WORK SHEET

Calc Number 250226-C-021	Rev. 1	Add.	Sheet: 3 of 3
Prepared By: DB			Date: 10-15-98
Reviewed By: CGR			Date: 10-22-98
Other (If Applicable):			Date:

Check ceiling mounted C-6 channel attachment to embedded concrete insert:

Total vertical load, ignoring the U-bolt bracket at mid-length of the tank,



F_v (total) = F_v (seismic) + Deadweight =163+508 =671 lb.

Pullout P = 671/3 = 224 lb./embedded strut

Per Ref. 4, for Unistrut P3270 embedded concrete insert, the maximum allowable point load is 2000 lb.

Since 2000 lb >> 224 lb, the ceiling mounted attachment is O.K.

Conclusion: ***Based on the above, the tank anchorage has adequate margin for USI A-46.***

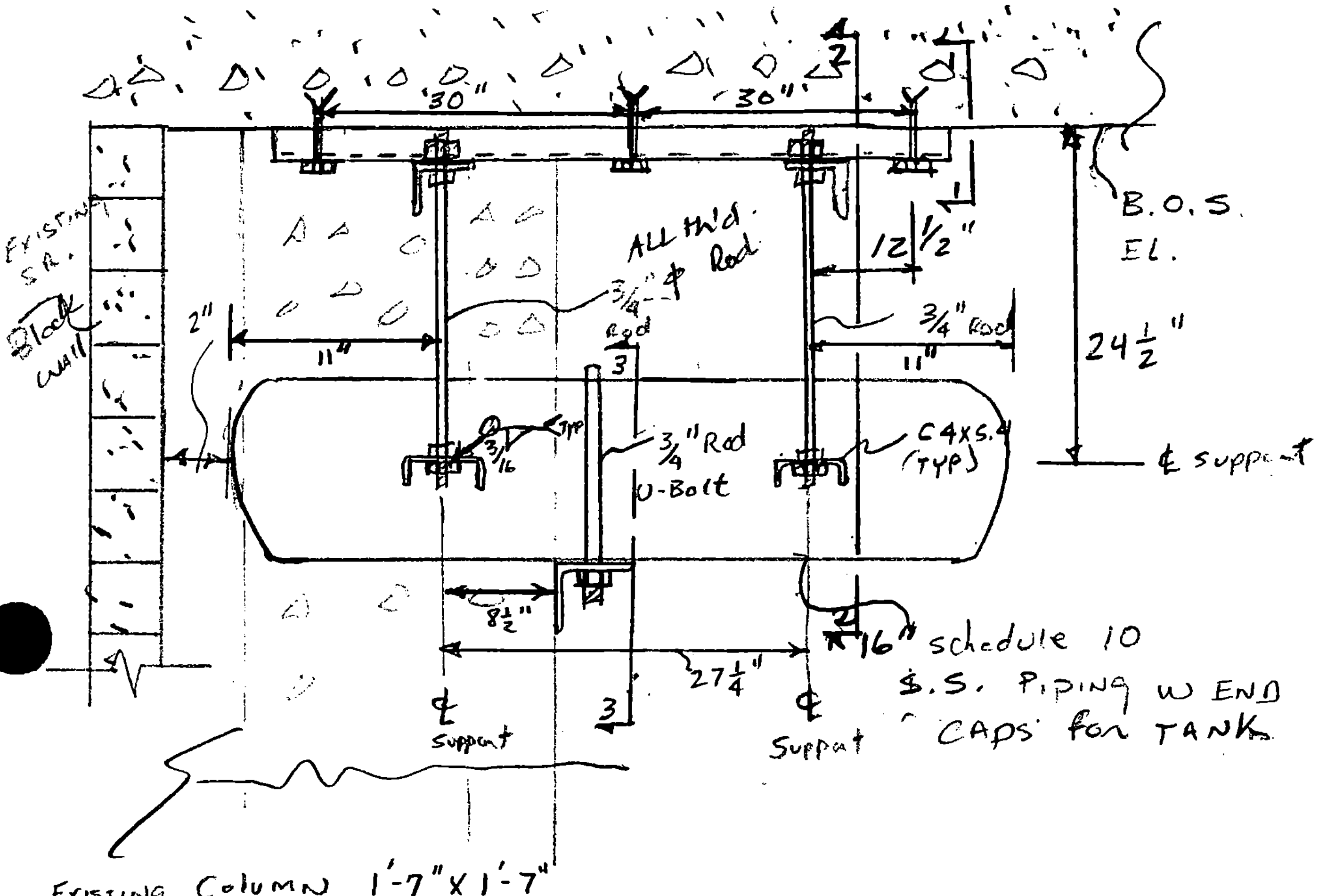
References:

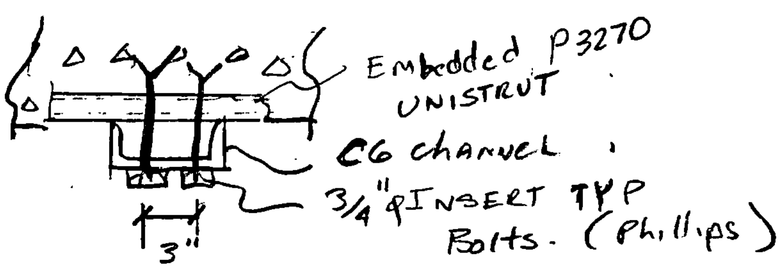
1. Calculation 250226-C-021, Rev. 0., dated 6-20-97.
2. Seismic Qualification Utility Group, "Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Plant Equipment," Rev. 2, Corrected 2-14-92.
3. Crocker and King, "Piping Handbook," Fifth Edition, McGraw-Hill Book Company, 1967.
4. Unistrut Corporation, "General Engineering Catalog,", Edition No. 12, 1993.
5. Walkdown data for Tanks 1-CC-TK-3, 2-CC-TK-3 (Attachment A).
6. Virginia Power Response Spectra database - In-structure ARS curves for Auxiliary Building, el. 26', DBE, 4% damping (Attachment B).
7. Virginia Power Nuclear Pipe Support Standard CEN-0018.

ATTACHMENT A

Field Walkdown Data for Tanks 1(2)-CC-TK-3

VIRGINIA POWER	Document Type: WALKDOWN UNIT # 1 & 2	Engineering Work Sheet		POW 14
	Project: A-46 / IPEEE Surry P.S	Doc. No.	Rev. No.	Sheet No. 1 of 3
	Subject: TYP. Support Detail for	Prepared By: [signature]		Date: 3-20-97
	System: 1-CC-TK-3, 2-CC-TK-3	Checked By:		Date: 3-20-97



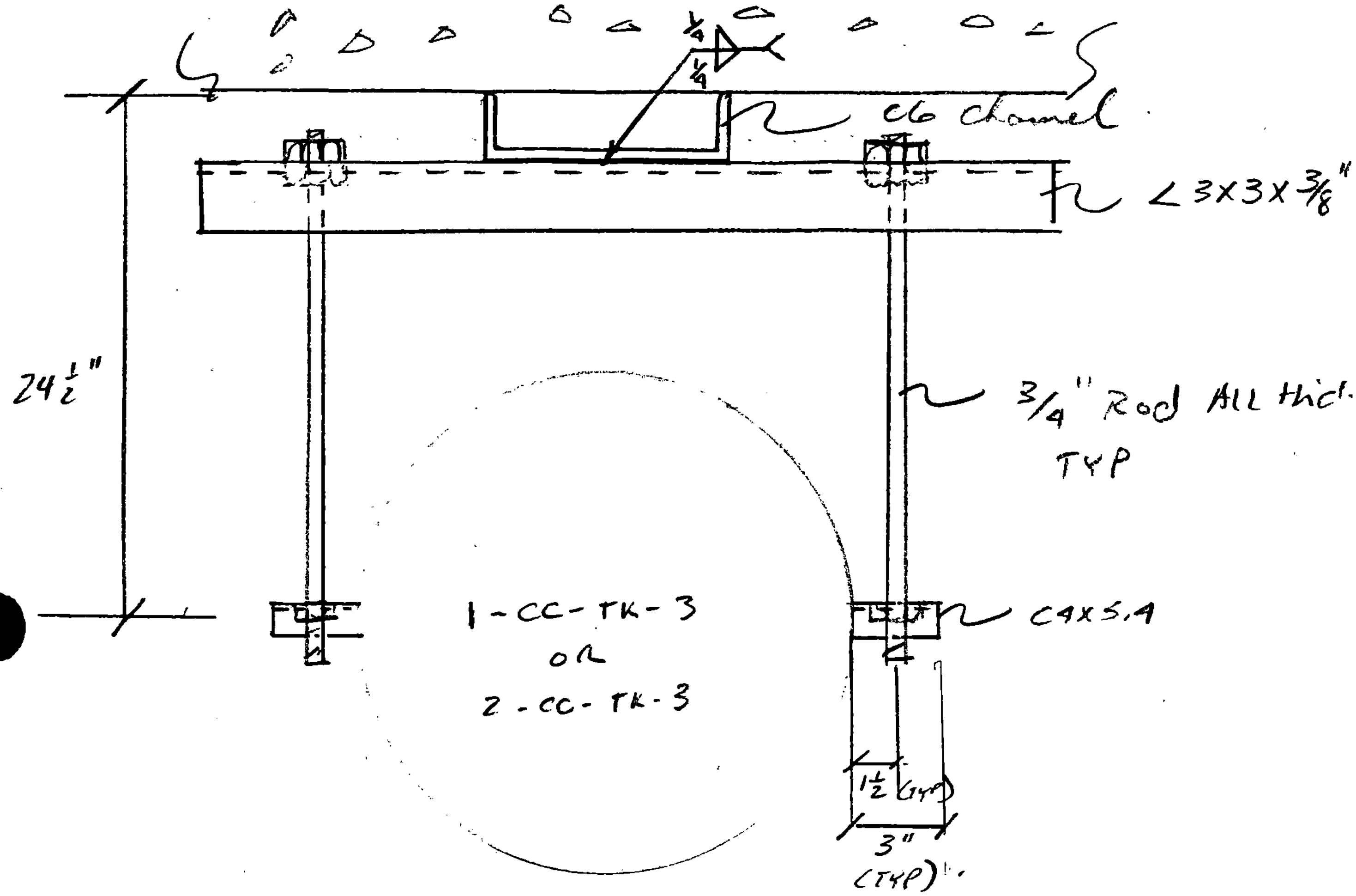


SECTION 1-1
(TYPICAL 3 Places)

Also EQE Calc. 250226-C-021

Attach A. P. 3 of 5

VIRGINIA POWER	Document Type: Walkdown Unit #1 & #2	Engineering Work Sheet		POW 14
	Project: A-46/IPEEE Surry P.S.	Doc. No.	Rev. No.	Sheet No. 2 of 3
	Subject: TYP. Support Detail for	Prepared By: [signature]		Date: 3-20-97
	System: 1-CC-TK-3, 2-CC-TK-3	Checked By: [signature]		Date: 3-20-97

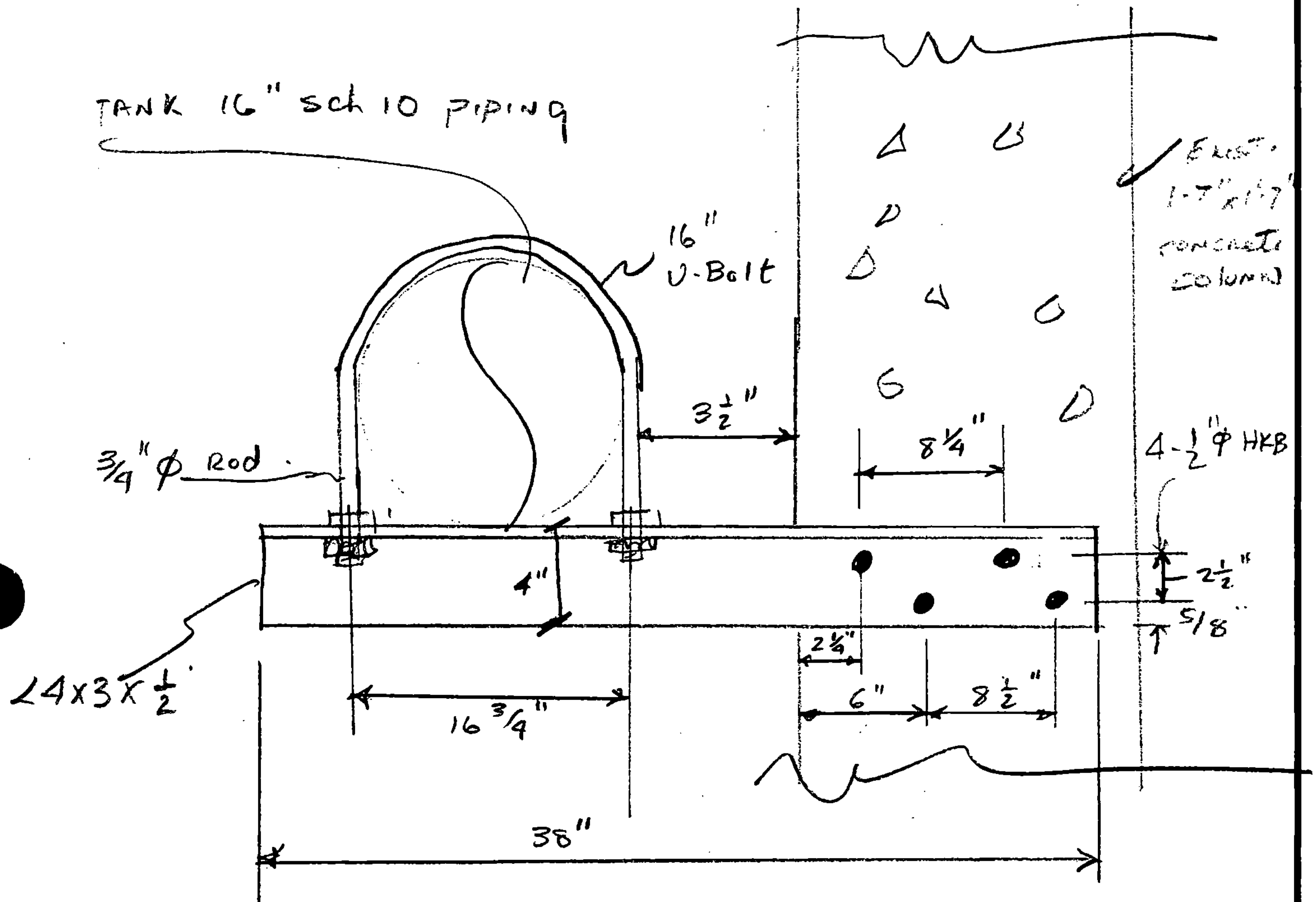


SECTION 2-2

Typical 2 Places (Angle reversed)

VIRGINIA POWER

Document Type	Engineering Work Sheet		POW 14
WAlkdown Unit # 1&2			
Project	Doc. No.	Rev. No.	Sheet No.
A-46 / IPEEE Surry P.S			3 of 3
Subject	Prepared By		Date
TYP Support Details	[signature]		3-20-97
System	Checked By		Date
1-CC-TK-3, 2-CC-TK-3	[signature]		3-20-97



SECTION 3-3

Attach. A p. 5 of 5

VIRGINIA POWER	Document Type: A-46 Walkdown	Engineering Work Sheet		POW 14
	Project: Surry Unit # 1	Doc. No.	Rev. No.	Sheet No. 1 of 1
	Subject: 1-CC-TK-3	Prepared By: [signature]		Date: 3-20-97
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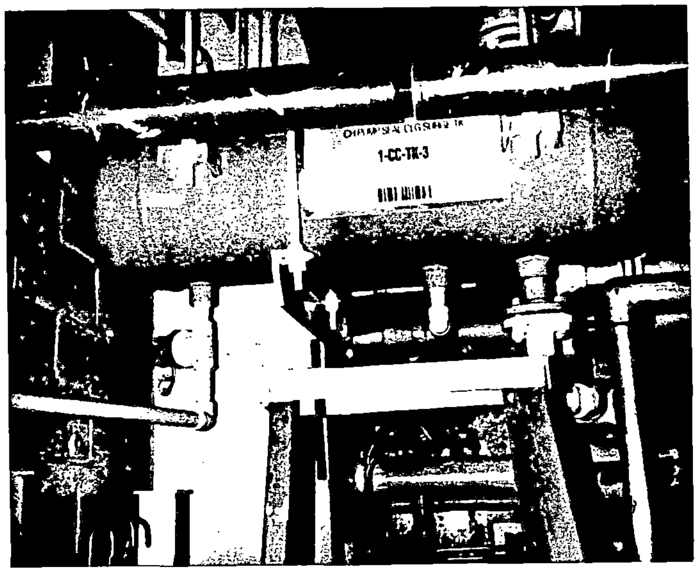
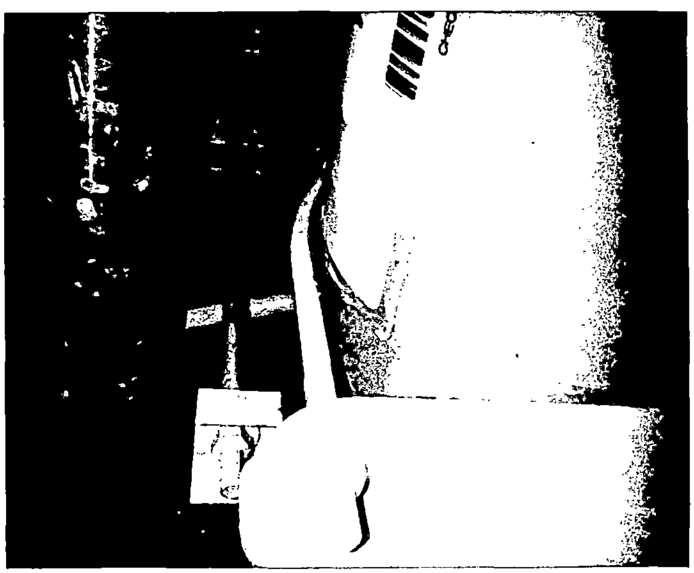


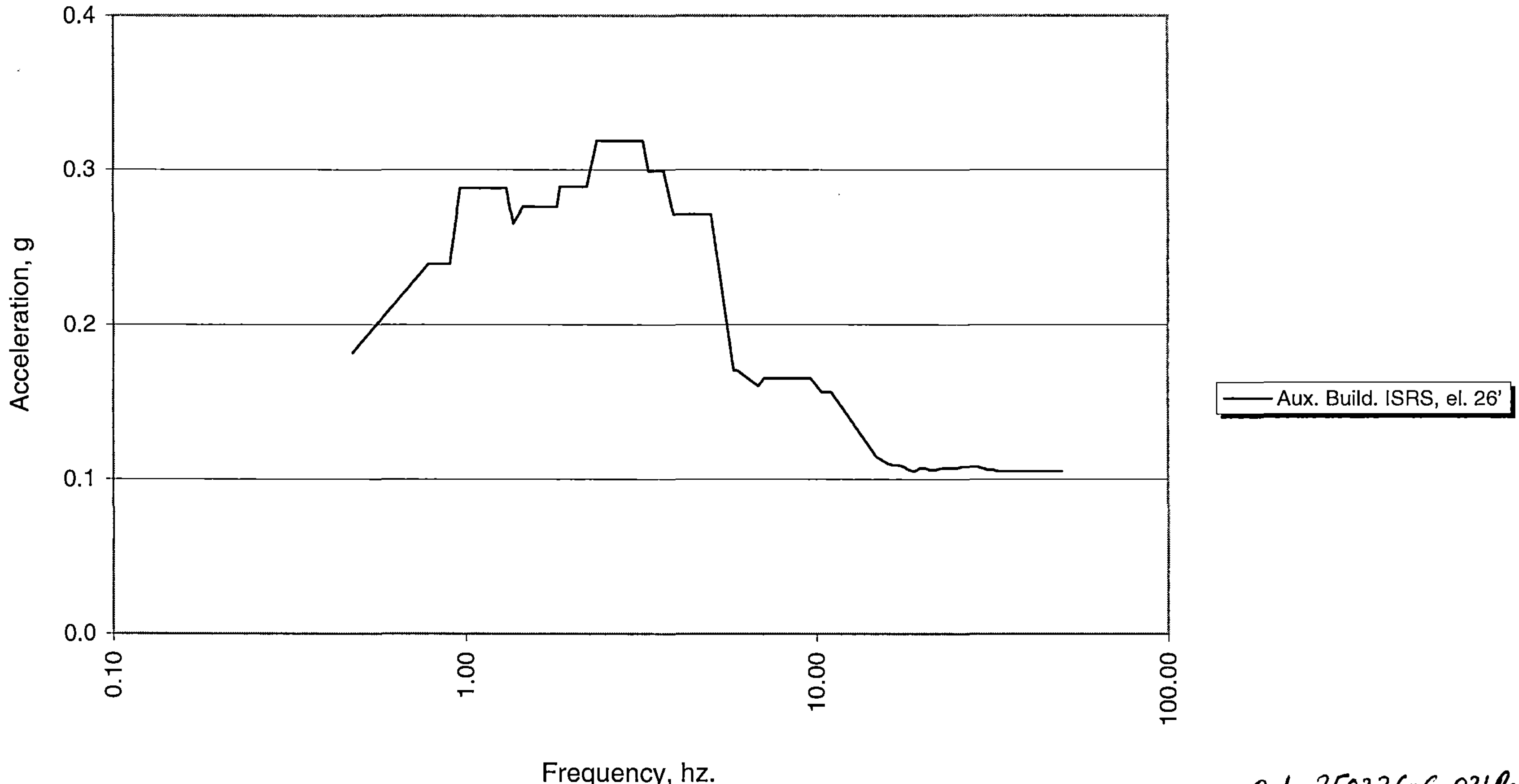


1-CC-TK-3

ATTACHMENT B

ARS Curves – Aux. Building el. 26'
Surry Power Station

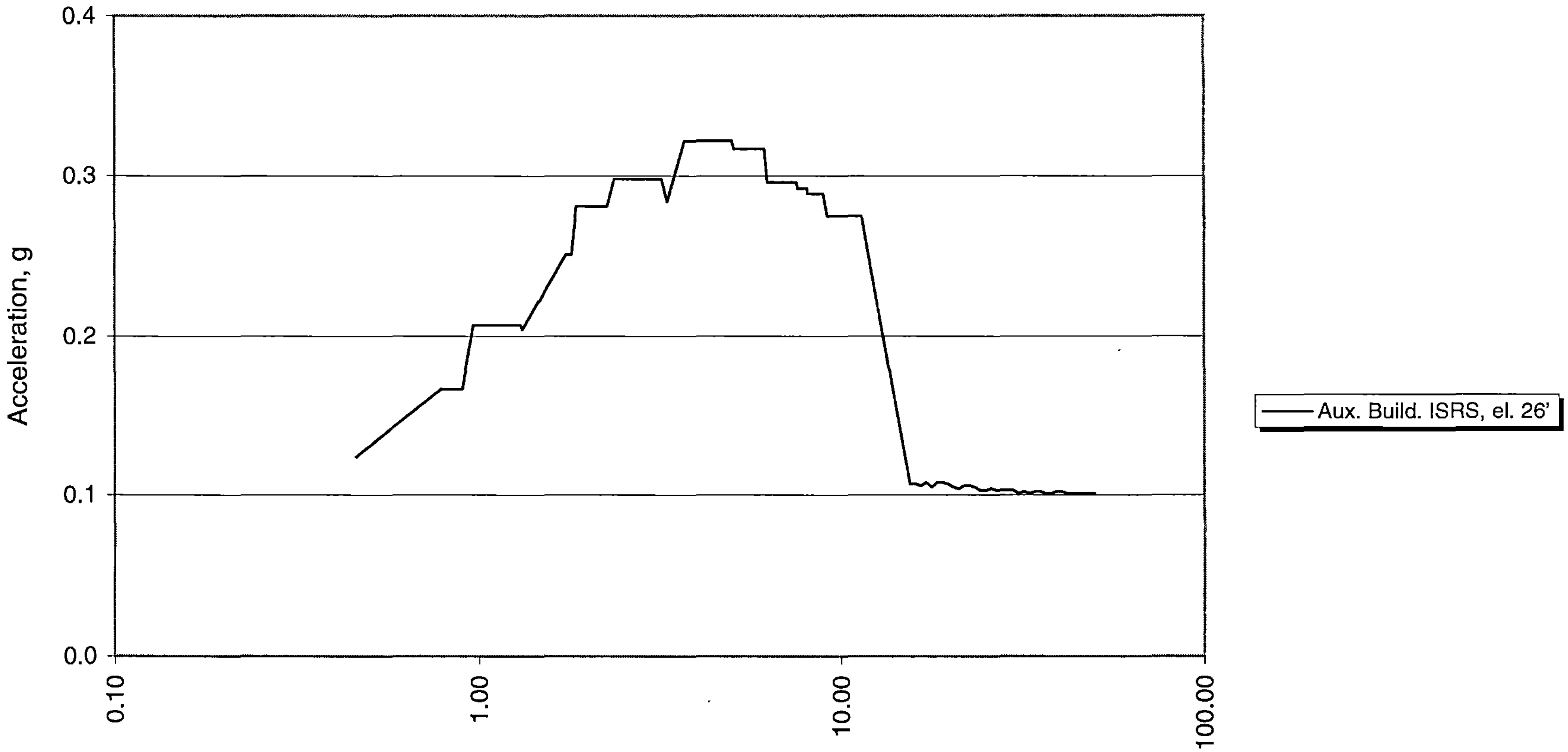
In-Structure Response Spectrum (ISRS) - Design Basis Earthquake
Auxiliary Bldg.- Elev. 26' - Horiz. Direction - 4% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



Calc. 250226-C-021 Rev 1

Prepared by: DB 10-16-98
Reviewed by: CJR 10-22-98

In-Structure Response Spectrum (ISRS) - Design Basis Earthquake
Auxiliary Bldg.- Elev. 26' - Vertical Direction - 4% Spectral Damping
SURRY POWER STATION UNITS 1 AND 2



Calc 250226-C-021 Rev. 1

Prepared by: DB 10-14-98
Reviewed by: CAR 10-22-98

ENCLOSURE 4

USI A-46 Evaluation of Refueling Water Storage Tanks

(Reference Response to NRC Question No. 9)

Surry Power Station Units 1 and 2