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SUBJECT: Forwards response to NRC 990218 RAI re SQUG resolution of USI A-46.Rev 1 to calculation N838SQUGOUT-035 & rev 0 to procedure 200138-P-001,encl.Proprietary EPRI TR-103960 re resolving achorage outliers,encl.Proprietary info withheld.

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May 14, 1999

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: Oconee Nuclear Station
Docket Nos. 50-269, -270, -287
Response to Request for Additional Information
SQUG Resolution of USI A-46

Gentlemen:

By letters dated December 30, 1996, and December 15, 1997 Duke Energy Corporation submitted two parts of its plant-specific summary report, in accordance with its commitment to Generic Letter 87-02, on the resolution of Unresolved Safety Issue A-46. By letter of September 28, 1998, Duke submitted Revision 1 of the report to include information associated with the ECCW upgrade modification and to update the submittal to reflect current status of outlier resolution. By letter of February 18, 1999, the NRC Office of Nuclear Regulatory Research staff requested additional information regarding these submittals.

Attached is Duke's response to the staff's request.

Please address any questions on this submittal to Randy Todd at (864) 885-3418.

Very truly yours, 160101

W. R. McCollum, Jr.

Attachment

Change: NRC PDR   A025   ltr encl 1 1 w/o prop   1/1

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50-269 DP OCONEE 1

RESPONSE TO RAI SQUG RESOLUTION OF USI A-46

REC'D W/LTR DTD 05/14/99....9905200114

Attachment 1
Response to February 18, 1999
Request for Additional Information
On Unresolved Safety Issue A-46

Request 1:
As summarized in Section 8 of the Keowee Seismic Evaluation Report in Reference 1, of the 200 SSEL items, 83 outliers were identified, 57 of which were resolved and described in Table 8-1, and 26 of which required further analysis and were discussed in Table 8-2.

Request 1a:
In Reference 1, on page 5-11, it was stated in Section 5.3, that a total of 70 outliers were identified out of the 202 ONS Emergency Power System SSEL walkdown items. However, these numbers are inconsistent with those (83 out of 200 were outliers) stated in the Executive Summary, in Table 5-1, and on page 8-1 in Section 8.1. Clarify the apparent inconsistency.

Response:
The numbers shown in Section 5.3 reflect old data. The numbers stated in the Executive Summary, in Table 5-1, and on page 8-1 in Section 8.1 are correct.

Request 1b:
26 outliers were described along with their proposed resolution in Table 8-2. Provide the resolution status for these outliers.

Response:
All walkdown outliers associated with the Keowee Seismic Evaluation Report have been resolved by analytical calculation or by field modification.

Request 2:
In Table 5-2 of Reference 1, clarify the following items of equipment that were considered to satisfy the intent but not the letter of caveats.

Request 2a:
There are several cabinets (IDA, IXA, 2DA, & 2XA) that are 14" deep (as opposed to 18" or 20" deep existed in the earthquake experience database) and were considered adequate because the cabinets are top braced by shielded cable penetrations. Discuss the adequacy of the electrical connection (not the shielded cable) to resist the overturning moment of the cabinet due to safe shutdown earthquake (SSE).

Response:
As noted on the SEWS form, cabinets 1DA and 2DA (KHS Battery Room) are structurally bolted at the top to the adjacent concrete wall at three separate locations. These cabinets (with the additional top anchorage) meet the equipment class description per the GIP and will respond at least as well as the 18" MCC's included in the A46 equipment database.

The shielded cables penetrate the top of the MCC's 1XA and 2XA at Keowee Hydro Station through "armored/metal clad terminators". Attachments RAI2a.1 & RAI2a.2 are catalog sheets from O-Z/Gedney Company catalog. Shown on these sheets are details for the "PG" and "PKH" type penetrations. No significant seismic loads are judged to reach the electrical cable connections due to the use of these cable terminators. Therefore, all loads will be transmitted to the MCC frame via the cable connectors.

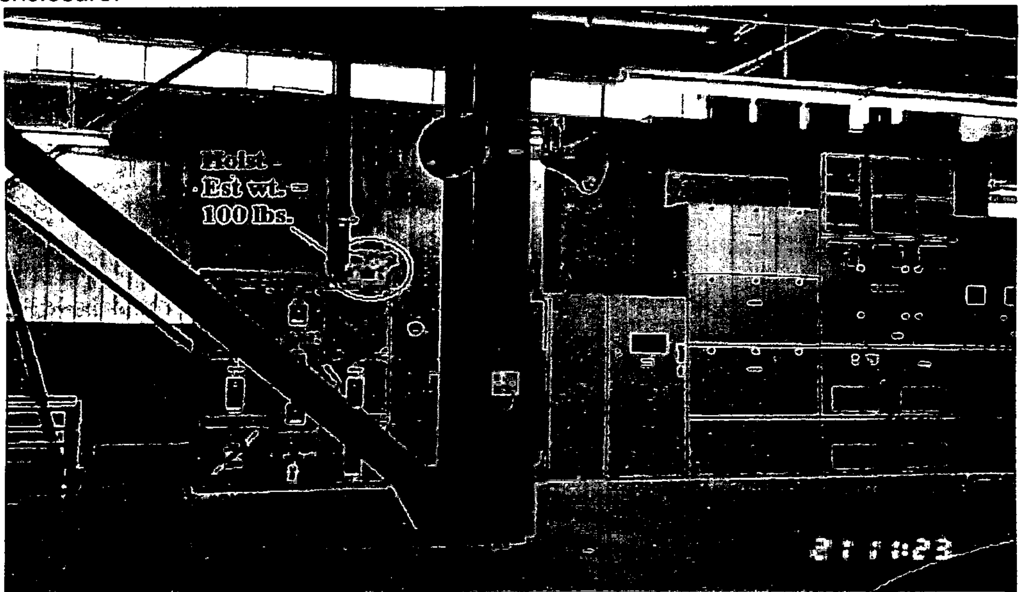
Request 2b:
The longitudinal bracing for Equipment IDs BB-1 and BB-2 were judged not to be effective due to geometric details. Discuss how the intent of the caveat was met.

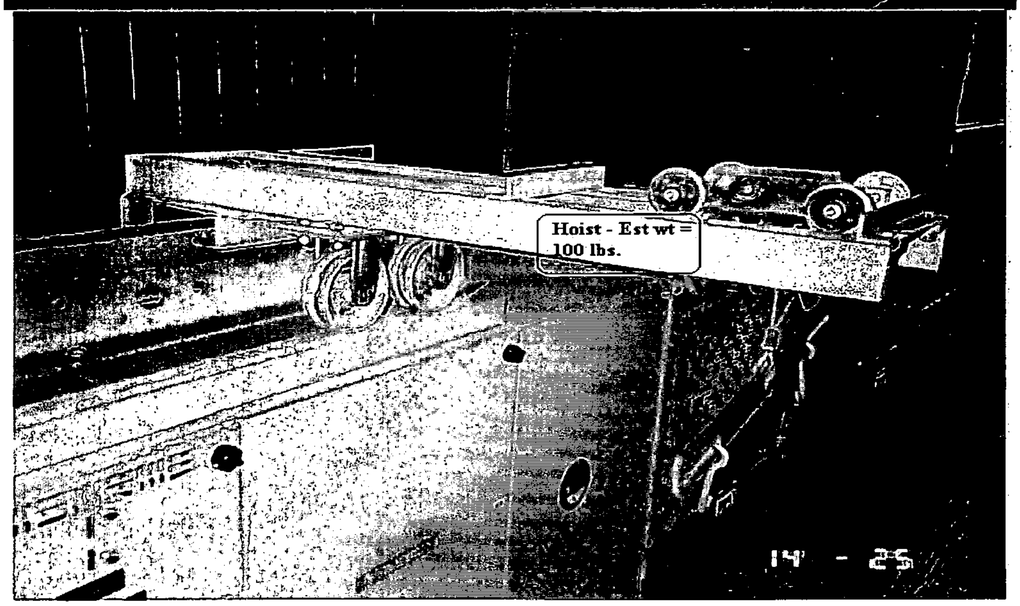
Response:
The caveat states " Battery Racks Have Longitudinal Cross Bracing. The racks should have longitudinal cross bracing unless engineering judgement or analysis shows that such bracing is not needed. The concern is that racks without cross bracing may not be able to transfer the lateral seismic loads to the base support... "

The walkdown team (EQE, Int.) made the **initial** comment that the lateral bracing supplied with the subject battery racks was not effective due to steepness of the brace angle and hinged brace connections. **Further** comment provided with this same caveat stated that lateral bracing was not needed since there are 27 tube steel posts spaced at 2' intervals, so bracing is not necessary by judgement. The walkdown team determined that the tube steel posts, without cross bracing, could adequately transfer the lateral seismic loads to the base support. Intent of caveat is met as a result.

Request 2c:
For Equipment IDs U1 SWGR and U2 SWGR, what is the weight of the breaker hoist? Demonstrate by calculations and/or other means that the weight of the breaker hoist (and its potential eccentricity) would not cause the SWGR cabinet and their anchorage to be inadequate due to SSE.

Response:
As seen in the photo, the weight of the hoist is negligible compared to the weight of the Switchgear enclosure.





(Hoist estimate weight = 100 lbs).

Per the SEWS form evaluation, "This hoist is equipment that is normally supplied with the Westinghouse equipment and the cabinet and its anchorage were judged to be adequate to seismically support this added weight. Thus, the intent of this caveat is met. The breaker hoist that is mounted on top of the ACB-5 and ACB-7 cubicles is free to slide, in both in the N-S (out from the face of the cubicle) and E-W (along the axis of the U1 SWGR) directions. The potential hoist movement in a seismic event is limited by the stops at the ends of the rails. Given the low level of acceleration and the distance to the nearest essential relay, any potential relay chatter is judged not to be a credible concern"

See Attachment RAI2c.1 and RAI2c.2 for SEWS forms for U1 SWGR & U2 SWGR.

Request 3:
For equipment outlier resolution in Table 8-1 of Reference 1, explain how the "capacity greater than demand" would resolve the Bounding Spectra caveats for the following equipment: 10GTK0001, 89A1X, 89G-1, and BPC-1.

Response:
In order to verify that the seismic capacity of a piece of equipment exceeds its demand using GIP methodology, all Bounding Spectrum caveats must be meet.
These items were determined to be outliers since one or more of the GIP Bounding Spectra caveats could not be met. As a result, the seismic capacity of these items could not be determined using GIP methodology since the items were not fully represented by the GIP. The seismic capacity for these items was determined outside the GIP via engineering calculations performed by EQE International.

Request 4:
For the proposed resolution for equipment outliers in Table 8-2 of Reference 1, it is not clear how the caveats are going to be resolved for the Equipment IDs 1XA, 1XXFMR, SRF6, and SY-DC1. Provide clarifications.

Response:
MCC 1XA – The anchorage was determined to be an outlier. Seismic adequacy of the anchorage was verified outside the GIP using alternate methods.

1XXFMR – The bolts anchoring the transformer to it's base were found to be loose with a gap > 1/4" under the bolt head. The loose bolts were tightened and lock washers added via station modification. This resolves the anchorage caveat #6 (gap under base < 1/4"). The transformers were found not to be within the equipment class due to the voltage range of 13.8 kV > 4.16 kV. Transformer seismic capacity was verified outside the GIP using alternate methods.

SRF6 – The adjacent unanchored Distribution Center #2 which was a source of seismic interaction has been anchored per station modification. This resolves the interaction concern.

SY-DC1 – This cabinet was originally installed as "non-safety" related. The item was included on the USI-A46 SSEL and anchorage was determined to be insufficient to meet GIP anchorage criteria. Additional weld has been added to the cabinet base via a station modification to enhance the cabinet anchorage.

Request 5:
As stated in the Keowee hydro station (KHS) Seismic Evaluation Report, emergency power would be transmitted to Oconee Station through two separate routes, one of which is a 230 KV overhead transmission line. Describe whether the 230 KV overhead transmission line is included in the SSEL, and how the seismic adequacy of this transmission line and its supports were determined.

Response:
The 230 kV overhead transmission lines are included in the SSEL. They are listed as OF1, OF2, OF3 and OF4 in the Composite SSEL on pages 25 and 26 of Appendix B. The results of the seismic evaluation are contained in SVDS group 8 on page 53 of Appendix D.1. EQE International performed evaluations of the SSEL components located in the switchyard and also included the 230 kV overhead transmission lines. The evaluation included: 1) an analysis to determine if excessive cable slack (between the transmission towers) exists and, 2) an evaluation of anchorage and member stresses of the transmission towers and the connection of the cables to the towers.

The concern with cable slack is that excessive slack could lead to conductors becoming too close to each other during a seismic event. The evaluation proved that maximum "swing" of the cables is approximately 3 feet which is much less that the existing 20'-4" cable separation.

The four transmission towers located between the Keowee Hydro Station and the 230 kV switchyard at Oconee were shown to be adequate for A-46 and IPEEE seismic demands. A combination of conservative analytical methods and past earthquake experience was used to arrive at this conclusion.

Request 6:
In the Keowee Cable and Conduit Raceway Review effort, 4 cable tray bounding samples were selected for a Limited Analytical Review (LAR). Provide a summary of the LAR evaluation for the case designated as AR-K-4.

Response:
AR-K-4 is a analytical review analysis of a 3-tier trapeze style support (HT-3) in which the vertical members attach to an embedded unistrut insert. The Vertical Capacity Check (reference GIP, Section 8.3.2) in which the support is subjected to 3.0 times dead load (3DL) in the downward direction was used to verify adequacy. The support carries 3-24" wide cable trays resulting in a total 3DL of 1890 lbs. for each vertical member based on 100% tray fill. Also attached to the embedded insert is a 3" diameter pipe with a 3DL of 485 lbs. and a 1 1/2" diameter air line with a 3DL of 29 lbs. This results in a total 3DL of 2404 lbs. This load was considered to be a single point load due to the proximity of the attached 3" and 1 1/2" lines to one of the vertical legs of the tray support. The critical item is the Unistrut Insert (P3266) which has a manufacturer's allowable capacity of 2000 lbs. The calculation states that demand/capacity (d/c) of 2404/2000 results in a d/c ratio of 1.2>1.0. Therefore, the embedded unistrut insert is not adequate for 100% tray fill. A calculation was then performed based on the actual tray fill with a 3DL of 851 lbs. combined with the 485lbs. and 29 lbs. previously mentioned resulting in a total 3DL of 1365 lbs. The calculation states that d/c of 1365/2000 results in a d/c ratio of .68<1. Therefore, the support is not an outlier per the GIP based on the Vertical Capacity Check. However, the embedded unistrut insert will be modified to meet 100% loading demands as stated in the original submittal section 7.1.3.

Request 7:
The description of the review effort in both Keowee Station (Reference 1) and Oconee Units 1, 2, and 3 (Reference 2) for tanks does not include enough information to allow for an assessment of their adequacy.

Request 7a:
Provide the SEWS and a summary description of the calculations performed to verify seismic adequacy for tank Nos.: 1CTK000C, and 2ESVTK0001 from the Oconee Units 1, 2, & 3 tank list, and tank Nos.: GOT1 and GPT2 from the Keowee Station tank list.

Response:
See Attachments RAI7a.1, RAI7a.2, RAI7a.3 & RAI7a.4 for SEWS forms for the requested equipment. Calculation summary follows

1CTK000C:
The Upper Surge Dome Tank was determined to be an Outlier since it is a vertical cylindrical tank, supported on legs. These type of tanks are not represented in the SQUG database. As recommended by GIP Section 7.2, this tank was analyzed using guidelines provided in EPRI Report NP-5228. A detailed computer model was developed to confirm the tank does qualify for the USI-A46 seismic input.

2ESVTK0001:
The ESV Receiver tank was deemed acceptable for A-46 by SRT judgement due to very small seismic input (.15g) and rugged construction within the SEWS. Anchorage was evaluated using standard GIP methodology.

GOT1:
The Governor Oil Sump Tank is a rectangular shaped, flat bottomed oil tank. These type of tanks are not represented in the SQUG database. It was considered an outlier due to it's unique configuration. Due to very small seismic input (.1g ZPA) and rugged construction, the tank was deemed to have an acceptable seismic capacity within the SEWS form. The anchorage was evaluated using standard GIP methodology.

GPT2:
The Governor Oil Pressure Tank is a circular air tank supported on a skirt. These type of tanks are not represented in the SQUG database. It was considered an outlier due to it's unique configuration. Due to very small seismic input (.1g ZPA) and rugged construction, the tank was deemed to have an acceptable seismic capacity within the SEWS form. The anchorage was evaluated using standard GIP methodology.

Request 7b.1:
The "1CTK000C tank" and "Dome Tanks" are installed at Elevation 838 feet in the Turbine Building. Were the liquid sloshing effects in the tanks considered in the calculations? If not, explain your rationale.

Response:
Note 1CTK000C tank" and "Dome Tanks are the same item.

Liquid sloshing effects were included in the calculation. All tanks were evaluated in accordance with Section II.7 of the GIP.

Request 7b.2:
Also, clarify Note 3 of Table 5.3 in Reference 2.

Response:
Table 5.3 lists specific buildings and elevations were the ISRS exceeds the Reference Spectrum. At Elev. 822' in the Turbine Building, the ISRS exceeds the Reference Spectrum below about 2.4 Hz (Ref. Attachment RAI10a.4). Note 3 is intended to convey that there are no capacity vs demand outliers at 822' in the Turbine Building due to the fact that all SSEL equipment has a fundamental frequency greater than about 3-4 Hz. This meets the requirements of the special exception to the Enveloping of Seismic Demand Spectrum listed on page 4-10 of the GIP, Rev.2:

"The seismic capacity spectrum needs only to envelop the seismic demand spectrum for frequencies at and above the conservatively estimated lowest natural frequency of the item of equipment being evaluated."

Request 8:
With respect to the walkdown inspection of relays at both Keowee Station (Reference 1) and Oconee Units 1, 2, and 3 (Reference 2), provide the following information:

Request 8a:
Approximately what fraction of the relay population was spot-checked for the seismic adequacy of their supports?

Response:
100%

The list of specific relays to be included on the A-46 Safe Shutdown Equipment List (SSEL) was incomplete at the time the equipment walkdowns were performed. As a result, the mounting of <u>each</u> relay within each cabinet included on the SSEL was evaluated for seismic adequacy.

Request 8b:
Provide two examples from each of the evaluation approaches performed to screen relays by the EPRI Relay GERS, the GIP Switchgear Relay Method, seismic test reports and seismic analyses.

Response:
See Enclosure 1 for examples of the relay evaluation methods utilized relays at both Keowee Station (Reference 1) and Oconee Units 1, 2, and 3 (Reference 2).

Request 9:
As described in the Oconee Seismic Evaluation Report, Method A.1 of GIP, Section 4.2, was used for comparing seismic capacity to seismic demand for equipment that is mounted below 40 feet above grade, and has a natural frequency greater than about 8Hz. However, there is a restriction for applying Method A.1 in accordance with GIP-2. The restriction is that the amplification factor established between the free-field response spectrum and the in-structure response spectra (IRS) will not exceed 1.5. For cases where this condition is not met, the use of Method A.1 may not be appropriate and may lead to non-conservative results. Provide a justification for the use of Method A.1 where this restriction was not met, or provide a description of the basis for finding the use of Method A to be acceptable.

Response:

This issue has been the subject of continuing discussion between the Seismic Qualification Utility Group (SQUG) representatives and the USNRC staff members on the application of Method A of GIP-2. It is SQUG's belief that the GIP criteria, as presented in the GIP-2 document, and reviewed and accepted by the NRC in SSER-2, does not require the Seismic Review Team (SRT) to justify the 1.5 amplification factor for elevations below about 40 ft above effective grade and frequencies above about 8 Hz.

As explained in Enclosure 2 of this response, the sentence on page 4-16 of the GIP-2, noting that "... the amplification factor between the free-field response spectra and the in-structure response spectra will not be more than about 1.5..." indicates the expectation of following the GIP requirements (within 40 feet of effective grade and equipment frequencies above 8 Hz.) and was not intended to require the SRT to justify the 1.5 amplification factor. The need for Method A, and the reason licensing basis in-structure response spectra (ISRS) frequently exceed 1.5 times the ground response spectrum, is due to the conservatism associated with the analytical procedures used in developing the ISRS. It was only intended that the SRT verify that the building in which Method A was applied was a typical nuclear plant reinforced concrete frame and shear wall or braced steel frame structure.

Method A was used at Oconee in the Turbine Building at elevation 796. Oconee endorses the SQUG position and considers use of Method A in the Turbine Building appropriate based on the fact that it is a typical heavily braced steel frame for which the 1.5 amplification factor is applicable as described in the SSRAP report "Use of Seismic Experience and Test Data to Seismic Ruggedness of Equipment in Nuclear Power Plants" (February 28, 1991) and Page 4-16 of GIP-2.

Oconee does not consider providing additional supporting information as a necessary requirement for the application of the GIP Method A; however, the following information for the Turbine Building is provided in response to this RAI.

a) Description of the Turbine Building identifying it as typical of nuclear plant construction and therefore appropriate to use the SSRAP estimated amplification factor.

b) Comparisons of the computed ISRS with the Oconee Design Basis spectrum.

c) Information showing that the licensing basis ISRS were very conservatively calculated, and that if more realistic median-centered type analyses were performed, the resulting ISRS would not greatly exceed 1.5 times the licensing basis free field response spectrum.

Use of Method A at Oconee

The Oconee Turbine Building is a partially embedded, multi-story steel frame structure founded on rock. It includes a combination of both moment resisting and cross-braced frames. It is typical of turbine buildings found at most nuclear and fossil power plants. The lower floors include mechanical and electrical equipment. The upper floor is the main turbine bay containing the turbine-generators which are independently supported on concrete pedestals. GIP Method A was used to estimate seismic demand for equipment mounted at elevation 796 feet. As required by the GIP, elevation 796 is within 40 foot of effective grade for the Turbine Building which is the basement at elevation 775' (Oconee A-46 Submittal, Revision 1 dated 9/15/98, Section 5.1.1.1).

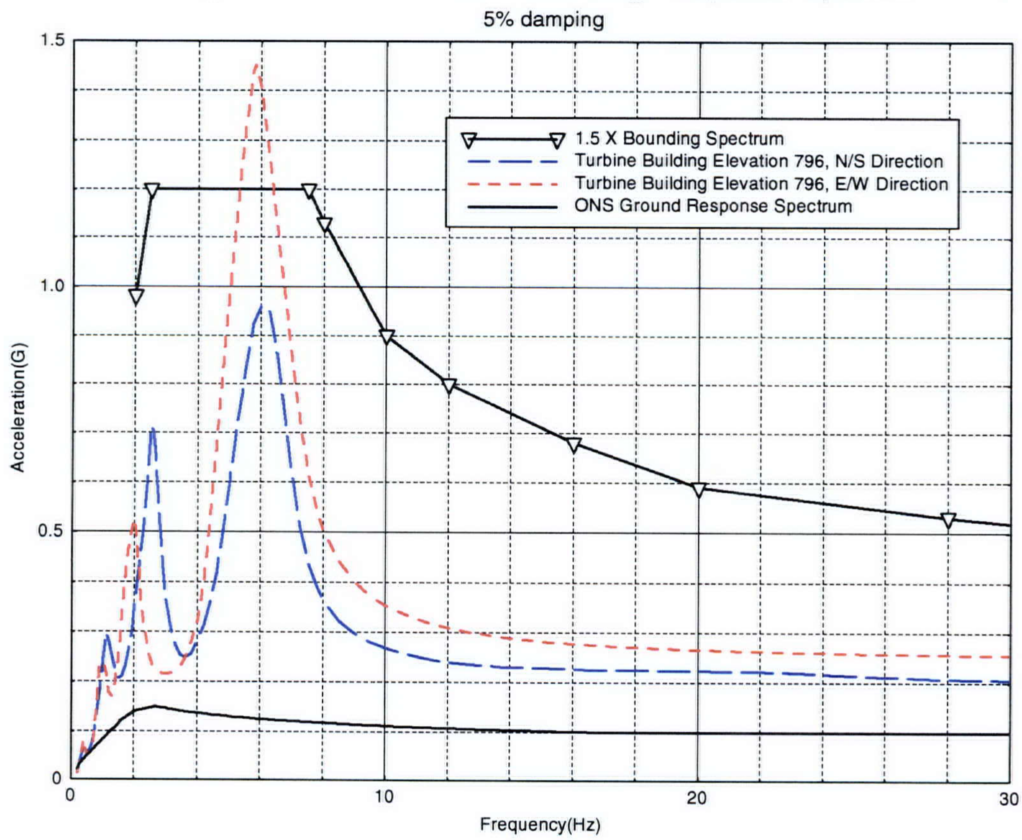
Figure 1 shows the 5% damped ISRS for Elevation 796 compared to 1.5 times the Bounding Spectrum and the 5% damped Oconee licensing basis rock response spectrum. While the maximum amplification is about 11 in the East/West direction at the primary structural frequency of about 5.8 Hz., the amplification is 4.3 for frequencies above 8 Hz. Note that these amplification factors are computed relative to the Oconee licensing basis rock spectrum. As discussed in Enclosure 2, the ISRS were computed using an El Centro time history input. Amplification factors relative to that time history are 6.9 at the structural frequency and 3.1 above 8 Hz.

Conservatisms in the Licensing Basis ISRS Enclosure 2 to this response contains a discussion of conservatisms in the calculation of the Oconee Turbine Building licensing basis ISRS. Two of the more easily quantifiable factors in the Turbine Building ISRS computations (structural damping and time history simulation) account for an over-conservative factor of 2.7 times above expected median centered ISRS. The total effect of these factors and others explain why the conservative Oconee licensing basis ISRS result in significantly exceeding 1.5 times the GRS.

Conclusion: The preceding discussion leads to the following conclusions.

- The Turbine Building at Oconee where Method A was used is a typical nuclear plant heavily braced steel frame building for which the 1.5 amplification factor is applicable as described in the SSRAP Report and Page 4-16 of GIP-2.
- The Oconee licensing basis conservative ISRS used for A-46 show amplifications of more than 1.5 due to conservatism in the analytical methodology, as discussed in Attachment 1 to this response. More realistic, median centered response spectra computations would result in ISRS which would not greatly exceed 1.5 times the licensing basis free field spectrum above 8 Hz. In addition, the median centered ISRS would fall well below 1.5 times the Bounding Spectrum.

Figure 1 Oconee Turbine Building Response Spectra



Request 10:
Table 5-3 of the Oconee Seismic Evaluation Report provided building locations and frequency ranges for which Method B.1 of GIP-2 was not satisfied, and according to the footnotes, all SSEL components identified with these situations were considered as capacity outliers. As summarized in Section 8 of the Seismic Evaluation Report, 83 capacity outliers were identified, 21 of which were resolved and described in Table 8-1, and 62 of which were unresolved and discussed in Table 8-2.

Request 10a:
Provide graphical comparisons of IRS vs. 1.5 x Bounding Spectrum for each of the floor elevations identified in Table 5-3.

Response:
See Attachments RAI10a.1, RAI10a.2, RAI10a.3 & RAI10a.4 for spectra graphs.

Request 10b:
Table 8-1 identified the 21 capacity outliers, which have been resolved by either Duke calculations or existing test reports contained in Miscellaneous section of A-46/IPEEE calculation. However, no references or descriptions of these calculations or reports were provided. To facilitate our evaluation, provide SEWS and calculations for the following equipment:

1) 125/250 VDC distribution centers; Equipment ID: 3DP,

2) Power battery chargers; Equipment ID IPA/BC, and 3PA/BC,

3) From miscellaneous section of A-46/IPEEE calculation, Equipment ID: 1MVC3 (250 VDC MCC) and 3XS3 (MCC 3XS3).

Response:

1) 125/250 VDC distribution centers; Equipment ID: 3DP,

See Attachment RAI10b.1 for a copy of the SEWS form and calculation.

2) Power battery chargers; Equipment ID IPA/BC, and 3PA/BC,

See Attachment RAI10b.2 & RAI10b.3 for a copy of the SEWS forms.

The calculation which resolves the capacity vs demand exceedance outlier for these items is a generic calculation addressing all equipment in the Turbine Building at Elev. 796' +6" and is contained as part of attachment RAI10b.1

3) From miscellaneous section of A-46/IPEEE calculation, Equipment ID: 1MVC3 (250 VDC MCC) and 3XS3 (MCC 3XS3).

See Attachment RAI10b.4 for a copy of the SEWS form and calculation.

Request 10c:
62 unresolved capacity outliers were described and their resolution proposed in Table 8-2. It appears that the proposed method for resolution of the 62 capacity outliers will involve the use of the screening table 2-4 of EPRI NP-6041. NRC has not approved the use of the seismic margin methodology outlined in EPRI NP-6041 for resolving A-46 outliers. Provide the justification for using EPRI NP-6041 to resolve these capacity outliers.

Response:
Table 2-4 of EPRI NP-6041 was NOT used in any case to resolve USI A46 capacity vs demand outliers. The wording in Table 8-2 relating to Table 2-4 of EPRI NP-6041 is meant to denote that the capacity vs demand comparison is applicable only to A-46 and not to IPEEE.

Request 11:
Based on our review of the Screening Verification Data Sheets (SVDS), we noted that where equipment GERS define the seismic capacity, the seismic demand is listed as the RRS. According to GIP Method B.3, the demand should be defined as the RRS (median-centered) amplified by 1.5 when the GERS are used to define capacity. Provide an explanation for this apparent inconsistency with the GIP methodology.

Response:
Equipment GERS were used to define the capacity for medium voltage switchgears TC,TD & TE in units 1,2 & 3. The SEWS forms for the 20 classes of equipment as defined in the GIP provide the following options for demand.

Ground Response Spectrum	(GRS)
1.5 x Ground response	(AGRS)
Conserv. Des. In-Str. Resp. Spec.	(CRS)
Realistic M-Ctr. In-Str. Resp. Spec.	(RRS)

There is no option for 1.5 x RRS as a demand selection. The SEWS form was filled out with RRS checked for demand and a note was added indicating that 1.5 x RRS was the appropriate demand spectrum for comparison to the GERS.

The capacity vs demand comparison was made using GERS vs 1.5 x RRS as specified by GIP method B.3.

Request 12:
In Section 5.1.4 of the Oconee Seismic Evaluation Report in Reference 2, unreinforced masonry block walls are identified as a source of interaction concern. It is also stated that 75 block walls, not previously reviewed as part of the IE Bulletin 80-11, needed a detailed review. Of these, 65 percent were qualified either by comparison to an existing calculation or with a unique calculation. Provide examples of the unique qualification methods.

Response:
A large number of masonry walls at ONS were evaluated and qualified during the course of the IEB 80-11 bulletin. There were many cases where one wall was included and qualified in the 80-11 review and an identical wall (same dimensions, seismic input, etc.) was not included in this review since there were no safety-related equipment in the area of the unanalyzed wall. Qualification of the identical previously unqualified wall now became necessary due to the presence of an item, included on the USI-A46 Safe Shutdown Equipment List (SSEL), located in the vicinity of an unqualified wall. Qualification of these walls was achieved by comparison to an identical or similar wall previously qualified during the IEB 80-11 review.

In cases where an unqualified wall needed qualification due to presence of an SSEL item located in the area and there were no comparable walls (i.e. larger openings, penetrations, etc) that were available for comparison, a unique calculation was performed. This "unique calculation" included qualification by traditional masonry wall qualification methods that were standardized during the Oconee Nuclear Station IEB 80-11 review. An example of a unique wall qualification calculation is attached (Ref. Attachment RAI12).

Request 13:
In the Oconee Cable and Conduit Raceway Review effort in Reference 2, 584 typical analytical cases were selected for a Limited Analytical Review (LAR), with 539 being selected from the reactor building.

Request 13a:
Provide a sample of LAR evaluations including three from the plant tray system, three from the reactor building and review Nos. R-4, R-6, R-18 and R-22.

Response:
See Attachments for the following:

Plant Tray System:
See Attachment RAI13a.1

Reactor Building:
See Attachment RAI13a.2

Outlier Analytical Reviews:
See Attachment RAI13a.3

Request 13b:
Clarify the number of analytical review cases and the number of supports involved in Sections 7.12, 7.13, and 7.14 of the Oconee Seismic Evaluation Report in Reference 2. Why were there so many samples selected in the reactor building compared to those other buildings?

Response:
Plant Tray System Analytical Review: There were 45 supports selected for analytical review. Of these 45 reviews, 18 were outliers. Seven of the 18 outliers have been resolved resulting in 11 unresolved outliers. Due to some of the outliers affecting multiple "typical" supports, 51 supports will require modification.

Reactor Building Analytical Review: Of the 539 supports reviewed, there were 4 outliers affecting 4 supports.

Walkdown Outliers: Of the 75 walkdown outliers identified, only 21 outliers affecting 37 supports are remaining to be modified. As stated earlier, some of the outliers affect multiple typical supports.

Number of Reactor Building Analytical Review Selections:
After reviewing the various types of Reactor Building tray supports, it was determined that two types of supports would serve as best representatives for analytical review. The analytical reviews were performed on an Excel spreadsheet. Since the calculations were automated using the spreadsheet, it was decided to review ALL of these type supports even though only a sampling was required. This resulted in the large number of 539 reactor building supports reviewed.

Request 14:
The Control Room Ventilation System (CRVS) was included in the Oconee A-46 review to ensure the integrity of the system. Section 7.3 of the Oconee Seismic Evaluation Report in Reference 2 states that the evaluation methodology used to verify the seismic adequacy of CRVS HVAC ducting and supports is consistent with the GIP-2. Since HVAC systems are not specifically addressed in the GIP-2, provide a description of the evaluation methodology used to review these systems including the walkdown screening and evaluation criteria and the walkdown screening guidelines.

Response:
See Attachment RAI14 for the following:

Request 15:
Referring to the Outlier Description and Proposed Resolution in Table 8-2 of the Oconee Seismic Evaluation Report:

Request 15a:
For outlier Reference No.12 on page 1 of the Table, both capacity vs. demand and category "0" concerns are checked in the Table. It is indicated that this outlier will be resolved per Table 2-4 of the EPRI report NP-6041. Noting the comments in question No.10.3, provide the justification for the seismic adequacy of this equipment.

Response:
Table 2-4 of EPRI NP-6041 was **NOT** used in any case to resolve USI A46 capacity vs demand outliers. The wording in Table 8-2 relating to Table 2-4 of EPRI NP-6041 is meant to imply that capacity vs demand comparison is applicable only to A-46 and not an IPEEE evaluation. Outlier Reference No. 12 (1,2,3MSPY0042) was evaluated as a GIP category "0 – Other". By definition, category "0 – Other" items are not within the 20 classes of equipment. Therefore, seismic capacity cannot be determined using GIP methodology. The seismic capacity of these items will be determined by alternate means.

Request 15b:
For outlier Reference No. 91 on page 8 of the Table, it is stated that an existing test report is to be used to resolve the capacity vs. demand concern. Provide a summary description of the test report.

Response:
The tests were conducted August 4 & 5, 1970.
The Seismic Test Facility was equipped with a hydraulically driven suspension platform which displaced simultaneously horizontally and vertically resulting in a 45^0 (from horizontal or vertical) application of simulated seismic acceleration. Twenty tests were conducted. The first four were explicitly for the observation of the structure and its mounting. The cabinet was subjected to a 1.2g maximum base acceleration at a frequency of 2 Hz, a 2g maximum base acceleration at 20 Hz, and a 1.96 g maximum base acceleration in a sine sweep of 2 to 20 Hz. There was no evidence of structural failure, chipping, or loosening of parts. Subsequent testing of electrical components contained in the cabinets subjected the structure to 6g maximum base acceleration in a sweep of frequencies of 1 to 10 Hz without detrimental effects. The test cabinet was bolted to the test platform. The cabinet in the plant is anchored by concrete anchor bolts. The 1.96 g base acceleration corresponds to and envelops the ZPA at any given cabinet location at Oconee Nuclear Station. The anchorage and load path adequacies are addressed in the anchorage evaluations and SEWS for the cabinet. While the testing was not in accordance with IEEE-344 1971 or 1975, IEEE-344 1975 permits sine sweep testing and notes that for this type of test "maximum response is obtained separately at every frequency in the test range".
The natural frequency of the cabinet and the structure to which it is mounted is estimated to be within the range of testing, and the maximum floor spectra ZPA is .24g.

Request 16:
In section 5.1.3 of the Oconee Seismic Evaluation Report, a description of the inspections made for equipment anchorage is provided.

Request 16a:
Item No.11 addresses electrical equipment with essential relays. In the description provided it is stated that "where other reduction factors were required (gaps greater than 1/4 inch etc.)." What is the reduction factor for the condition that gaps are greater than 1/4 inch?

Response:
The wording within Item No. 11 was not intended to imply that there is a special anchor capacity reduction factor for equipment containing essential relays which have a gap greater than 1/4". No such reduction factor exists.

The USI A-46 Generic Implementation Manual (GIP), section 4.4.1- check #6 states that "there should be no gap at the bolt or stud anchor for equipment containing essential relays". SSEL items that contained essential relays and had any gap between the base of the equipment and the floor were considered an outlier. Resolution will include the installation of shim plates to eliminate the gap.

In accordance with GIP section 4.4.1- check #6, "anchorage with gaps larger than about 1/4" should be considered as outliers and evaluated in more detail". Anchorage with gaps greater than 1/4" (no essential relays) were classified as outliers and evaluated in accordance with structural analysis techniques. Guidance provided within EPRI TR-103960, Recommended Approaches for Resolving Anchorage Outliers", was frequently used as a reference.

Request 16b:
Under item No.12, it is stated that, where anchorage and load path could produce significant prying action, an analysis was performed in accordance with EPRI report TR-103960. Submit the EPRI report and provide two examples to demonstrate how the significant prying action issue was resolved.

Response:
Applicable section of EPRI Report TR-103960 is contained on Attachment RAI16b.1 Copies of the calculations for MCC 2XP and MCC 3XS3 are contained in Attachments RAI16b.2 and RAI16b.3 respectively.

Enclosure 1
Evaluation Approaches for Relay Screening

Request 8b:

Provide two examples from each of the evaluation approaches performed to screen relays by the EPRI Relay Generic Equipment Ruggedness Spectra (GERS), the Generic Implementation Procedure (GIP) Switchgear Relay Method, seismic test reports, and seismic analyses.

Response 8b:

Shown below are responses to request 8b:

8b.1 Keowee Hydro Units and Oconee Switchyard (Reference 1)

8b.1.1 EPRI Relay GERS

Shown below are examples of the application of EPRI Relay GERS to screen essential relays located in Keowee Hydro Station and Oconee Switchyard.

Relay 1EXRX/1A is located at Keowee Hydro Station in Logic Cabinet 1MTC1 at elevation 675. Relay 81X/RX1 is located in Oconee Switchyard Cabinet SRF17 on grade at elevation 770. Details concerning these relays, accelerations and relay capacities are shown in Table 8b.1.1 below.

Table 8b.1.1
Examples using EPRI Relay GERS at Keowee Hydro Station and Oconee Switchyard

			Floor Acceleration (g)	Adjustment Factors	Relay Acceleration (g)	Relay GERS (g)
Relay ID	***Manufacturer/ Model***	***Cabinet***	***4-16 Hz/ ZPA***	***Cab Amp Factor/ Median-Centered Factor***	***4-16 Hz/ ZPA***	***4-16 Hz/ ZPA***
1ESRX/1A	Cutler-Hammer D23MRD40A1	1MTC1 (KEO)	0.15 0.1	4.5 1.5	1.013 0.675	9.0 3.6
81X/RX1	Struthers-Dunn 219DXBP	SRF17 (SWYD)	0.24 0.15	4.5 1.0	1.08 0.675	5.0 2.0

The screening technique used was as follows:

- Relays were identified by reviewing the circuit involved and the function which the relay performed
- Floor accelerations were used for the cabinet in which the relays are located
- The appropriate cabinet amplification and median-centered factors were applied
- Relay accelerations were calculated for both the 4-16 Hz and ZPA frequency ranges by multiplying floor accelerations by both adjustment factors (Cabinet Amplification Factor and Median-Centered Factor)
- The resulting relay accelerations were then compared to relay capacities as documented in EPRI NP-7147-SL
- In each example, it can be seen that relay capacities are greater than demand

8b.1.2 GIP Switchgear Relay Methodology

The GIP Switchgear Relay Methodology was not used to screen essential relays at Keowee Hydro Station or the Oconee Switchyard.

8b.1.3 Seismic Test Reports and Seismic Analyses

Keowee Hydro Units and Oconee Switchyard (Reference 1)

Seismic Test Reports and Seismic Analyses

Table 8b.1.3 provides two examples of SQUG relay reviews using a combination of Seismic Test Reports and Seismic Analyses. In both cases, the seismic in-cabinet demand was determined using Seismic Analyses and the seismic capacity for the relays was obtained from Seismic Test reports.

Table 8b.1.3

Examples using Seismic Test Reports and Seismic Analyses

Relay ID	Manufacturer	Model	Cabinet
51VR-1X	General Electric	12IJCV51	EB03
50-51Y	Westinghouse	C0-8	EB06

Development of Worst Case In-Cabinet Demand Spectrum

The Keowee EB03 and EB06 cabinets are included in a row of cabinets connected together to form one large shock-mounted main control board type enclosure. The Keowee boards are seismically similar to the Unit 1/2 Electrical Control Boards at Oconee, for which detailed response spectra exist. Therefore, seismic similarity was used to estimate the in-cabinet spectra for the Keowee boards. Seismic similarity was based on an extensive comparison of the physical size, construction, mass distribution, stiffness, and anchorage configurations between the two enclosures.

The easiest method of estimating the in-cabinet spectrum for the Keowee boards was to use the envelope generated for the Unit 1/2 boards. However, this method was too conservative because the input spectrum for the Unit 1/2 boards had much higher spectral accelerations than the input spectrum for the Keowee boards. The input and output in-cabinet spectra for the Unit 1/2 boards are given in Figure 8b.1.3.1. Also shown in Figure 8b.1.3.1 are the input ground response spectrum and the estimated in-cabinet spectrum for the Keowee boards.

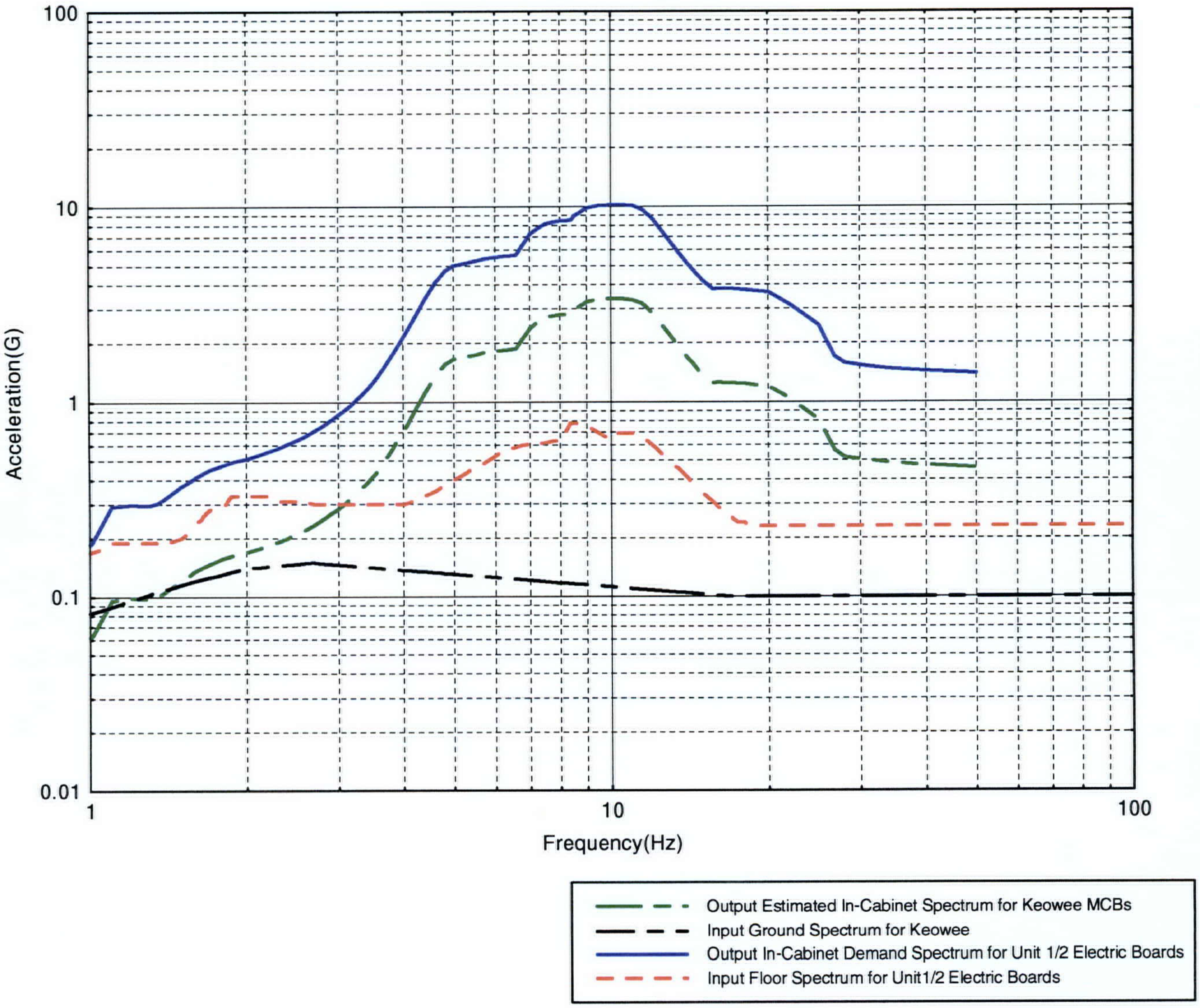
A more accurate method of estimating the in-cabinet spectrum for the Keowee boards was to determine the worst-case acceleration amplification for the Unit 1/2 boards based on the control board natural frequencies and the input and output in-cabinet spectra given in Figure 8b.1.3.1. The cabinet natural frequencies are easily seen in the figure because they produce acceleration amplifications above the input spectral accelerations. The in-cabinet spectrum for the Unit 1/2 boards shows acceleration amplifications in the frequency range from 5 to 20 Hz. The in-cabinet spectrum for Keowee could be estimated by multiplying the ground response spectrum by the computed worst-case amplification factor. This method produces an accurate estimate of the peak acceleration, but it severely over-estimates the spectral accelerations in the lower frequency range and produces an in-cabinet spectrum with an inappropriate spectral shape.

Because of the seismic similarity, the computed in-cabinet spectrum for the Keowee boards was expected to have a spectral shape similar to the in-cabinet spectrum for the Unit 1/2 boards. Therefore, the Unit 1/2 spectrum was shifted downward until the peak acceleration was equal to the acceleration value computed using the worst case amplification factor above. However, this method under-estimated the spectral accelerations in the lower frequency range.

To correct the spectral accelerations in the lower frequency range, the final estimated in-cabinet spectrum for Keowee was computed by shifting the Unit 1/2 board spectrum back up until the spectral accelerations in the lower frequency range were approximately the same as the input ground spectrum for Keowee. This final method conservatively over-estimates the peak acceleration of the in-cabinet spectrum with a corresponding cabinet amplification several times greater than the maximum amplification factor given in the GIP.

Figure 8b.1.3.1

Input Floor Spectrum and Calculated In-Cabinet Demand Spectrum for Unit 1&2 Electric Boards Vs. Input Ground Spectrum and Estimated In-Cabinet Demand Spectrum for Keowee 5% Damping



Development of Relay Capacity

General Electric 12IJCV51 Relay
The General Electric 12IJCV51 relay was seismically tested in accordance with IEEE-344 1975. The capacity spectra are given in Figure 8b.1.3.2 and represent the front-to-back, side-to-side, and vertical capacity of the relay.

Westinghouse CO-8 Relay
The Westinghouse CO-8 relay was seismically tested in accordance with IEEE-344 1975. The capacity spectra are given in Figure 8b.1.3.3 and represent the front-to-back, side-to-side, and vertical capacity of the relay.

Capacity versus Demand Comparisons

General Electric 12IJCV51 Relay
The capacity versus demand comparison for the General Electric relay is given in Figure 8b.1.3.2. The figure shows that the in-cabinet demand spectrum is fully enveloped by the relay capacity spectra at all frequency points, therefore, the relay is seismically qualified for the EB03 control board at Keowee.

Westinghouse CO-8 Relay
The capacity versus demand comparison for the Westinghouse relay is given in the Figure 8b.1.3.3. The figure shows that the in-cabinet demand spectrum is fully enveloped by the relay capacity spectra at all frequency points, therefore, the Westinghouse C0-8 relay is seismically qualified for the EB06 control board at Keowee.

Figure 8b.1.3.2

General Electric 12IJCV51 Relay Capacity Spectra vs. Estimated Keowee MCBs Demand Spectrum 5% Damping

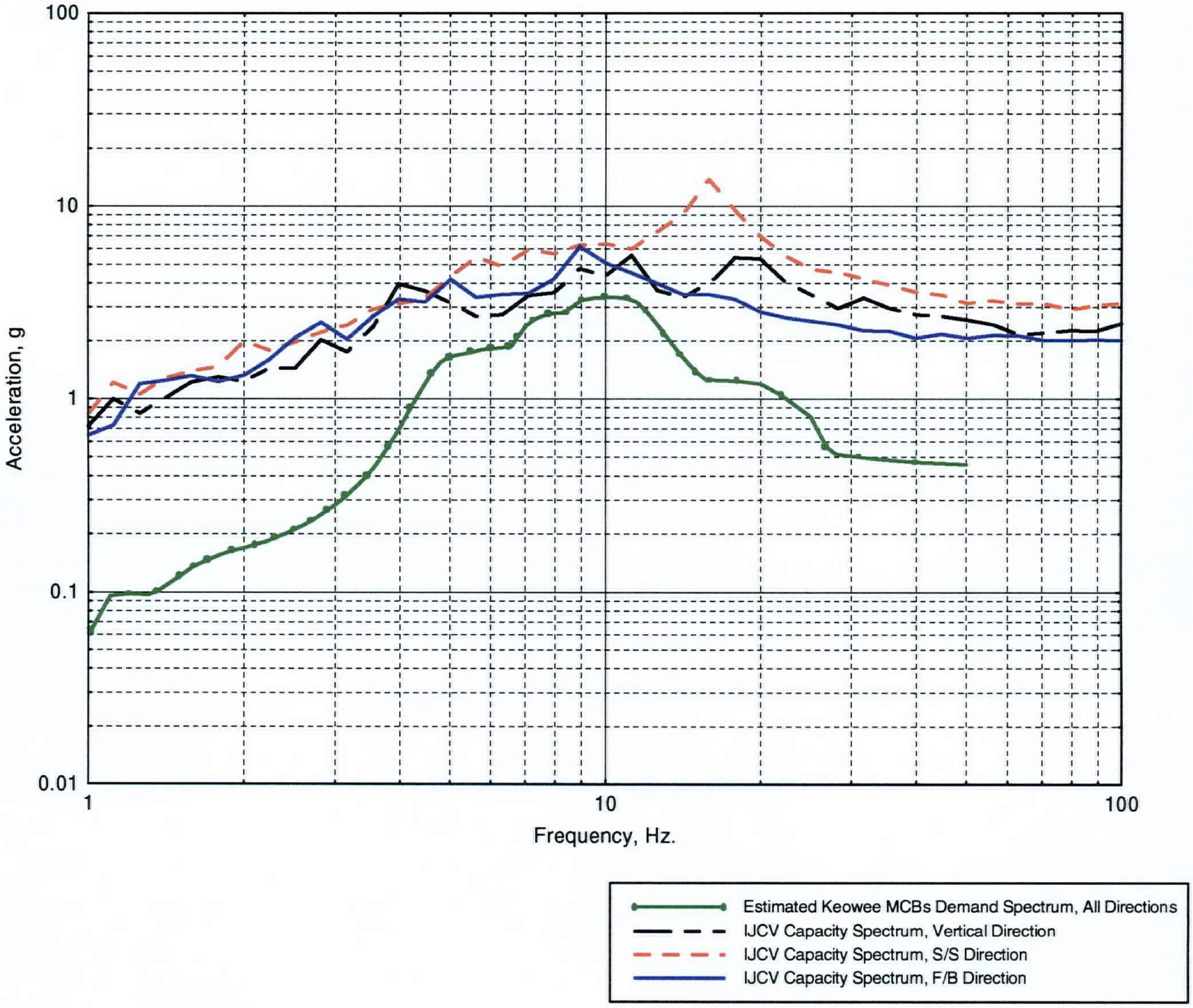
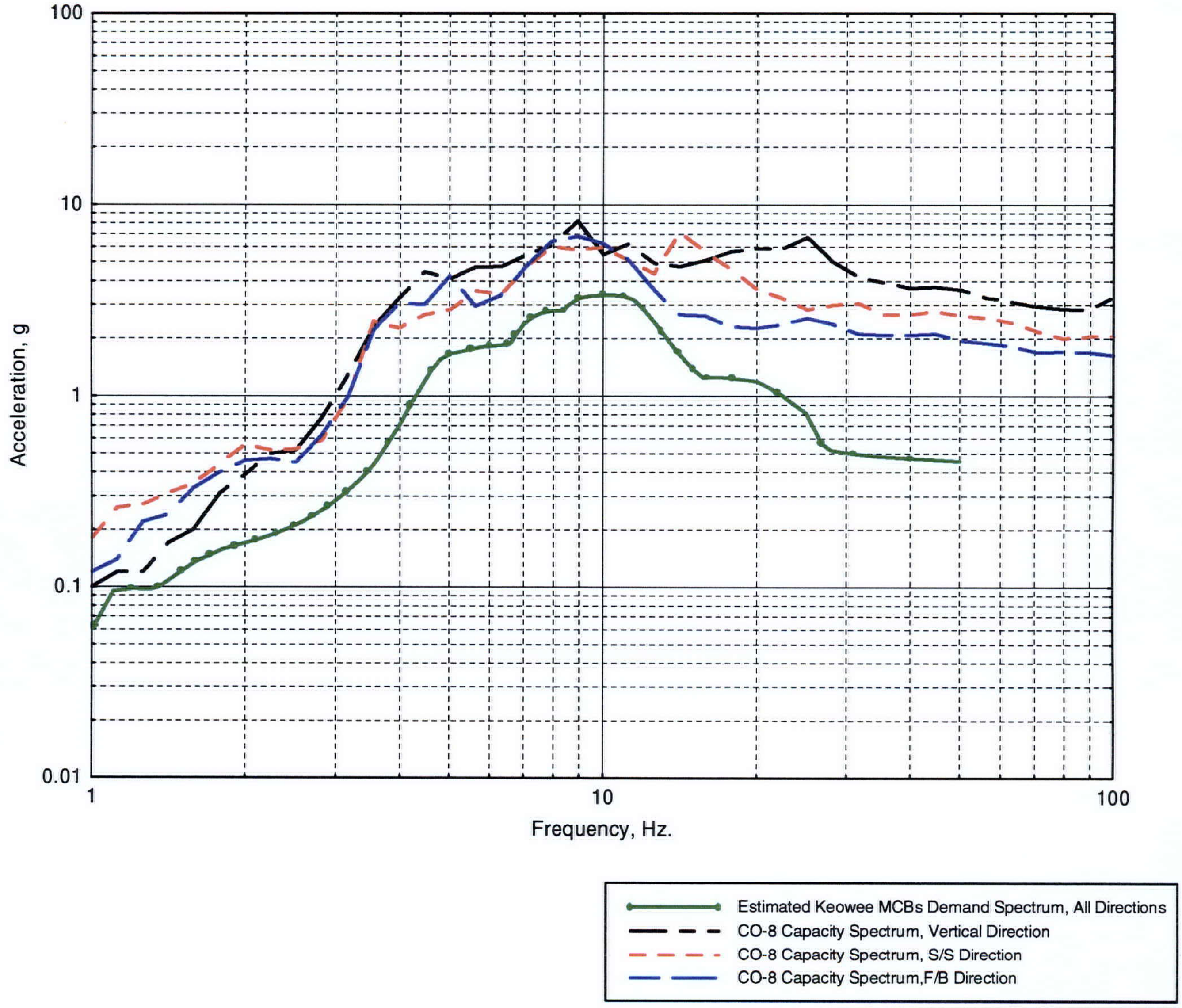


Figure 8b.1.3.3

Westinghouse C0-8 Relay Capacity Response Spectra vs. Estimated Keowee MCBs Demand Spectrum 5% Damping



8b.2 Oconee Nuclear Station, Units 1, 2, and 3 (Reference 2)

8b.2.1 EPRI Relay GERS

Shown below are two examples of the application of EPRI Relay GERS to screen essential relays located at Oconee Nuclear Station.

Relay 1RX/1 is located in Oconee Cabinet 1EPSLP2 at elevation 809 in the Oconee Cable Room and relay 83-L/SSV/U1 is located at elevation 822 in the Unit 1 Control Room. Details concerning these cabinets, relay accelerations and relay capacities are shown in Table 8b.2.1 below.

Table 8b.2.1

Examples using EPRI Relay GERS at Oconee Nuclear Station

Relay and Location			Floor Acceleration (g)	Adjustment Factors	Relay Acceleration (g)	Relay GERS (g)
Relay ID	**Manufacturer/ Model**	**Cabinet**	**4-16 Hz/ ZPA**	**Cab Amp Factor/ Median-Centered Factor**	**4-16 Hz ZPA**	**4-16 Hz/ ZPA**
1RX/1	Cutler-Hammer D23MRD70A1	1EPSLP2	0.64 0.23	7.0 1.5	6.72 2.415	9.0 3.6
83-L/SSV/U1	Potter-Brumfield KRP11AG	1ICS	0.77 0.23	4.5 1.5	5.198 1.553	8.0 3.2

As described in Reference 1 examples above, the screening technique used was as follows:

- Relays were identified by reviewing the circuit involved and the function which the relay performed
- Floor accelerations were used for the cabinet in which the relays are located
- The appropriate cabinet amplification and median-centered factors were applied
- Relay accelerations were calculated for both the 4-16 Hz and ZPA frequency ranges by multiplying floor accelerations by both adjustment factors (Cabinet Amplification Factor <u>and</u> Median-Centered Factor)
- The resulting relay accelerations were then compared to relay capacities as documented in EPRI NP-7147-SL
- In each example, it can be seen that relay capacities are greater than demand

8b.2.2 GIP Switchgear Relay Methodology

Shown below are examples of the application of GIP Switchgear Relay Methodology to screen essential relays located at Oconee Nuclear Station.

Relay 27(1TC-05) is located in Switchgear 1TC at elevation 796 in the Unit 1 Turbine Building. Relay RXE2(3B1T-03) is located in Switchgear 3B1T at elevation 796 in the Unit 3 Blockhouse. Details concerning these relays are shown in Table 8b.2.2 below.

Table 8b.2.2

Examples using GIP Switchgear Relay Methodology at Oconee Nuclear Station

Relay and Location			
Relay ID	**Manufacturer**	**Model**	**Location**
27(1TC-05)	WESTINGHOUSE	CV-2 (1875508)	1TC Switchgear
RXE2(3B1T-03)	WESTINGHOUSE	AR (606B029A13)	3B1T Switchgear

Switchgear 3B1T has been determined to be seismically adequate using the seismic evaluation method given in Section 4 of the GIP. Seismic evaluation of Switchgear 1TC has determined that seismic interactions exist for this switchgear and plans are underway to resolve these interaction issues as part of USI A-46 outlier resolution. In each of the examples above, the relay is used only to control operation of the associated switchgear. Neither relay is one of the low-ruggedness relays listed in Appendix E of EPRI Report NP-7148, "Procedure for Evaluating Nuclear Power Plant Relay Seismic Functionality." Each of these relays are included in the relay evaluation report entitled "Oconee Nuclear Station, USI A-46 Relay Evaluation Report, September 1998."

8b.2.3 Seismic Test Reports and Seismic Analyses

Table 8b.2.3 gives two examples of SQUG relay reviews using Seismic Test Reports and Seismic Analyses. In both cases, the seismic in-cabinet demand was determined using Seismic Analyses and the seismic capacity was obtained from Seismic Test reports.

Table 8b.2.3

Examples using Seismic Test Reports and Seismic Analyses

Relay ID	Manufacturer	Model	Cabinet
50BN13 (3B1T-05)	General Electric	CHC11A21A	Switchgear 3B1T
1CPS0015	ITT Barton	581A-2	Turbine Building at Upper Surge Tank Platform

Development of Worst Case In-Cabinet Demand Spectrum

Switchgear 3B1T

The estimation of in-cabinet response spectra for switchgear 3B1T was based on hand calculations using simplified plates, the response of a single degree of freedom oscillator model, in-situ modal data collected by Stevenson and Associates, and dynamic theory similarity techniques. The extensive work was documented in a Duke Power internal calculation.

It was shown by in-situ modal testing that the 3TC switchgear enclosure had no global modes less than the rigid range and that the in-cabinet response was dominated by the fundamental mode of each local panel. Therefore, using physical and dynamic similarity, it was shown that the B1T/B2T switchgear was also rigid and that the in-cabinet response spectra were dominated by single plate modes of the local panels. The demand spectrum envelope for all of the local panels on the 3B1T switchgear is given in Figure 8b.2.3.1.

Turbine Building at Upper Surge Tank Platform
The pressure switches are mounted to rigid, Duke designed, mounting plates which are connected directly to the structure, therefore, there will be no amplification of the in-structure response spectra.

There are no existing in-structure response spectra for the Upper Surge Tank Platform in the Turbine Building. However, EQE extrapolated from the spectra at Elevations 796 and 822 to determine a conservative set of spectra at Elevation 838. The same technique was used for this analysis to be consistent. The estimated in-structure response spectra for the Upper Surge Tank Platform at Elevation 838 are given in Figure 8b.2.3.2.

Development of Relay Capacity

General Electric
The General Electric CHC11A29A relay was seismically tested in accordance with IEEE-344 1975 and documented in a Duke Power internal calculation. The front-to-back, side-to-side, and vertical capacity spectra are given in Figure 8b.2.3.1.

ITT Barton
The ITT Barton pressure switch was also seismically tested in accordance with IEEE 344-1975 and documented in a Duke Power internal calculation. The front-to-back, side-to-side, and vertical capacity spectra are given in Figure 8b.2.3.2.

In addition to the seismic qualification level concern, pressure switches are vulnerable to chatter if the set point pressure is close to the operating pressure (within ±10%). Site personnel confirmed that the set point pressure was 7' 1-1/2" of water in the tank. The operating pressure is 11' of water in the tank, therefore, the set point pressure is well outside the ±10% requirement.

Capacity versus Demand Comparisons

General Electric
The capacity versus demand comparison for the General Electric relay is given in the Figure 8b.2.3.1. The figure shows that the in-cabinet demand spectrum for the front-to-back excitation direction is enveloped by the relay capacity spectrum at all frequency points. In addition, the side-to-side and vertical excitation directions are enveloped between 4 and 16 Hz in accordance with the GIP, therefore, the General Electric CHC11A21A relay is seismically qualified for the 3B1T switchgear at Oconee.

ITT Barton

The capacity versus demand comparison for the ITT Barton pressure switch is given in the Figure 8b.2.3.2. The figure shows that the estimated in-structure demand spectra are enveloped by the pressure switch capacity spectrum between 4 and 16 Hz in accordance with the GIP, therefore, the ITT Barton 581A-2 pressure switch is seismically qualified for the Turbine Building Upper Surge Tank Platform.

Figure 8b.2.3.1

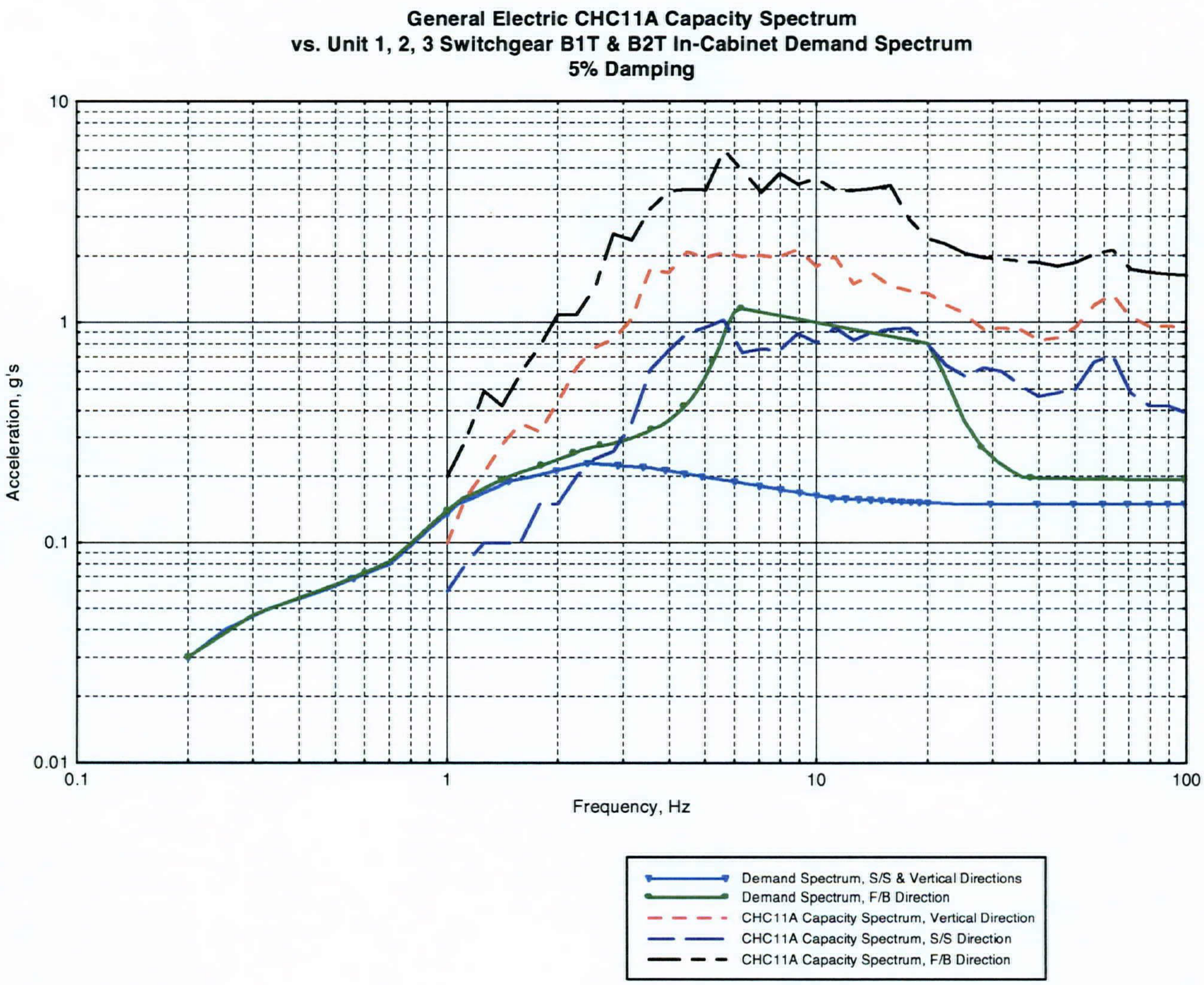
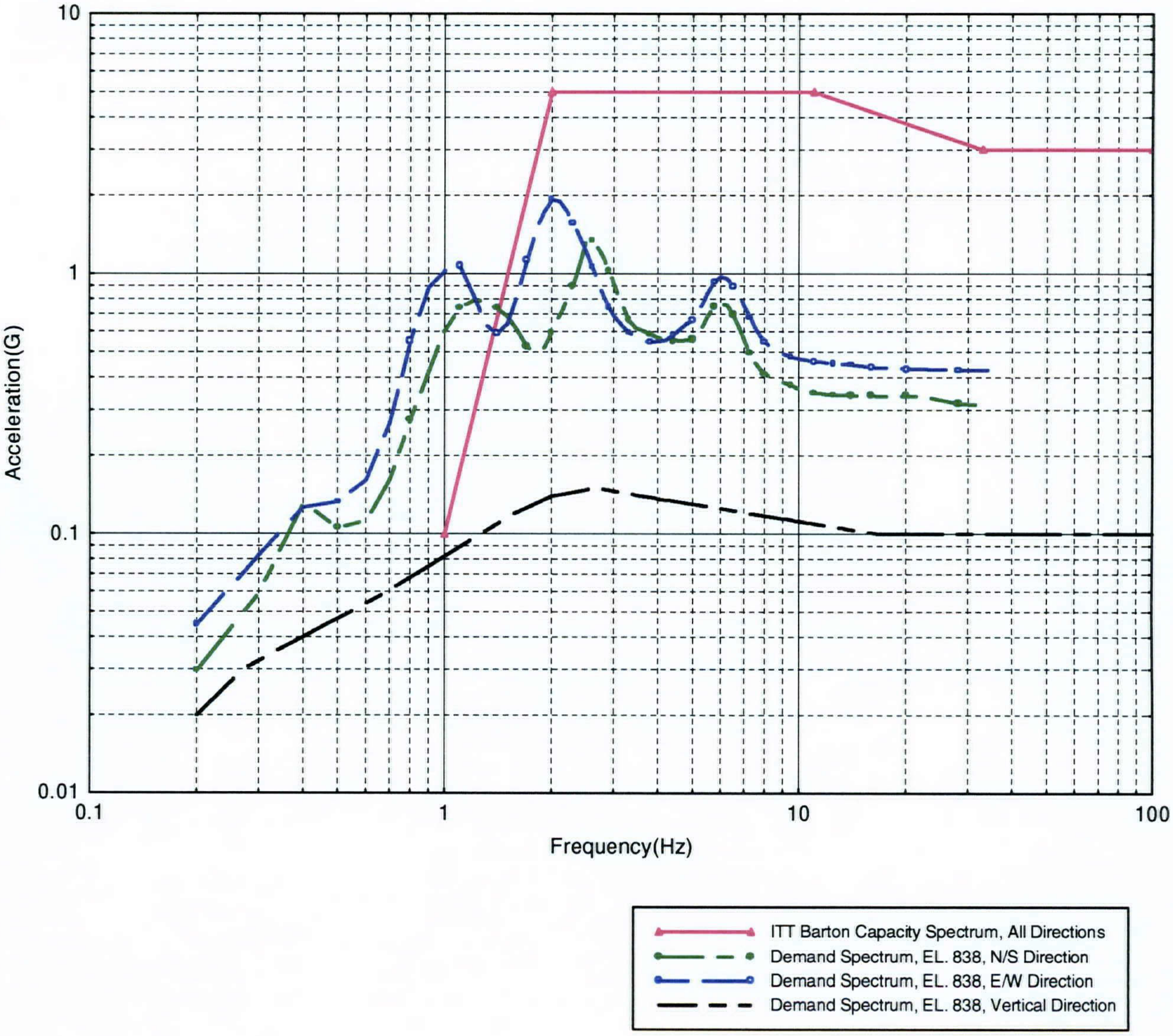


Figure 8b.2.3.2

ITT Barton Differential Pressure Switch Capacity Spectrum vs. Turbine Building Upper Surge Tank Platform Demand Spectra 5% Damping



Enclosure 2

Bases for Interpretation and Implementation of GIP-2 Rules for Method A

References:

1) Seismic Qualification Utility Group (SQUG), "Generic Implementation Procedure (GIP) For Seismic Verification of Nuclear Plant Equipment," Revision 2, Corrected 2/14/92.
2) Senior Seismic Review and Advisory Panel (SSRAP), "Use of Seismic Experience and Test Data to Show Ruggedness of Equipment in Nuclear Power Plants," Revision 4.0, February 28, 1991.
3) U.S. Nuclear Regulatory Commission, "Seismic Qualification of Equipment in Operating Nuclear Power Plants," NUREG-1030, February 1987.
4) U.S. Nuclear Regulatory Commission, "Regulatory Analysis for Resolution of Unresolved Safety Issue A-46, Seismic Qualification of Equipment in Operating Plants," NUREG-1211, February 1987.
5) U.S. Nuclear Regulatory Commission, "Supplement No.1 to Generic Letter (GL) 87-02 That Transmits Supplemental Safety Evaluation Report No. 2 (SSER No.2) on SQUG Generic Implementation Procedure, Revision 2, As Corrected on February 14, 1992 (GIP-2)," May 22, 1992.
6) "A Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1)," EPRI NP-6041-SL, Rev.1, August 1991.

Discussion:

Method A of GIP Table 4-1 (Reference 1) provides a methodology to evaluate the seismic adequacy of equipment by comparing equipment capacity based on earthquake experience ground response spectra at database sites with the plant's SSE ground response spectrum (GRS). The composite earthquake experience GRS from the database sites (Reference Spectrum) was reduced by a factor of 1/1.5 to account for possible additional amplification of motion in nuclear plants compared to database plants and is referred to as the "Bounding Spectrum" in the GIP.

The seismic capacity of equipment defined by the Bounding Spectrum is compared to the seismic demand at the effective grade using the plant licensing basis SSE GRS. The GIP Method A conservatively limits use of this approach to equipment which has a fundamental frequency above about 8 Hz and is located lower than about 40' above the effective grade of the building. These restrictions prohibit the use of GIP Method A for equipment with low fundamental frequencies and for equipment located at high elevations in buildings where the structure seismic response is known to be typically high.

Additional details justifying the use of GIP Method A may be found in the Senior Seismic Review and Advisory Panel (SSRAP) report (Reference 2). This report, included as Reference 5 in GIP-2, summarizes SSRAP's judgment on this subject:

> "..... the use of very conservative floor response spectra should be avoided when assessing the seismic ruggedness of floor mounted equipment ...... Only for cases of equipment mounted more than 40 feet above grade or equipment with as-anchored frequencies less than about 8 Hz is it necessary to use floor spectra."
>
> [Ref. 2, pages 102 and 103]

It is Oconee's position that we have interpreted and implemented the rules for use of GIP Method A as they were previously reviewed and accepted by the NRC in the "Supplementary Safety Evaluation Report (SSER-2)" of Reference 5. Note that where Method A was used at Oconee, it is fully justifiable based on the requirements of GIP-2 and its basis documents, such as the SSRAP Report and SQUG's guidelines on the use of Method A. The basis for this position is provided below.

1. **SQUG and Oconee's Interpretation of the GIP**

The caution given on page 4-16 of GIP-2 lists two limitations governing the use of Method A:

- Equipment should be mounted in the nuclear plant below about 40 feet above the effective grade, and
- Equipment should have a fundamental natural frequency greater than about 8 Hz.

The introductory wording in GIP-2 for these two limitations provides the bases or purposes for imposing them, specifically (1) to limit amplification to no more than about 1.5 and (2) to avoid the high-energy frequency range of the earthquake, below about 8 Hz. The specific limitations which are intended by the SQUG/NRC expert panel (SSRAP) and SQUG to satisfy these bases are included in the two bullet items listed above. Indeed, Table 4-1 of GIP-2 which describes the two methods (Method A and Method B) in detail, includes the criteria which need to be met for each of the two methods. The table includes the above two limitations, but does not include the requirement for checking the amplification between the in-structure response and the free field.

The statement on page 4-16 that "the amplification will not exceed about 1.5" is the expected result of meeting the above limitations, and not a third condition which is required to be met.

The caution on page 4-16 of GIP-2 makes it clear that the advantage of Method A is:

> "The advantage of using ground response comparisons is that with the applicable restrictions and limitations [i.e. the two bullet items listed above], all the equipment covered by the Bounding Spectrum or the GERS can be evaluated for seismic adequacy without the need for using in-structure response spectra which are often based on very conservative modeling techniques or may not be available."
>
> [Ref. 1, page 4-16]

2. **The Intent of the GIP**

The GIP cites the SSRAP report (Ref. 2) as the basis for the Bounding Spectrum development and use in Method A (page 4-11, Ref. 2). The SSRAP report explains the limitations and conditions which appear on page 4-16 of the GIP. SSRAP's report states:

> "Thus, it is SSRAP's judgment that amplifications greater than a factor of 1.5 are unlikely in stiff structures at elevations less than 40 feet above grade except possibly at the fundamental frequency of the building where higher amplifications occur when such a frequency is less than about 6 Hz. Thus, for equipment with fundamental frequencies greater than about 8 Hz in the as-anchored condition it was judged that floor spectral amplifications within 40 feet of grade would be less than 1.5 when reasonably computed using more median centered approaches."
>
> [Ref. 2, page 102]

This judgment by the SSRAP was based on numerous studies and actual earthquake measurements which led them to conclude that:

> "Thus, amplification of the horizontal free-field ground spectra by factors greater than 1.5 are considered to be generally unlikely for elevations less than 40 feet above grade."
>
> [Ref. 2, page 104]

The SSRAP was aware that many nuclear plants were originally licensed based on very conservative ISRS and that the use of conclusions based on earthquake experience and more median-centered approaches would be more appropriate. A detailed discussion of some of the sources of this conservatism is presented in item 3 below. With reference to this topic, the SSRAP report states:

> "It was judged by SSRAP that the use of very conservative floor spectra should be avoided when assessing the seismic ruggedness of floor mounted equipment. It was also the opinion

of SSRAP that many of the operating plants may only have these very conservatively computed floor spectra available. To avoid the burden of having to compute more realistic floor spectra, SSRAP decided to anchor its conclusions to ground spectra at the nuclear plant sites in those cases where this was judged to be reasonable."

[Ref. 2, page 102]

This was the basis for SSRAP's recommendation (and included in GIP-2 as methods A and B) that:

"Thus, for the case of equipment with fundamental frequencies greater than about 8 Hz mounted less than 40 feet above grade, SSRAP's conclusions are based upon comparing the bounding spectra with nuclear power plant ground spectra. Only for the case of equipment mounted more than 40 feet above grade or equipment with as-anchored frequencies less than about 8 Hz is it necessary to use floor spectra."

[Ref. 2, page 102]

The SSRAP Chairman and developer of Method A, Dr. Robert Kennedy, was contacted by SQUG and concurs with the interpretation given in item 1 above.

3. **Conservatisms Associated with Licensing Basis Calculated ISRS**

The following is a detailed description of the typical conservatisms normally found in the analytical methods used for calculating in-structure response spectra (ISRS), at nuclear plants in general and at Oconee in particular. Please note that Oconee does not consider providing this additional supporting information as a necessary requirement for the application of the GIP Method A. It is solely provided as additional evidence of the validity of Method A as originally developed by the SSRAP.

The process of calculating ISRS is a complicated analytical exercise requiring a significant amount of approximations, modeling assumptions and engineering judgments. As a result, the historical development of ISRS has included a large amount of conservatism, which has typically served two purposes:

1) It has reduced the technical debate as to the correct modeling of the many parameters which are intrinsic to the ISRS calculational methodology, and
2) It has reduced the costs associated with a very detailed, state-of-the-art analysis, (which would attempt to trim out all the unnecessary conservatisms).

As a part of the A-46 program resolution methodology, the SSRAP had developed, and SQUG subsequently endorsed, an alternate ISRS estimation technique (referred to as Method A within GIP-2) which was much more median centered and realistic than the typical design practice. Oconee's position is that the application of Method A was appropriate and technically justified. The fact that design ISRS may show amplifications greater than 1.5 is not surprising, nor does it negate the validity of Method A. In fact, as noted in the SSRAP report it was even expected:

"Secondly, most unbroadened computed in-structure spectra have very narrow, highly amplified peaks at the resonant frequency of the structure. In most cases these narrow, highly amplified peaks are artificially broadened to account for uncertainty in the structure's natural frequency. This process simply increases the emphasis on these highly amplified peaks.... SSRAP is also of the opinion that these narrow peaks will not be as highly amplified in real structures at high ground motion levels as is predicted by linear elastic mathematical models, nor are such narrow peaked in-structure spectra likely to be as damaging to equipment as is a broad frequency input which is represented by 1.5 times the Bounding Spectrum."

[Ref. 2, pages 19 and 20.]

As described below, three areas are presented to support the application of Method A in general at U.S. nuclear plants, and specifically at Oconee.

3.1 Measurements of ISRS in Actual Earthquakes

SSRAP developed the Method A response estimation technique based on their research of both actual earthquake measurements and on recent "median centered" analysis. They reference (Ref. 2, page 102) the measured floor response spectra at elevations less than 40 feet above grade for moderately stiff structures at the Pleasant Valley Pump Station, the Humboldt Bay Nuclear Power Plant and the Fukushima Nuclear Power Plant, where amplifications over the ground response spectra do not exceed 1.5 for frequencies above about 6 Hz. Other, more recent earthquake data from the Manzanillo Power Plant and SICARTSA Steel Mill in Mexico, as well as several facilities in California and Japan, have been reviewed by SQUG. These data also show that stiff buildings (similar to typical nuclear structures) amplify very little at elevations less than 40 feet above grade and frequencies over 8 Hz. SQUG knows of no new measured data that challenge GIP Method A.

3.2 Calculations of Overall Conservatism in Typical ISRS

Calculated ISRS have never been portrayed as representing the realistic expected response during an actual earthquake. As previously stated, ISRS typically contain many conservatisms which make them unrealistically high. The primary reason for the development of Method A was to establish a more median centered method of establishing the structural response without having to embark on costly new analyses of all the site buildings. (It is noted that even the most modern, state-of-the-art ISRS contain significant conservatisms; even those classified as "median centered" are often very conservative). NUREG/CR-1489, "Best Estimate Method vs. Evaluation Method: A Comparison of Two Techniques in Evaluating Seismic Analysis and Design", stated that typical calculated ISRS contain factors of conservatism of 1.5 to 8. Recent surveys by SQUG show similar levels of conservatism in calculated ISRS.

It was the contention of SSRAP that the ISRS for nuclear structures (considering the 40' and 8 Hz conditions) would be within about 1.5 times the ground response spectrum (GRS) if the plant were subjected to an actual earthquake. In deriving the Method A criteria they recognized that due to the variety of ground motions, soil characteristics and structure characteristics there could be occasional exceedances of the 1.5 amplification, but still strongly justified Method A's applicability:

> "It is SSRAP's firm opinion that the issue of potential amplifications greater than 1.5 above about 8 Hz for high frequency input is of no consequence for the classes of equipment considered in this document except possibly for relay chatter[1]."
>
> [Ref. 2, Page 106]

1 Because of the SSRAP concern related to possible relay chatter at frequencies above 8 Hz, the SQUG methodology specifically addresses relays which are sensitive to high frequency vibration. Such relays are included on the Low Ruggedness Relays list in Appendix E of EPRI Report NP-7148.

The basis SSRAP gave for drawing this conclusion was that high frequency ground motions do not have much damage potential due to low spectral displacement, low energy content, and short duration. They further noted that the equipment covered does not appear to have a significant sensitivity to high frequencies (except possibly for relay chatter, which is addressed separately in the GIP).

3.3 Description of Conservatisms in ISRS in General and Oconee ISRS in Particular

The most significant sources of conservatism involved in the development of the ISRS for PNPS include the following:

- Location of Input Motion (variation from the free field input location)
- Ground Response Spectrum Shape
- Soil-Structure Interaction (soil damping, wave scattering effects)
- Ground Motion Incoherence
- Frequency (structure modeling)
- Structural Damping
- Time History Simulation
- Nonlinear Behavior (e.g., soil property profile variation, concrete cracking)
- Peak Clipping for Narrow Peaks

The degree of conservatism involved in each of these parameters is specific to the building being analyzed, to the floor level being considered, and, often, to the equipment location within the specified floor level. These conservatisms typically cannot be accurately quantified using simplistic calculation techniques since each parameter fits into an overall set of highly nonlinear equations. Thus, it would take a considerable effort to quantify the exact excess conservatisms inherent in the calculated ISRS at Oconee. However, on a qualitative level, it is easy to see the origins and levels of this conservatism. The following parameters are the source of the major portions of the excess conservatism:

Location of Input Motion The defined location of the plant SSE is typically part of the design basis documentation. The SSE should typically be defined at the ground surface in the free field as defined in the current Standard Review Plan criteria. The Oconee UFSAR defines an SSE at bedrock and a separate SSE at "overburden" or top of soil. For purposes of generating ISRS, some plants conservatively defined the input (currently identified as the "control point" location) at another location, such as the embedded depth of a building basemat. This conservatism can be significant depending on the specific plant/building configuration

The Oconee UFSAR Section 2.5.2.6, Maximum Hypothetical Earthquake (MHE) states that "The MHE acceleration value is 0.10 g for Class 1 structures founded on bedrock and 0.15 g for structures founded on overburden." For purposes of generating Turbine Building ISRS, the original analyses used the 0.10g MHE input at the building basemat, which rests directly on bedrock. Since this is in agreement with the licensing basis, this source of conservatism is not relevant to the Turbine Building ISRS.

Ground Response Spectrum Shape The SSE defined within the plant licensing basis is the appropriate review level for the A-46 program. Some utilities used alternative (conservative) spectral shapes for the earthquake levels for their A-46 resolution (i.e., submitted as part of their 120-day response letters). The amount of conservatism is directly related to the difference between these two spectral shapes at the frequencies of interest for the structures being reviewed. This factor can range from 1.0 to around 2.0 depending on the differences between the spectra.

The licensing basis MHE earthquake is characterized by an Oconee site specific shape for the horizontal ground response anchored at 0.10g. Since the same ground spectrum was used for the USI A-46 program, the GRS shape did not contribute conservatism to the original licensing basis ISRS at Oconee.

Soil Structure Interaction (SSI). Typical design analyses do not account properly for the phenomenon of SSI, including the deamplification with depth that occurs for embedded structures or for the radiation damping effects inherent at soil sites. Fixed-base analyses have been performed for structures founded on rock, and soil-spring analyses, with low damping, for structures founded on soil columns. For soil founded structures the soil spring analyses can vary between conservative and very conservative compared to sophisticated SSI analyses. The simplified analyses that used the frequency-independent soil springs were typically very conservative in that radiation and/or material soil damping were either conservatively eliminated or artificially limited during the analysis. Soil properties were also typically not adjusted to reflect anticipated soil strain levels. Significant reductions have been demonstrated over design type analyses using more modern techniques. These reduction factors are highly dependent on the specific soil conditions and structure configurations, but values of around 2 to 4 have been seen in past studies.

The Oconee Turbine Building is founded on rock; therefore, the amount of SSI conservatism inherent in the foundation input is small.

Ground Motion Incoherence. As has been documented in the EPRI seismic margin report (EPRI NP-6041) there can be a deamplification effect on nuclear type structures due to the incoherence of ground motion. Conservative reduction factors as a function of frequency and building footprint have been documented within NP-6041 to account for the statistical incoherence of the input wave motion. These conservative values range from a factor of 1.1 to around 1.5. More recent studies have documented even greater reduction factors. This ground motion incoherence is applicable to rock sites like Oconee, and is particularly appropriate in the high frequency range.

Structural Damping Structural damping is one of the parameters of dynamic analysis to which the seismic analysis results are quite sensitive. It is a physical property of the different materials included in the dynamic model. Values used in current analyses and licensing bases are controlled by Regulatory Guide 1.61 (R.G. 1.61). Values specified in R.G. 1.61 have been shown by several studies to underestimate actual response of steel and concrete structures. Damping values recommended in NP-6041 (Ref. 6) are more realistic, and are suggested for use in median centered analyses. Damping values specified in Oconee's licensing basis are compared to those in R.G. 1.61 and NP-6041 below:

Structure or Component	*R. G. 1.61 OBE*	*R. G. 1.61 SSE*	*NP-6041 at About ½ Yield*	*NP-6041 Just Below Yield*	*Oconee OBE License Basis*	*Oconee SSE License Basis*
Welded Steel	2%	4%	3%	7%	1%	1%
Bolted Steel	4%	7%	7%	10%	2%	2%
Prestressed Concrete	2%	5%	3%	7-10%	2%	5%
Reinforced Concrete	4%	7%	3-5%	10%	5%	5%

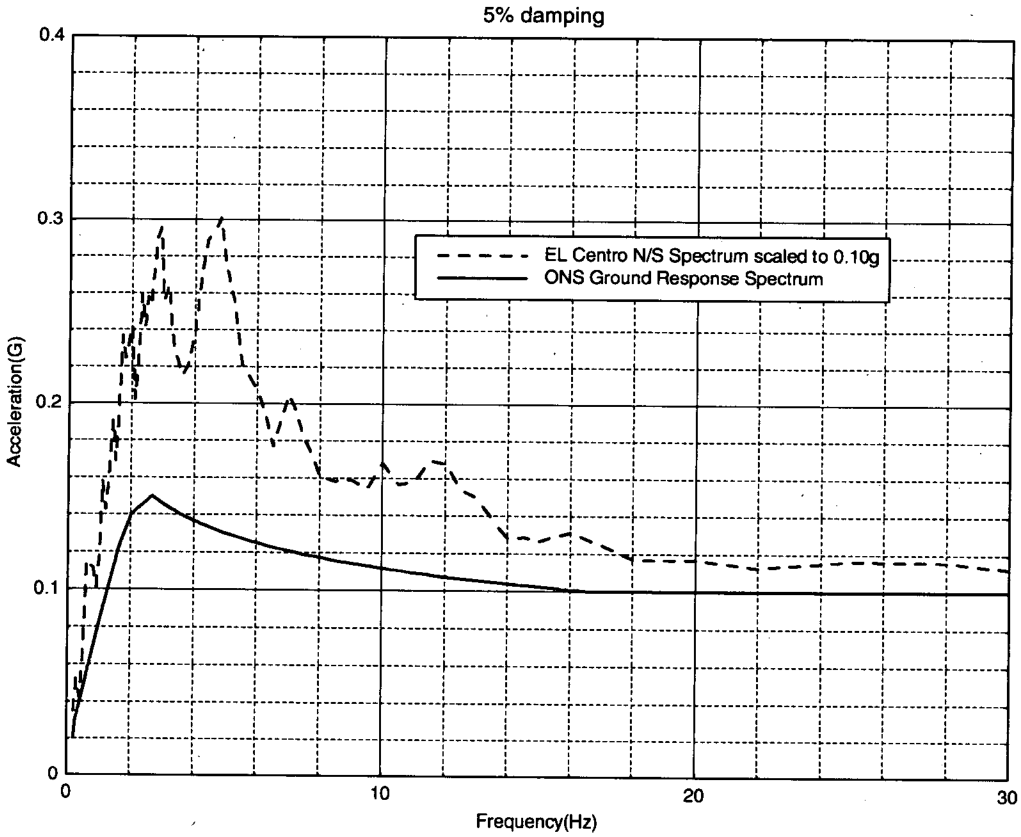
As can be seen, the damping values for both the OBE and SSE licensing basis at Oconee are much lower than values allowed by the regulatory guide for bolted steel structures such as the Turbine Building. Note that the same damping value is conservatively applied for OBE and SSE analysis of steel structures. The Turbine Building licensing basis ISRS were computed using a structural damping of 2%. The table above indicates that damping values between 7% and 10% would be appropriate for a median centered analysis. Even taking into consideration the Oconee site specific spectrum discussed below, a conservative damping of 5% would be reasonable. This would result in a reduction factor of approximately 1.58 [$(.05/.02)^{0.5}$] at the peak responses.

Time Histories Simulation. The Oconee licensing basis safe shutdown earthquake is characterized by a site specific shape for the MHE horizontal ground response spectrum anchored to a PGA of 0.10g. The Oconee UFSAR Section 3.7.1.2, Design Time History, notes that the design time history used was "The Time History record of the N-S, May 1940 El Centro earthquake..." For computation of ISRS, this time history was scaled to a PGA of 0.10g and used to represent bedrock input motion. Figure 2 shows a comparison of the Oconee Design basis MHE with the North/South component of the El Centro earthquake scaled to 0.10g.

The Turbine Building response spectra in Figure 1 show dominant responses at 2.5 and 5.8 Hz. The following table compares accelerations from the Oconee Ground Response Spectrum with the El Centro Response Spectrum at those dominant frequencies. At the frequencies of interest, the El Centro input is 1.7 times the required Oconee input which means that the structural response of the building and the resulting floor response spectra are over-conservative by a factor of 1.7.

Frequency (Hz)	***ONS Ground Spectral Accel. (g)***	***El Centro Spectral Accel. (g)***	***Factor of Conservatism***
2.5	0.15	0.26	1.73
5.8	0.12	0.21	1.75

Figure 2 Oconee Ground Response Spectra



Peak Clipping for Narrow Peaks The SSRAP report and the GIP recommend procedures for adjusting narrow peaks to reflect two areas of conservatism:

1. Narrow peaks are not as highly amplified in real structures as are predicted by linear elastic models.
2. Narrow peaks in ISRS are not as damaging to equipment as are broad frequency input such as the Reference Spectrum.

The GIP recommends an averaging technique over a frequency range of 10% of the peak frequency (e.g., 1 Hz. range for a 10 Hz. peak frequency) using the unbroadened ISRS. The Turbine Building ISRS have narrow peaks and Oconee did not utilize the peak reduction methods of the GIP. The conservatism involved has been shown to be in the range of 5% to 20% for typical narrow peaks at several plants.

Overall Conservatism. There are several additional sources of conservatism (e.g., structural modeling, structural/soil nonlinearities, etc.) which add to the overall conservatism in the calculation of ISRS. These additional conservatisms, coupled with those described above, reinforce the overall levels of conservatism in ISRS of between 1.5 and 8 which were referenced by SSRAP (LLNL Report NUREG/CR 1489). The two major sources of conservatism in the Turbine Building ISRS (structural damping and time history simulation) account for an over-conservative factor of 2.7 above the expected median centered ISRS. The total effect of these two factors and others explain why the conservative Oconee licensing basis ISRS result in significantly exceeding 1.5 times the GRS.

4. Not a Significant Safety Issue

The expected differences between calculated ISRS and actual building response do not represent a significant safety question. The lessons learned from review of hundreds of items of equipment at various sites that have experienced earthquakes which were significantly larger than those for Eastern U.S. nuclear plants are that missing anchorage, seismic interaction hazards, and certain equipment-specific weaknesses (incorporated into the GIP caveats) were the seismic vulnerabilities which cause equipment damage. These areas are conservatively addressed in the GIP. The NRC staff acknowledged the seismic ruggedness of nuclear power plant equipment in the backfit analysis for USI A-46 in which they stated the following:

> " ... subject to certain exceptions and caveats, the staff has concluded that equipment installed in nuclear power plants is inherently rugged and not susceptible to seismic damage."
>
> [Ref. 4, page 16]

Method A is only applicable to relatively stiff equipment with fundamental frequencies over about 8 Hz. As noted above, SSRAP and SQUG have agreed that excitations over 8 Hz have little damage potential due to low spectral displacements, low energy content and short duration. This judgment is supported by industry and NRC guidance for determining whether an Operating Basis Earthquake (OBE) is exceeded following a seismic event at a nuclear power plant. EPRI Report NP-5930 and NRC Regulatory Guide 1.166 recognize that damage potential is significantly reduced for earthquake ground motions above 10 Hz. In other words, the question of what is the precise value of building amplification over 8 Hz has very little safety significance.

5. Conclusions

The discussion above leads to several conclusions:

- The results from actual measured ISRS on "nuclear type" structures support the 1.5 response levels advocated within Method A.
- Qualitative assessments of the conservatism inherent within the methods utilized to calculate ISRS have been provided above. These conservatisms are typically quite significant (as has been independently verified by median/modern assessments such as the LLNL study) and result in ISRS which show amplifications well beyond the 1.5 factor from Method A. Specific exceedances noted for Oconee (beyond the 1.5 factor) are due to the conservatisms inherent in the ISRS calculation methods, and do not invalidate the application of Method A.

O-Z / GEDNEY
A UNIT OF GENERAL SIGNAL

Attachment RAI2a.1

ARMORED/METAL CLAD CABLE TERMINATORS

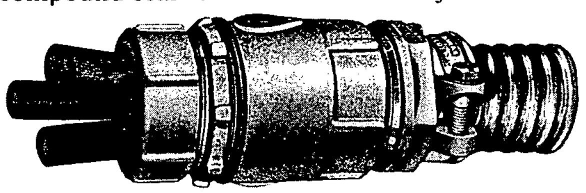
For Non-Jacketed Interlocked Armor Cable Horizontal—Watertight-Compound Type

Use with Interlocked Armor Cable with no jacket over armor but having a waterproof jacket under armor and fillers between conductors△:

TYPE "PKH" —To terminate and ground the armor.
—To secure and seal cable entrance into a cabinet or terminal box through:

(1) A standard IPS knockout or slip hole ("PKH" Fig. 1).
(2) A standard IPS drilled and tapped entrance ("PKHA" Fig. 2).
(3) A standard IPS drilled and tapped entrance with inside shoulder ("PKHA" Fig. 3).

—To provide compound seal for cable core where jacket is removed.



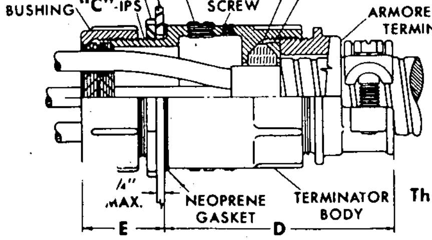


Fig. 1 Through IPS K.O. or Slip Hole

Catalog Numbers apply to Cast Aluminum fittings, furnished complete with Electro-plated steel screws, and steel or malleable iron locknut. (Locknuts are not required on the Type "PKHA".) Stainless steel screws and/or Aluminum Locknuts are available at additional cost.

Nominal Diameter Over Armor (Range in Inches) Min.	Max.	"C" I.P.S.	Type "PKH" Catalog Number	List Price EACH *	Approx. Wt. Lbs.	Dimensions in Inches D	E	Max. Dia.	Type "PKHA" Catalog Number	List Price EACH	Approx. Wt. Lbs.	Dimensions in Inches F	G	H	Turning Radius	Approx. Comp'd. Req'd. Pints
.45	.62	3/4"	PKH 62-07	$48.80	.50	3 5/8	1 5/8	1 1/2	PKHA 62-07	$50.80	.75	1/2	7/8	5 1/4	7/8	1/8
.63	.80		PKH 80-07						PKHA 80-07							
.81	.96	1"	PKH 96-10	63.40	.85	4 1/4	1 5/8	1 3/4	PKHA 96-10	66.00	1.0	5/8	7/8	5 7/8	1 1/8	1/8
.97	1.18	1 1/4"	PKH 118-12	79.40	1.0	4 3/8	1 3/4	2 3/8	PKHA 118-12	82.40	1.5	3/4	1	6 1/8	1 3/8	1/4
1.19	1.34		PKH 134-12		1.0	4 1/2	1 3/4	2 1/2	PKHA 134-12		1.5	3/4	1	6 1/4	1 5/8	1/4
1.35	1.56	1 1/2"	PKH 156-15	101.60	1.5	4 5/8	1 3/4	2 5/8	PKHA 156-15	106.40	2.0	3/4	1	6 3/8	1 3/4	1/4
1.57	1.78	2"	PKH 178-20	122.40	2.0	4 5/8	1 3/4	3 1/8	PKHA 178-20	128.80	2.5	3/4	1 1/8	6 3/8	1 7/8	1/2
1.79	2.00		PKH 200-20		2.0	4 5/8	1 3/4	3 1/4	PKHA 200-20		2.5	3/4	1 1/8	6 3/8	2	1/2
2.01	2.20	2 1/2"	PKH 220-25	151.00	3.0	5 1/2	2 1/8	3 5/8	PKHA 220-25	159.00	3.5	7/8	1 1/8	7 5/8	2 1/8	3/4
2.21	2.40		PKH 240-25		3.0	5 1/2	2 1/8	3 5/8	PKHA 240-25		3.5	7/8	1 1/8	7 5/8	2 1/4	3/4
2.41	2.58	3"	PKH 258-30	184.20	4.0	5 7/8	2 3/8	4 3/8	PKHA 258-30	194.00	5.0	7/8	1 1/4	8 1/8	2 1/4	1
2.59	2.78		PKH 278-30		4.0	6	2 3/8	4 3/8	PKHA 278-30		5.0	7/8	1 1/4	8 1/4	2 1/2	1
2.79	2.98		PKH 298-30		4.0	6	2 3/8	4 3/8	PKHA 298-30		5.0	7/8	1 1/4	8 1/4	2 5/8	1
2.99	3.20	3 1/2"	PKH 320-35	224.00	5.5	6 1/4	2 3/8	5	PKHA 320-35	234.00	6.5	7/8	1 1/4	8 1/2	2 3/4	1 1/2
3.21	3.44		PKH 344-35		5.5	6 1/2	2 3/8	5 1/8	PKHA 344-35		6.5	7/8	1 1/4	8 3/4	3	1 1/2
3.45	3.67	4"	PKH 367-40	286.00	6.5	7	2 1/2	5 1/2	PKHA 367-40	298.00	8.0	7/8	1 3/8	9 3/8	3 1/8	2
3.68	3.91		PKH 391-40		6.5	7	2 1/2	5 3/8	PKHA 391-40		8.0	7/8	1 3/8	9 3/8	3 1/4	2
3.92	4.14	5"	PKH 414-50	436.00	10.0	8	2 5/8	6 7/8	PKHA 414-50	453.00	11.5	1 1/8	1 1/2	10 5/8	3 5/8	4
4.15	4.39		PKH 439-50		10.0	8	2 5/8	6 7/8	PKHA 439-50		11.5	1 1/8	1 1/2	10 5/8	3 3/4	4
4.40	4.60		PKH 460-50		10.0	8	2 5/8	6 7/8	PKHA 460-50		11.5	1 1/8	1 1/2	10 5/8	3 7/8	4
4.61	4.84		PKH 484-50		10.0	8	2 5/8	6 7/8	PKHA 484-50		11.5	1 1/8	1 1/2	10 5/8	3 7/8	4

Apply SCHEDULE R discounts to above UNIT PRICES

* FILLING COMPOUND NOT INCLUDED—SHOWN ON PAGE 22.

† Select fitting size on basis of Nominal Diameter of Cable over Armor. This diameter should be in the range shown in column headed "Nominal Diameter Over Armor."

When there are no fillers and/or waterproof jacket under the armor, the interstices at the termination should be filled with duct seal or other suitable material before pouring compound. If there are bare stranded ground conductors in the cable core, the strands should be spread apart in the Terminator Body to allow compound to seal around each strand.

**SPECIFY: 1. Catalog number. 2. Number of conductors.
3. Diameter over insulation of individual conductors and over any bare conductors.**

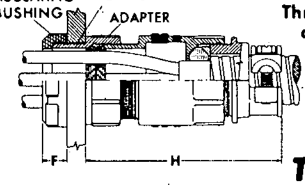


Fig. 2 Through IPS Drilled and Tapped Hole

TYPE "PKHA"

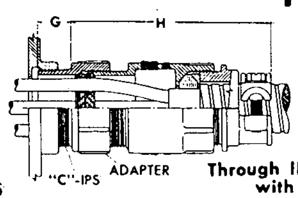


Fig. 3 Through IPS D&T Entrance with Inside Shoulder

O-Z / GEDNEY
A UNIT OF GENERAL SIGNAL

Attachment RAI2a.2

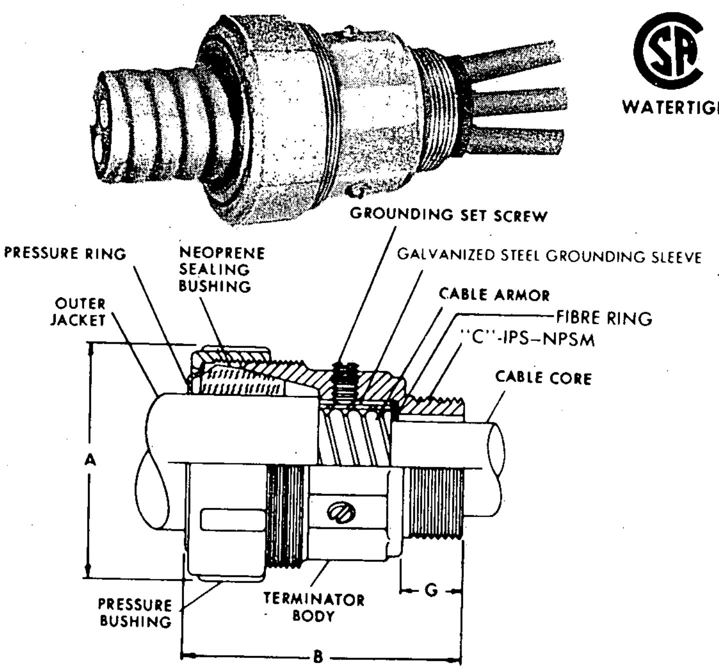
ARMORED/METAL CLAD CABLE TERMINATORS

TYPES "PG" & "PG-A"

UL File No. E-36853 (645B)
CSA File No. 15553

RAINTIGHT

WATERTIGHT



For Jacketed Metal Clad Cable*

Watertight for Wet Locations
Gland Type (With Grounding Sleeve & Set Screws)
LISTED AS RAINTIGHT BY UL

Use with Armored Cable having waterproof jacket over armor to terminate and ground the armor, and to secure and seal cable entrance into a cabinet or terminal box through a standard IPS knockout, slip-hole or D & T entrance.

SPECIFY (1) Catalog number
(2) Cable Core Diameter

* Such as Interlocked Armor, corrugated metal sheath, smooth aluminum sheath and similar types.

Malleable iron fittings are zinc plated. They are supplied with Electro-Plated Grounding Screws and Pressure Ring. They are available with Stainless Steel Grounding Screws and Pressure Ring. Prices on application. Aluminum fittings are supplied with Stainless Steel Grounding Screws and Pressure Ring. All fittings can be supplied with Neoprene Gasket, Locknut and Insulating Bushing. Prices on application.

Cable Range Dia over Jacket (Range in Inches)		"C" IPS NPSM	Malleable Iron Fittings		Aluminum Fittings		Dimensions in Inches			Max Dia of Cable Core	Wt Lbs. Each †
Min	Max		Catalog Number	List Price Each	Catalog Number	List Price Each	A Max Dia	B Approx	G		
.48	.57	½"	PG-57-05	13.40	PG-57-05A	13.40	1-9/16	2-1/2	9/16	.31"	.4
.57	.66		PG-66-05		PG-66-05A					.40	
.64	.78		PG-78-05		PG-78-05A					.51	
.75	.89		PG-89-05		PG-89-05A					.61	
.85	.98		PG-98-05		PG-98-05A					.61	
.75	.89	¾"	PG-89-07	18.20	PG-89-07A	18.20	1-15/16	2-5/8	9/16	.61	.7
.85	.98		PG-98-07		PG-98-07A					.72	
.88	1.07		PG-107-07		PG-107-07A					.77	
1.03	1.21		PG-121-07		PG-121-07A					.85	
.88	1.07	1"	PG-107-10	21.20	PG-107-10A	21.20	2-5/16	3-1/16	11/16	.75	.9
1.03	1.21		PG-121-10		PG-121-10A					.91	
1.18	1.38		PG-138-10		PG-138-10A					1.04	
1.18	1.38	1¼"	PG-138-12	32.80	PG-138-12A	32.80	2-13/16	3-3/8	11/16	1.04	1.5
1.36	1.63		PG-163-12		PG-163-12A					1.24	
1.62	1.88		PG-188-12		PG-188-12A					1.42	
1.73	2.00	1½"	PG-200-15	50.80	PG-200-15A	50.80	3-1/8	4	3/4	1.61	2.0
1.93	2.19		PG-219-15		PG-219-15A					1.61	
1.93	2.19	2"	PG-219-20	62.40	PG-219-20A	62.40	3-15/16	4-5/16	25/32	1.79	3.5
2.10	2.40		PG-240-20		PG-240-20A					1.96	
2.35	2.61		PG-261-20		PG-261-20A					2.09	
2.50	2.75		PG-275-20		PG-275-20A					2.09	
2.37	2.63	2½"	PG-263-25	84.40	PG-263-25A	84.40	4-5/8	5-1/4	1-3/16	1.99	5.0
2.56	2.83		PG-283-25		PG-283-25A					2.43	
2.73	3.00		PG-300-25		PG-300-25A					2.43	
2.97	3.22		PG-322-25		PG-322-25A					2.49	
2.73	3.00	3"	PG-300-30	98.00	PG-300-30A	98.00	5-3/16	5-3/8	1-1/4	2.43	7.5
2.94	3.22		PG-322-30		PG-322-30A					2.49	
3.20	3.47		PG-347-30		PG-347-30A					3.05	
3.37	3.63		PG-363-30		PG-363-30A					3.05	
3.37	3.63	3½"	PG-363-35	127.60	PG-363-35A	127.60	5-7/8	5-9/16	1-1/4	3.19	9.0
3.59	3.88		PG-388-35		PG-388-35A					3.39	
3.82	4.10		PG-410-35		PG-410-35A					3.55	
3.80	4.10	4"	PG-410-40	162.00	PG-410-40A	162.00	6-3/8	5-5/8	1-5/16	3.59	11.0
4.00	4.28		PG-428-40		PG-428-40A					3.79	
4.20	4.47		PG-447-40		PG-447-40A					3.99	
4.40	4.65		PG-465-40		PG-465-40A					4.11	

Apply **SCHEDULE R** discounts to above **UNIT PRICES**

† Weights shown apply to Ferrous fittings. Weights of Aluminum fittings are approximately 1/3 of those shown above.

Attachment RAI2c.1

Revision 2, Corrected, 6/28/91
Status Y N U
Sheet 1 of ______
Rev. 2

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. U1 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 1 SWGR

Location: Bldg. Keowee Floor El. 702' Room, Row/Col AA

Manufacturer, Model, Etc. (optional) WESTINGHOUSE

SEISMIC CAPACITY VS DEMAND

1. Elevation where equipment receives seismic input — 702
2. Elevation of seismic input below about 40' from grade — [Y] N U
3. Equipment has fundamental frequency above about 8 Hz — Y N U [N/A]
4. Capacity based on: Existing Documentation — DOC
   Bounding Spectrum — BS
   1.5 x Bounding Spectrum — [ABS]
   GERS — GERS
5. Demand based on: Ground Response Spectrum — GRS
   1.5 x Ground Response Spectrum — AGRS
   Conserv. Des. In-Str. Resp. Spec. — CRS
   Realistic M-Ctr. In-Str. Resp. Spec. — [RRS]

Does capacity exceed demand? [Y] N U

CAVEATS - BOUNDING SPECTRUM (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in earthquake experience equipment class — [Y] N U N/A *
2. 2.4 KV to 4.16 KV rating — [Y] N U N/A *
3. Internally mounted potential and/or control power transformers are restrained to prevent damage to or disconnection of contacts — [Y] N U N/A *
4. Adjacent cabinets which are close enough to impact, or sections of multi-bay cabinets, are bolted together if they contain essential relays — [Y] N U N/A *
5. Attached weight (excluding conduit) less than about 100 lbs per cabinet bay — [Y] N U N/A *
6. Externally attached items rigidly anchored — [Y] N U N/A *
7. General configuration similar to ANSI C37.20 standards — [Y] N U N/A
8. Cutouts in lower half of cabinet sheathing less than 30% of width of side panel wide and less than 60% of width of side panel high excluding bus transfer compartment — [Y] N U N/A
9. All doors secured by latch or fastener — [Y] N U N/A
10. Anchorage adequate (See checklist below for details) — [Y] N U N/A *
11. Relays mounted on equipment evaluated — [Y] N U N/A *
12. Have you looked for and found no other adverse concerns? — [Y] N U N/A

Is the intent of all the caveats met for Bounding Spectrum? [Y] N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

uip. ID No. U1 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 1 SWGR

CAVEATS - GERS (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1.	Equipment is included in generic seismic testing equipment class	Y N U [N/A]
2.	Meets all Bounding Spectrum caveats	Y N U [N/A]
3.	Floor mounted enclosure	Y N U [N/A]
4.	The switchgear is not a specifically-designed type	Y N U [N/A]
5.	Circuit breakers are truck-mounted type, not jack-up or vertical-lift	Y N U [N/A]
6.	Average weight per vertical section less than 5000 lbs	Y N U [N/A]
7.	Base anchorage adequate (See checklist below for details)	Y N U [N/A]
8.	Relays used for breaker function are not on "Low Ruggedness Relays" list	Y N U [N/A]
9.	Relay evaluations completed for all relays that are essential to other equipment or cause unacceptable lockout	Y N U [N/A]
10.	For 2.5g level GERS, vertical restraint prevents circuit breaker uplift	Y N U [N/A]
11.	For 2.5g level GERS, circuit break arc chutes are restrained horizontally	Y N U [N/A]
12.	For 2.5g level GERS, a Beaver Type Z relay is not used in Westinghouse MV switchgear for the "Y" anti-pump relay	Y N U [N/A]
13.	Separate evaluation of breaker racking mechanism completed; seismic positioner or sufficient side-to-side restraints used	Y N U [N/A]

Is the intent of all the caveats met for GERS? Y N U [N/A]

ANCHORAGE

1.	Appropriate equipment characteristics determined (mass, CG, natural freq., damping, center of rotation)	[Y] N U N/A
2.	Type of anchorage covered by GIP	[Y] N U N/A
3.	Sizes and locations of anchors determined	[Y] N U N/A *
4.	Adequacy of anchorage installation evaluated (weld quality and length, nuts and washers, expansion anchor tightness, etc.)	[Y] N U N/A
5.	Factors affecting anchorage capacity or margin of safety considered: embedment length, anchor spacing, free-edge distance, concrete strength/condition, and concrete cracking	[Y] N U N/A
6.	For bolted anchorages, gap under base less than 1/4-inch	Y N U [N/A]

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. U1 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 1 SWGR

ANCHORAGE (Cont'd)

7.	Factors affecting essential relays considered: gap under base, capacity reduction for expansion anchors	[Y] N U N/A
8.	Base has adequate stiffness and effect of prying action on anchors considered	[Y] N U N/A
9.	Strength of equipment base and load path to CG adequate	[Y] N U N/A
10.	Embedded steel, grout pad or large concrete pad adequacy evaluated	[Y] N U N/A *

Are anchorage requirements met? [Y] N U

INTERACTION EFFECTS

1.	Soft targets free from impact by nearby equipment or structures	[Y] N U N/A
2.	If equipment contains sensitive relays, equipment free from all impact by nearby equipment or structures	[Y] N U N/A *
3.	Attached lines have adequate flexibility	[Y] N U N/A
4.	Overhead equipment or distribution systems are not likely to collapse	[Y] N U N/A *
5.	Have you looked for and found no other adverse concerns?	[Y] N U N/A

Is equipment free of interaction effects? [Y] N U

IS EQUIPMENT SEISMICALLY ADEQUATE [Y] N U

COMMENTS

Original W/D by LJB & RMP.

COMMENTS OF CAVEATS - BOUNDING SPECTRUM

1 This SEWS addresses the Unit 1 Switchgear cubicles which are covered by the GIP equipment classes. Items not included in the GIP which are part of this overall line-up will be covered by separate SEWS forms.

This SEWS form will be used to address generic concerns for the entire switchgear assembly, such as anchorage and seismic interaction.

Equipment included by this SEWS are: TRANS CX, ACB-5, ACB-7, 2A, 2B, 2C, 2D.
2 Transformer CX and associated equipment under this SEWS are rated at 4.16KV.
3 Switchgear contains low voltage breakers (DB 25 in 2A, 2B, 2C and 2D; and DB 50 in ACB-5 and ACB-7).

Coils and core for Transformer CX are anchored to a channel at their base. The adequacy of this anchorage is bounded by the SEWS for Transformer 1X.
4 Adjacent cabinets are bolted together at their top, middle, and bottom.
5 There is a breaker hoist mounted on top of the U1 SWGR cubicle. This hoist is equipment that is normally supplied with the Westinghouse equipment and the cabinet

and its anchorage were judged to be adequate to seismically support this added weight. Thus, the intent of this caveat is met.
6 The breaker hoist that is mounted on top of the ACB-5 and ACB-7 cubicles is free to slide, in both in the N-S (out from the face of the cubicle) and E-W (along the axis of the U1 SWGR) directions. The hoist could slide in a seismic event, impacting its stops at the ends of the rails, possibly leading to relay chatter. However, given the low level of acceleration and the distance to the nearest essential relay, this is judged not to be a credible concern.
10 See EQE Calculation 59040-C-KAA-01.
11 Essential relays will be evaluated by others. Use amplification factor of 4.5.

COMMENTS OF ANCHORAGE
3 Not all cubicles could be readily opened to inspect anchorages. A sampling basis was used to characterize the anchorage. Generally, plug welds were used to fasten the corners of the front (N) base channel to an embedded plate. Small fillet welds about 1" long were used to anchor one side of the rear channel to the embedded plate.
10 Determined to be adequate through visual inspection and judgement.

COMMENTS OF INTERACTION EFFECTS
2 There are two large, orange, sliding steel, missile protection doors which serve as the entrance to the ACB 3 & 4 missile vault. When open, these doors may pose an impact hazard to the SWGR. However, the doors are kept in the closed position during operation and latched shut. Impact with the SWGR is not credible.

There also exists an interaction concern resulting from the potential sliding of the breaker hoist mounted on top of the cubicle containing ACB-5 and ACB-7. This hoist is free to slide in the N-S and E-W directions and may impact against its stops. However, given the low level of acceleration and the fact that the nearest essential relay is more than 10 ft. from the hoist, this is not considered a credible hazard for relay chatter.

A potential interaction was reviewed resulting from the swinging of the suspended fluorescent light fixture in the N-S direction, possibly impacting the top of the ACB-1 cubicle. This light fixture has a 14" space beteen itself and the cubicle, and interaction was judged not to be a credible event.
The overhead buss ducts are evaluated under a separate SEWS. Their anchorage, from an interaction standpoint, appeared to be adequate.

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. U1 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 1 SWGR

RELAY WALKDOWN

1. Does spot check of essential relays indicate relays present and properly mounted? [Y] N U N/A

2. Are essential relays required to function during earthquake screened out? Y N [U] N/A

   If no, attach list of relays with locations in cabinet and general dimensions, thicknesses and details of mounting plates that support relays for later analysis.

   Evaluation of relays performed by others.

3. No other relay concerns? [Y] N U N/A

Requirements for relays satisfied? Y N [U] N/A

SYSTEMS INTERACTION EFFECTS?

1. No potential sources could flood or spill onto cabinet? [Y] N U N/A

   The roof drain line which runs above the cabinets was judged to be adequately supported.

IS EQUIPMENT FREE OF NEED FOR FURTHER INVESTIGATION, EXCLUDING RELAY CHATTER?

YES X NO ___

IS EQUIPMENT FREE OF NEED FOR FURTHER RELAY CHATTER INVESTIGATION? YES ___ NO X

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. U1 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 1 SWGR

Evaluated by:

R M Polivka
Date: 04/19/95

S J Eder
Date: 04/19/95

Sketch 1

Attachment RAI2c.2

SCREENING EVALUATION WORK SHEET (SEWS)

Revision 2, Corrected, 6/28/91
Status Y N U
Sheet 1 of ______
Rev. 0

Equip. ID No. U2 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 2 SWGR

Location: Bldg. Keowee Floor El. 702' Room, Row/Col AA

Manufacturer, Model, Etc. (optional) WESTINGHOUSE

SEISMIC CAPACITY VS DEMAND

1. Elevation where equipment receives seismic input ______
2. Elevation of seismic input below about 40' from grade Y N U
3. Equipment has fundamental frequency above about 8 Hz Y N U N/A
4. Capacity based on: Existing Documentation DOC
   Bounding Spectrum BS
   1.5 x Bounding Spectrum ABS
   GERS GERS
5. Demand based on: Ground Response Spectrum GRS
   1.5 x Ground Response Spectrum AGRS
   Conserv. Des. In-Str. Resp. Spec. CRS
   Realistic M-Ctr. In-Str. Resp. Spec. RRS

Does capacity exceed demand? Y N U

CAVEATS - BOUNDING SPECTRUM (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in earthquake experience equipment class [Y] N U N/A *
2. 2.4 KV to 4.16 KV rating Y N U N/A
3. Internally mounted potential and/or control power transformers are restrained to prevent damage to or disconnection of contacts Y N U N/A
4. Adjacent cabinets which are close enough to impact, or sections of multi-bay cabinets, are bolted together if they contain essential relays Y N U N/A
5. Attached weight (excluding conduit) less than about 100 lbs per cabinet bay Y N U N/A
6. Externally attached items rigidly anchored Y N U N/A
7. General configuration similar to ANSI C37.20 standards Y N U N/A
8. Cutouts in lower half of cabinet sheathing less than 30% of width of side panel wide and less than 60% of width of side panel high excluding bus transfer compartment Y N U N/A
9. All doors secured by latch or fastener Y N U N/A
10. Anchorage adequate (See checklist below for details) Y N U N/A
11. Relays mounted on equipment evaluated Y N U N/A
12. Have you looked for and found no other adverse concerns? Y N U N/A

Is the intent of all the caveats met for Bounding Spectrum? Y N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. U2 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 2 SWGR

CAVEATS - GERS (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1.	Equipment is included in generic seismic testing equipment class	Y N U N/A
2.	Meets all Bounding Spectrum caveats	Y N U N/A
3.	Floor mounted enclosure	Y N U N/A
4.	The switchgear is not a specifically-designed type	Y N U N/A
5.	Circuit breakers are truck-mounted type, not jack-up or vertical-lift	Y N U N/A
6.	Average weight per vertical section less than 5000 lbs	Y N U N/A
7.	Base anchorage adequate (See checklist below for details)	Y N U N/A
8.	Relays used for breaker function are not on "Low Ruggedness Relays" list	Y N U N/A
9.	Relay evaluations completed for all relays that are essential to other equipment or cause unacceptable lockout	Y N U N/A
10.	For 2.5g level GERS, vertical restraint prevents circuit breaker uplift	Y N U N/A
11.	For 2.5g level GERS, circuit break arc chutes are restrained horizontally	Y N U N/A
12.	For 2.5g level GERS, a Beaver Type Z relay is not used in Westinghouse MV switchgear for the "Y" anti-pump relay	Y N U N/A
13.	Separate evaluation of breaker racking mechanism completed; seismic positioner or sufficient side-to-side restraints used	Y N U N/A

Is the intent of all the caveats met for GERS? Y N U N/A

ANCHORAGE

1.	Appropriate equipment characteristics determined (mass, CG, natural freq., damping, center of rotation)	Y N U N/A
2.	Type of anchorage covered by GIP	Y N U N/A
3.	Sizes and locations of anchors determined	Y N U N/A
4.	Adequacy of anchorage installation evaluated (weld quality and length, nuts and washers, expansion anchor tightness, etc.)	Y N U N/A
5.	Factors affecting anchorage capacity or margin of safety considered: embedment length, anchor spacing, free-edge distance, concrete strength/condition, and concrete cracking	Y N U N/A
6.	For bolted anchorages, gap under base less than 1/4-inch	Y N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. U2 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 2 SWGR

ANCHORAGE (Cont'd)

7.	Factors affecting essential relays considered: gap under base, capacity reduction for expansion anchors	Y N U N/A	
8.	Base has adequate stiffness and effect of prying action on anchors considered	Y N U N/A	
9.	Strength of equipment base and load path to CG adequate	Y N U N/A	
10.	Embedded steel, grout pad or large concrete pad adequacy evaluated	Y N U N/A	
Are anchorage requirements met?			Y N U

INTERACTION EFFECTS

1.	Soft targets free from impact by nearby equipment or structures	Y N U N/A	
2.	If equipment contains sensitive relays, equipment free from all impact by nearby equipment or structures	Y N U N/A	
3.	Attached lines have adequate flexibility	Y N U N/A	
4.	Overhead equipment or distribution systems are not likely to collapse	Y N U N/A	
5.	Have you looked for and found no other adverse concerns?	Y N U N/A	
Is equipment free of interaction effects?			Y N U

IS EQUIPMENT SEISMICALLY ADEQUATE [Y] N U

COMMENTS

See SEWS for U1 SWGR. Unit 2 switchgear is identical to the Unit 1 assembly except it does not contain transformer CX or the CX disconnect.

COMMENTS OF CAVEATS - BOUNDING SPECTRUM

1 The Unit 2 switchgear line-up is identical to the Unit 1 line-up, except that it does not contain Transformer CX or the Transformer CX disconnect.

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. U2 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 2 SWGR

RELAY WALKDOWN

1. Does spot check of essential relays indicate relays present and properly mounted? Y N U N/A

2. Are essential relays required to function during earthquake screened out? Y N U N/A

   If no, attach list of relays with locations in cabinet and general dimensions, thicknesses and details of mounting plates that support relays for later analysis.

3. No other relay concerns? Y N U N/A

Requirements for relays satisfied? Y N U N/A

SYSTEMS INTERACTION EFFECTS?

1. No potential sources could flood or spill onto cabinet? Y N U N/A

IS EQUIPMENT FREE OF NEED FOR FURTHER INVESTIGATION, EXCLUDING RELAY CHATTER?

YES ___ NO ___

IS EQUIPMENT FREE OF NEED FOR FURTHER RELAY CHATTER INVESTIGATION? YES ___ NO ___

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. U2 SWGR Equip. Class 03 - Medium Voltage Switchgear

Equipment Description UNIT 2 SWGR

Evaluated by:

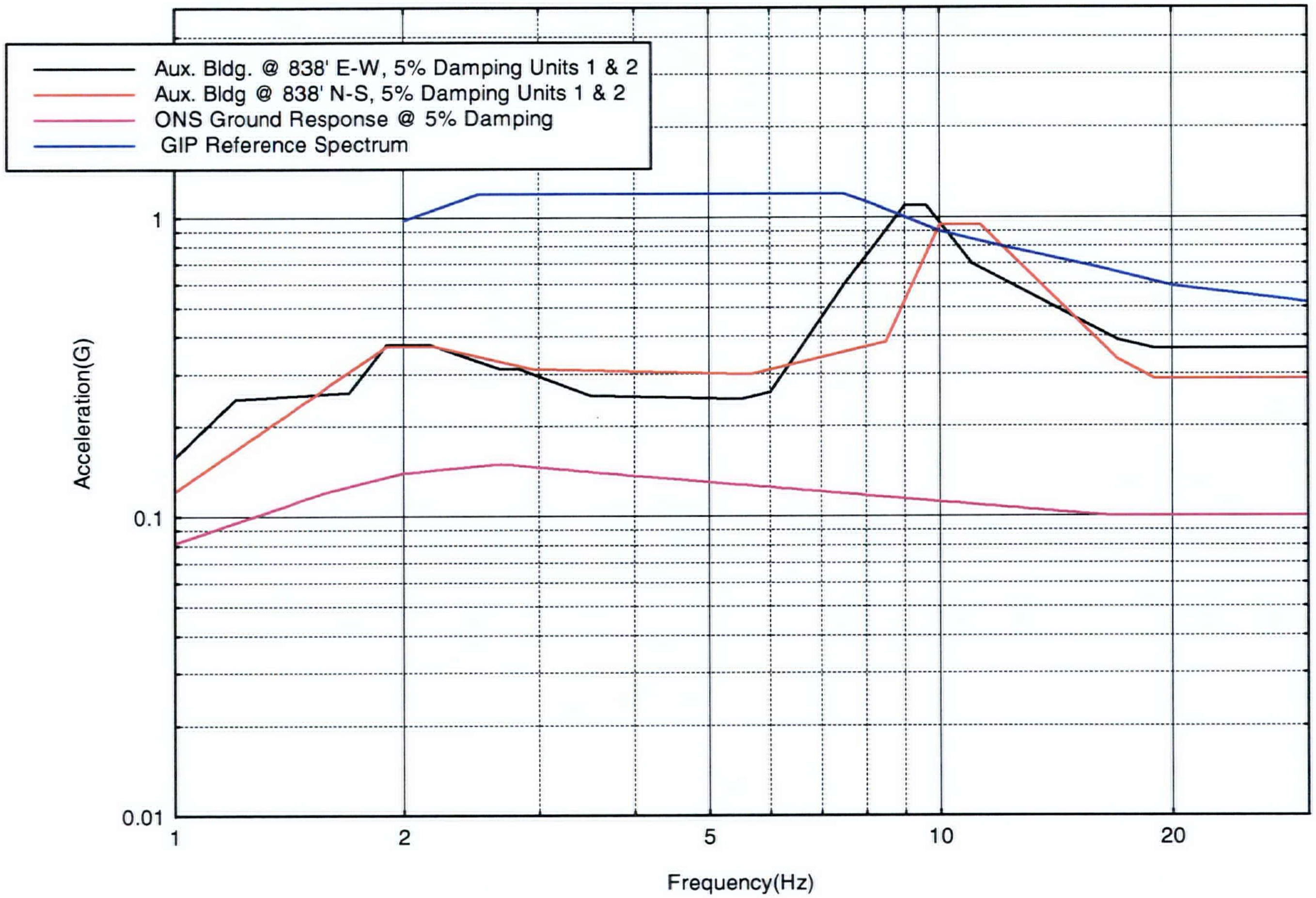
R M Polivka
Date: 10/12/94

L J Bragagnolo
Date: 10/12/94

Sketch 1

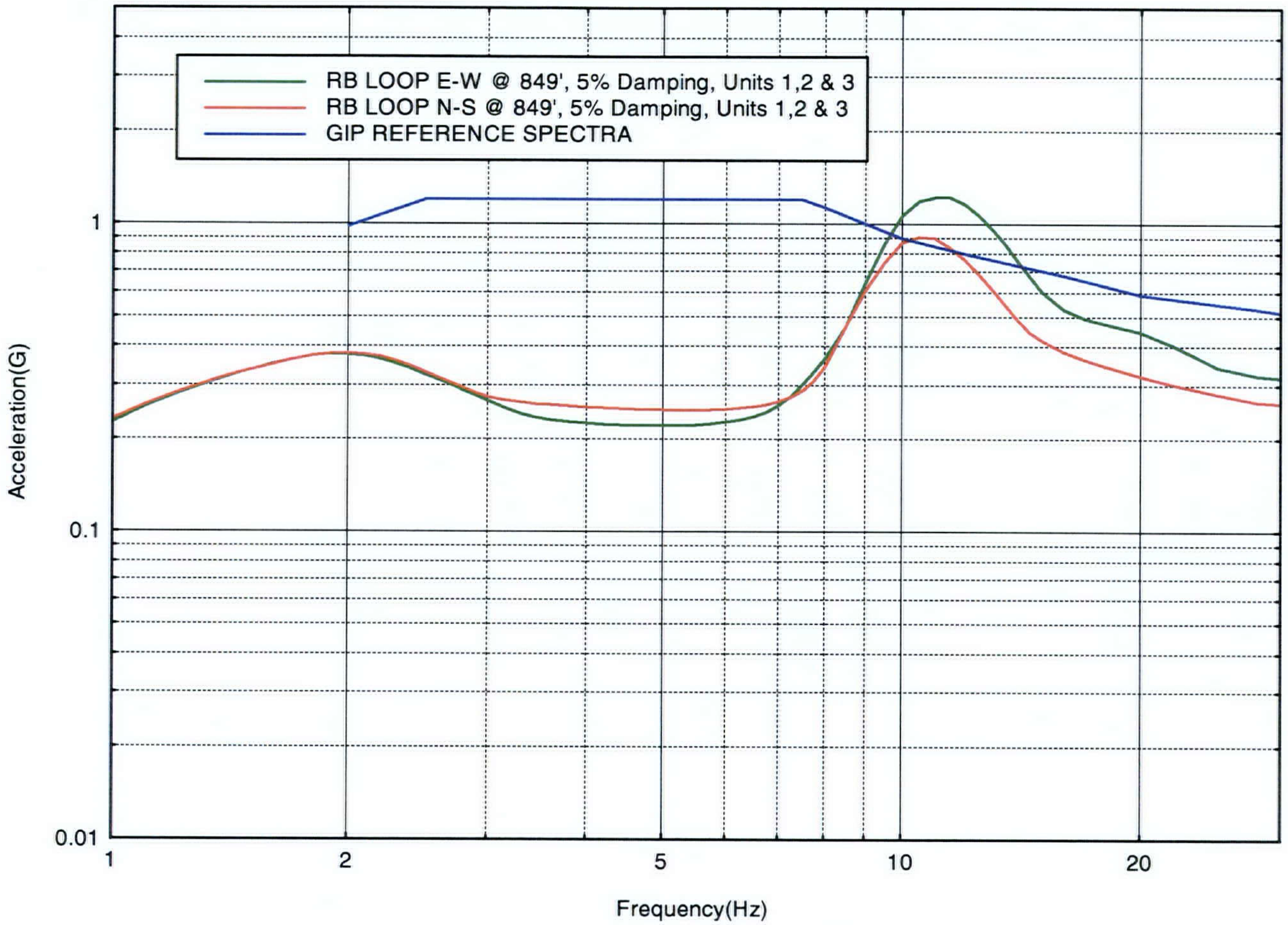
Attachment RAI10a.1

Table 5-3 Auxiliary Building Spectra Exceedance



Attachment RAI10a.2

Table 5-3 Reactor Bldg. NSSS Loop Spectra Exceedance



Attachment RAI7a.1

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1CTK000C Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description UPPER SURGE TANK DOME

Location: Bldg. TB Floor El. 838'+0" Room, Row/Col ______

Manufacturer, Model, Etc. (optional) SUPERIOR ATLANTA MFG

SHELL CAPACITY VS DEMAND

Buckling capacity of shell of large, flat-bottom, vertical tank is equal to or greater than demand: Y N U [N/A]*

ANCHOR BOLTS AND EMBEDMENT

Capacity of anchor bolts and their embedments is equal to or greater than demand: Y [N] U N/A

CONNECTION BETWEEN ANCHOR BOLTS AND SHELL

Capacity of connections between the anchor bolts and the tank shell is equal to or greater than the demand: Y [N] U N/A

FLEXIBILITY OF ATTACHED PIPING

Attached piping has adequate flexibility to accommodate motion of large, flat-bottom, vertical tank: [Y] N U N/A *

TANK FOUNDATION

Ring-type foundation is not used to support large, flat-bottom, vertical tank: Y N U [N/A]

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1CTK000C Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description UPPER SURGE TANK DOME

COMMENTS

Vertical Cylindrical Tank on legs is not included in the Database. A detailed analytical review of the tank support structure is required. Envelopes 2 & 3CTK000C.

SHELL CAPACITY VS DEMAND: Tank is not flat bottomed.

FLEXIBILITY OF ATTACHED PIPING: Adjacent piping to Upper Surge Tanks has flexible connections.

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1CTK000C Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description UPPER SURGE TANK DOME

Evaluated by:

R V Hester
Date: 10/21/96

R P Childs
Date: 10/23/96

----------------------Sketch 1----------------------

Attachment RAI7a.2

SCREENING EVALUATION WORK SHEET (SEWS)

Revision 2, Corrected, 6/28/91
Status Y N U
Sheet 1 of ______

Equip. ID No. 2ESVTK0001 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description ESV Receiver Tank 2A

Location: Bldg. ESV Floor El. 796'+6" Room, Row/Col ______

Manufacturer, Model, Etc. (optional) Gaston County Dyeing Machine Co.

SHELL CAPACITY VS DEMAND
Buckling capacity of shell of large, flat-bottom, vertical tank is equal to or greater than demand: Y N U [N/A]

ANCHOR BOLTS AND EMBEDMENT
Capacity of anchor bolts and their embedments is equal to or greater than demand: [Y] N U N/A *

CONNECTION BETWEEN ANCHOR BOLTS AND SHELL
Capacity of connections between the anchor bolts and the tank shell is equal to or greater than the demand: [Y] N U N/A

FLEXIBILITY OF ATTACHED PIPING
Attached piping has adequate flexibility to accommodate motion of large, flat-bottom, vertical tank: Y N U [N/A]

TANK FOUNDATION
Ring-type foundation is not used to support large, flat-bottom, vertical tank: Y N U [N/A]

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 2ESVTK0001 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description ESV Receiver Tank 2A

COMMENTS

Tank is considered a resolved outlier due to support by skirt. Tank anchorage is acceptable for A-46 & IPEEE per calculation contained in OSC-6040.Tank capacity is acceptable per SRT judgement due to low seismic input(.15g) and rugged construction. Ref. OSC-6532 for Licensing basis qualification.

NOTE: THIS EVALUATION ENVELOPES THE SEWS EVALUATION FOR 2ESVTK0002.

ANCHOR BOLTS AND EMBEDMENT: See calculation contained in OSC-6040

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 2ESVTK0001 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description ESV Receiver Tank 2A

Evaluated by:

R.P.Childs
Date: 07/29/98

L.B.Elrod
Date: 08/04/98

Sketch 1

Attachment RAI 7a.3

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1OGTK0002 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL SUMP TANK(GOT1)

Location: Bldg. Keowee Floor El. 683' Room, Row/Col AD

Manufacturer, Model, Etc. (optional) WOODWARD GOVERNOR

SHELL CAPACITY VS DEMAND

Buckling capacity of shell of large, flat-bottom, vertical tank is equal to or greater than demand: Y N U [N/A]

ANCHOR BOLTS AND EMBEDMENT

Capacity of anchor bolts and their embedments is equal to or greater than demand: [Y] N U N/A

CONNECTION BETWEEN ANCHOR BOLTS AND SHELL

Capacity of connections between the anchor bolts and the tank shell is equal to or greater than the demand: Y N U [N/A]

FLEXIBILITY OF ATTACHED PIPING

Attached piping has adequate flexibility to accommodate motion of large, flat-bottom, vertical tank: [Y] N U N/A

TANK FOUNDATION

Ring-type foundation is not used to support large, flat-bottom, vertical tank: Y N U [N/A]

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

SCREENING EVALUATION WORK SHEET (SEWS)

uip. ID No. 1OGTK0002 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL SUMP TANK(GOT1)

COMMENTS

Identical comments as for GOT2.
Photos 16.14.16

Tank is considered an OUTLIER due to unique configuration (rectangular tank).

Rev. 1: See 2OGTK0002 for complete evaluation of the Woodward Govenor Oil Sump System.

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1OGTK0002 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL SUMP TANK(GOT1)

Evaluated by:

R P Childs
Date: 12/16/98

L. B. Elrod
Date: 01/12/99

Sketch 1

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 2OGTK0002 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL SUMP TANK(GOT2)

Location: Bldg. Keowee Floor El. 683' Room, Row/Col AD

Manufacturer, Model, Etc. (optional) WOODWARD GOVERNOR

SHELL CAPACITY VS DEMAND
Buckling capacity of shell of large, flat-bottom, vertical tank is equal to or greater than demand: Y N U [N/A]

ANCHOR BOLTS AND EMBEDMENT
Capacity of anchor bolts and their embedments is equal to or greater than demand: [Y] N U N/A *

CONNECTION BETWEEN ANCHOR BOLTS AND SHELL
Capacity of connections between the anchor bolts and the tank shell is equal to or greater than the demand: Y N U [N/A]

FLEXIBILITY OF ATTACHED PIPING
Attached piping has adequate flexibility to accommodate motion of large, flat-bottom, vertical tank: [Y] N U N/A *

TANK FOUNDATION
Ring-type foundation is not used to support large, flat-bottom, vertical tank: Y N U [N/A]

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 2OGTK0002 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL SUMP TANK(GOT2)

COMMENTS

Tank is 12' x 7' x 3' high, constructed of 1/2" plate. A cover plate was removed allowing access to the inside of the tank. No anchor bolts were seen. However, Duke drawing K-247 shows a 3/4" Mk. A.B.-11 bolt in each of the four corners. Conservatively check that sliding will be restricted by friction of the tank bottom and concrete.

The pumps on top of the tank are bolted to inverted steel channels which are in turn welded to the top of the tank. The mounting of the pumps is typical of database pumps and is judged to not be a seismic vulnerability. Junction boxes and other items are anchored. There are no fragile appurtenances.

If the overhead lights fall, they will only hit the corner of the tank or the motor of a pump. These interactions are considered to be insignificant.

Tank is less than 1/2 full (slightly more than 1', varies inversely with governor pressure tank). Some pipes and screens inside tank, but nothing fragile.

The tank capacity is considered acceptable due to very low seismic input (.1g ZPA) and rugged construction.

Photos: 16.13.37 (2 photos) .39
sj & rda

Tank is considered an OUTLIER due to unique configuration (rectangular tank).

Rev. 1: Revised to enhance evaluation of the Woodward Oil Sump System shown on drawing KM-200-0084 by adding details for the Governor Oil Sump Pumps (1GPU0001A,1B & 1C and 2GPU0001A,1B & 1C) which are considered to be evaluated as "Rule of the Box". with the Governor Oil Sump Tank. Both the pumps and the tank are supplied as a unit by the Woodward Governor Company. The Governor Oil Sump Pumps are judged to meet the inclusion rules for a Kinetic Horizontal Pump as represented in the GIP equipment class 05- Horizontal Pumps. They are single stage pumps utilizing a rotary impeller mounted on a common drive shaft driven by an electric motor rated at 50 Hp. Both motor and pump are mounted on a common skid which is mounted to the top of the Governor Oil Sump Tank.

****

Inclusion Rules for GIP Equipment Class 5 (Horizontal Pumps)

1. Includes all pumps commonly found in power plant applications which have their axes aligned horizontally.
2. The class includes pumps driven by electric motors, reciprocating piston engines, and steam turbines.
3. Common peripheral components such as conduit, instrumentation, and suction and

discharge lines up to their first structural anchor point are included in the equipment class.

The Governor Oil Pumps are considered to be within the equipment class of horizontal pumps Class #5

Applying an amplification factor of 1.5 to the to the A-46 seismic demand to account of potential amplification due to the mounting of the Gov. Oil Pumps on top of the Gov. Oil Tank results in a peak of 1.5(.194) = ~.3g and a ZPA of 1.5(.125) = .19g. The bounding spectrum capacity with a peak of .6g and ZPA of .33g fully envelopes the demand.

The driver and pump are mounted on a common/rigid skid.

There are thrust bearings in both axial directions.

There are no long, unsupported piping. the piping within the tank is all welded and considered to be rugged.

There is no base vibration isolation system.

There is sufficient slack/flexibility in all attached lines.

The pumps are ruggedly attached to the top of the tank (See Rev. 0 comments above). See calculation OSC-2026-016 for anchorage evaluation of the Gov. Oil Sump Tank.

The are no relays attached to either to pumps or the tank.

There are no interaction concerns.

The Governor Oil Pumps are considered to be seismically acceptable based on the above evaluation.

ANCHOR BOLTS AND EMBEDMENT: OK per EQE Calculation 59040-C-KAD-002.

FLEXIBILITY OF ATTACHED PIPING: Straight run of pipe goes into adjacent cabinet. However, it is near the floor, so no differential displacement is expected. Configuration is judged to be seismically adequate.

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 2OGTK0002 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL SUMP TANK(GOT2)

Evaluated by:

R P Childs
Date: 12/16/98

L. B. Elrod
Date: 01/12/99

Sketch 1

Attachment RAI 76.4

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 2OGTK0003 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL PRESS TANK(GPT2)

Location: Bldg. Keowee Floor El. 683' Room, Row/Col AD

Manufacturer, Model, Etc. (optional) ALLIS-CHALMERS

SHELL CAPACITY VS DEMAND
Buckling capacity of shell of large, flat-bottom, vertical tank is equal to or greater than demand: Y N U [N/A]

ANCHOR BOLTS AND EMBEDMENT
Capacity of anchor bolts and their embedments is equal to or greater than demand: [Y] N U N/A *

CONNECTION BETWEEN ANCHOR BOLTS AND SHELL
Capacity of connections between the anchor bolts and the tank shell is equal to or greater than the demand: [Y] N U N/A *

FLEXIBILITY OF ATTACHED PIPING
Attached piping has adequate flexibility to accommodate motion of large, flat-bottom, vertical tank: Y N U [N/A]

TANK FOUNDATION
Ring-type foundation is not used to support large, flat-bottom, vertical tank: Y N U [N/A]

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 20GTK0003 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL PRESS TANK(GPT2)

COMMENTS

This is an air filled tank with a max. working pressure of 350 psi. Thickness of head .926", shell thickness 1.125". This tank is a vertical pressure vessel on a 1"thick 15" high skirt. The welded connections are very substantial, approximately 7/16" fillet, continuous all around.

Piping connects this tank and the air receiver tank at the top of the vessels. These tanks are very stiff and differential displacement between them that could cause damage is not considered as a credible occurrence. Piping to GOT2 has some flexibility and is near the base, so would not be a problem as long as GOT2 does not slide. See SEWS for GOT2 to address this issue.

No fragile appurtenances or other items that could be impacted by falling overhead items. If overhead light fixture should fall, it is judged that the light would impact the top of the tank, and would not be a significant interaction with any fragile items.

The tank capacity is accpetable due to very low seismic input (.1g ZPA) and rugged construction.

Photos 16.14.01

Tank is considered an OUTLIER due to unique configuration.

ANCHOR BOLTS AND EMBEDMENT: Per EQE Calculation 59040-C-KAD-01.

CONNECTION BETWEEN ANCHOR BOLTS AND SHELL: The anchor bolts secure the tank by going through holes in a 1" thick ring plate. The ring plate is welded to the tank skirt by a continuous 7/16" all around fillet weld. This connection is adequate by inspection (see photo).

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 2OGTK0003 Equip. Class 21 - Tanks and Heat Exchangers

Equipment Description GOVERNOR OIL PRESS TANK(GPT2)

Evaluated by:

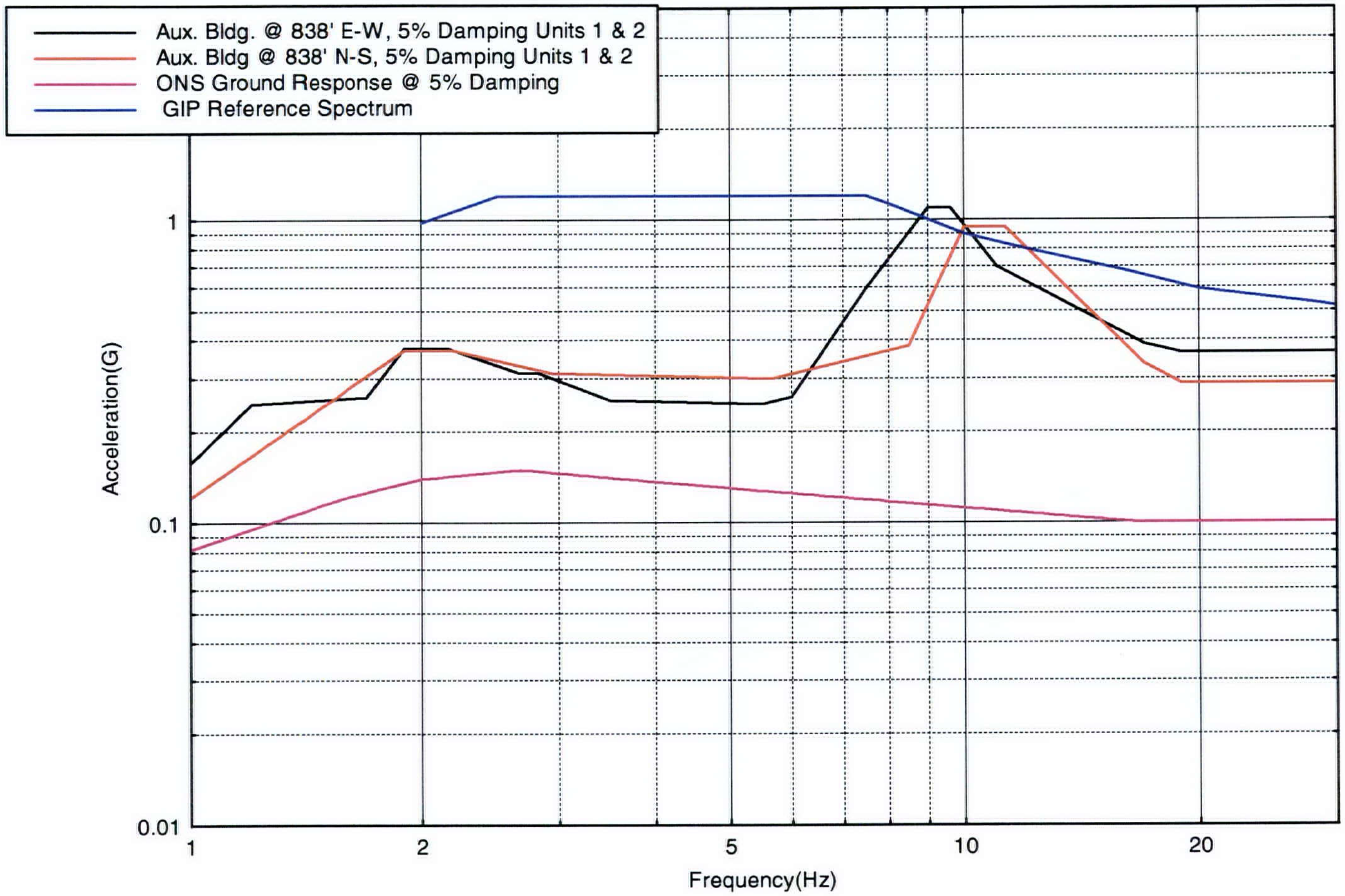
G S Johnson
Date: 09/22/94

R D Augustine
Date: 01/23/95

----------------------Sketch 1----------------------

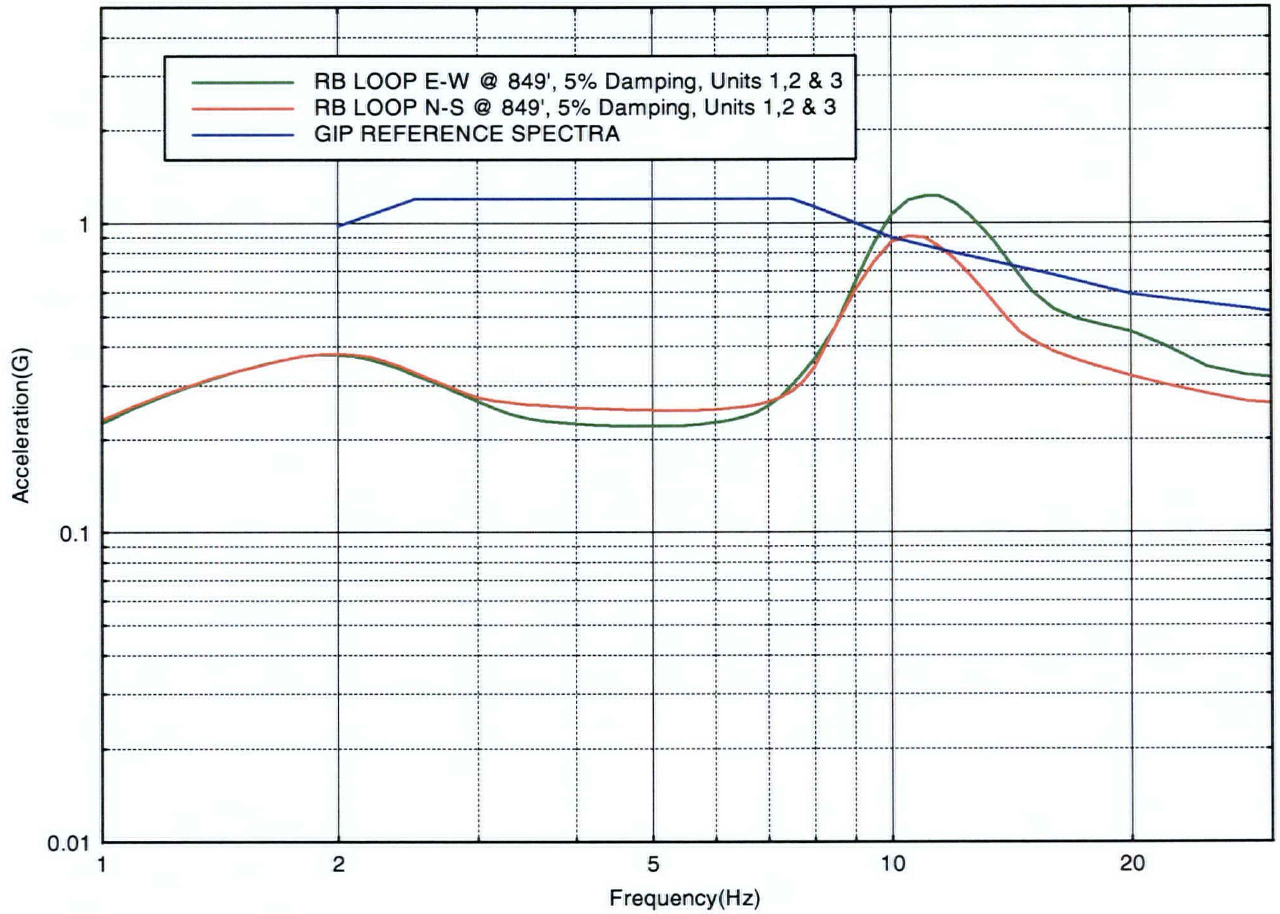
Attachment RAI10a.1

Table 5-3 Auxiliary Building Spectra Exceedance



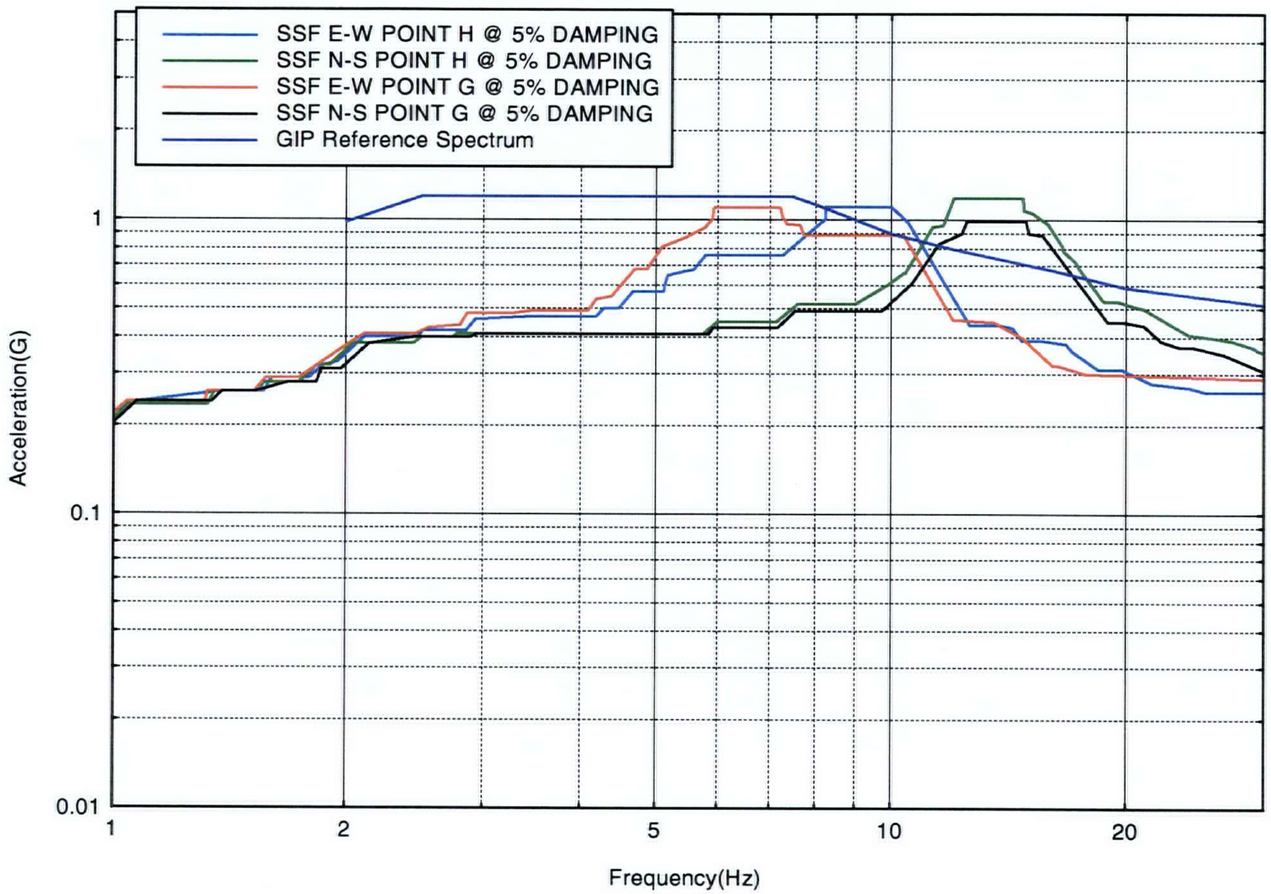
Attachment RAI10a.2

Table 5-3 Reactor Bldg. NSSS Loop Spectra Exceedance



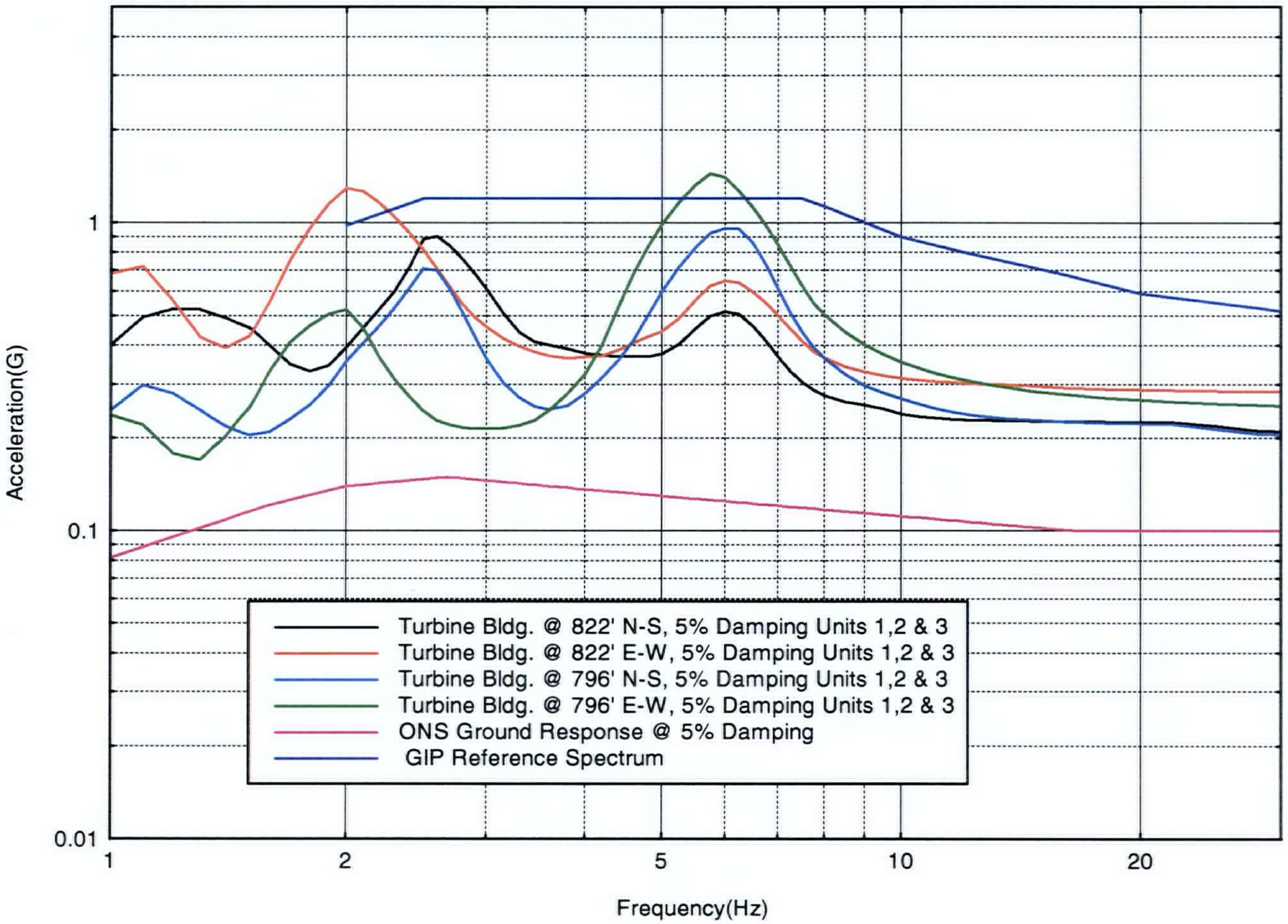
Attachment RAI10a.3

Table 5-3 SSF Spectra Exceedance



Attachment RAI10a.4

Table 5-3 Turbine Building Spectra Exceedance



Attachment RAI 10b.1

SCREENING EVALUATION WORK SHEET (SEWS)

Revision 2, Corrected, 6/28/91
Status Y N U
Sheet 1 of ______
Rev. 1

Equip. ID No. 3DP Equip. Class 01 - Motor Control Centers

Equipment Description 125/250V DC 3DP

Location: Bldg. TB Floor El. 796'+6" Room, Row/Col ______

Manufacturer, Model, Etc. (optional) CLARK/AO SMITH(BACK TO BACK) N/A

SEISMIC CAPACITY VS DEMAND

1.	Elevation where equipment receives seismic input		796'+6"
2.	Elevation of seismic input below about 40' from grade		[Y] N U
3.	Equipment has fundamental frequency above about 8 Hz		Y [N] U N/A
4.	Capacity based on:	Existing Documentation	DOC
		Bounding Spectrum	BS
		1.5 x Bounding Spectrum	[ABS]
		GERS	GERS
5.	Demand based on:	Ground Response Spectrum	GRS
		1.5 x Ground Response Spectrum	AGRS
		Conserv. Des. In-Str. Resp. Spec.	CRS
		Realistic M-Ctr. In-Str. Resp. Spec.	[RRS]

Does capacity exceed demand? Y [N] U *

CAVEATS - BOUNDING SPECTRUM (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1.	Equipment is included in earthquake experience equipment class	[Y] N U N/A *
2.	600 V rating or less	[Y] N U N/A
3.	Adjacent cabinets which are close enough to impact, or sections of multi-bay cabinets, are bolted together if they contain essential relays	[Y] N U N/A
4.	Attached weight (except conduit) less than about 100 lbs per cabinet assembly	[Y] N U N/A
5.	Externally attached items rigidly anchored	[Y] N U N/A
6.	General configuration similar to NEMA Standards	[Y] N U N/A
7.	Cutouts in lower half less than 6 in. wide and 12 in. high	[Y] N U N/A
8.	All doors secured by latch or fastener	[Y] N U N/A
9.	Natural frequency relative to 8 Hz limit considered	[Y] N U N/A
10.	Anchorage adequate (See checklist below for details)	[Y] N U N/A *
11.	Relays mounted on equipment evaluated	[Y] N U N/A
12.	Have you looked for and found no other adverse concerns?	[Y] N U N/A

Is the intent of all the caveats met for Bounding Spectrum? [Y] N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3DP Equip. Class 01 - Motor Control Centers

Equipment Description 125/250V DC 3DP

CAVEATS - GERS (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in generic seismic testing equipment class — Y N U N/A
2. Meets all Bounding Spectrum caveats — Y N U N/A
3. Floor mounted cabinet — Y N U N/A
4. Average weight per section less than 800 pounds — Y N U N/A
5. Base anchorage utilizing MCC base channels — Y N U N/A
6. Adequate strength and stiffness in load transfer path from anchorage to base frame (only for "function after" GERS) — Y N U N/A
7. Essential relays have GERS > 4.5g (only for "function during" GERS) — Y N U N/A
8. Able to reset starters (only for "function after" GERS) — Y N U N/A

Is the intent of all the caveats met for GERS? — Y N U N/A

ANCHORAGE

1. Appropriate equipment characteristics determined (mass, CG, natural freq., damping, center of rotation)
2. Type of anchorage covered by GIP — [Y] N U N/A
3. Sizes and locations of anchors determined — [Y] N U N/A
4. Adequacy of anchorage installation evaluated (weld quality and length, nuts and washers, expansion anchor tightness, etc.) — [Y] N U N/A
5. Factors affecting anchorage capacity or margin of safety considered: embedment length, anchor spacing, free-edge distance, concrete strength/condition, and concrete cracking — [Y] N U N/A
6. For bolted anchorages, gap under base less than 1/4-inch — [Y] N U N/A
7. Factors affecting essential relays considered: gap under base, capacity reduction for expansion anchors — [Y] N U N/A
8. Base has adequate stiffness and effect of prying action on anchors considered — [Y] N U N/A
   [Y] N U N/A
9. Strength of equipment base and load path to CG adequate — [Y] N U N/A
10. Embedded steel, grout pad or large concrete pad adequacy evaluated — [Y] N U N/A

Are anchorage requirements met? — [Y] N U N/A *

SCREENING EVALUATION WORK SHEET (SEWS)

ip. ID No. 3DP Equip. Class 01 - Motor Control Centers

Equipment Description 125/250V DC 3DP

INTERACTION EFFECTS

1.	Soft targets free from impact by nearby equipment or structures	[Y] N U N/A
2.	If equipment contains sensitive relays, equipment free from all impact by nearby equipment or structures	[Y] N U N/A
3.	Attached lines have adequate flexibility	[Y] N U N/A
4.	Overhead equipment or distribution systems are not likely to collapse	[Y] N U N/A
5.	Have you looked for and found no other adverse concerns?	[Y] N U N/A

Is equipment free of interaction effects? [Y] N U

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

COMMENTS

Anchorage acceptable for IPEEE with FOC applied.

COMMENTS FROM SEISMIC CAPACITY VS DEMAND
Does capacity exceed demand? RRS exceeds Reference Spectra between 5.5 - 6.5 Hz

MENTS OF CAVEATS - BOUNDING SPECTRUM
e shear flow calculation contained in miscallaneous section of A-46/IPEEE culation. 14.5in Clark AO Smith MCCs bolted back to back are verified to act as a unit per this calculation. 14.5in deep Clark MCCs will essentially act as a 29in deep MCC. This meets the intent of the caveat
10 See calculation in file.

COMMENTS OF ANCHORAGE
Are anchorage requirements met? See calculation in file.

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3DP Equip. Class 01 - Motor Control Centers

Equipment Description 125/250V DC 3DP

RELAY WALKDOWN

1. Does spot check of essential relays indicate relays present and properly mounted? [Y] N U N/A

2. Are essential relays required to function during earthquake screened out? Y [N] U N/A

   If no, attach list of relays with locations in cabinet and general dimensions, thicknesses and details of mounting plates that support relays for later analysis.

3. No other relay concerns? [Y] N U N/A

Requirements for relays satisfied? Y [N] U N/A

SYSTEMS INTERACTION EFFECTS?

1. No potential sources could flood or spill onto cabinet? [Y] N U N/A

IS EQUIPMENT FREE OF NEED FOR FURTHER INVESTIGATION, EXCLUDING RELAY CHATTER?

YES X NO ___

IS EQUIPMENT FREE OF NEED FOR FURTHER RELAY CHATTER INVESTIGATION? YES ___ NO X

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3DP Equip. Class 01 - Motor Control Centers

Equipment Description 125/250V DC 3DP

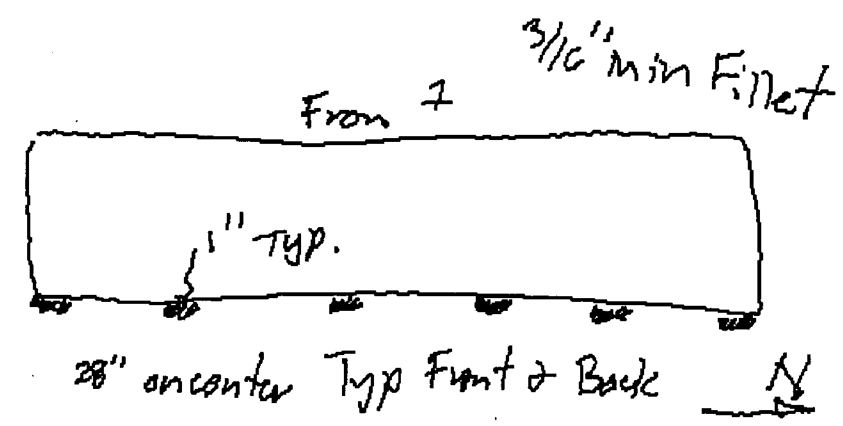
Evaluated by:

R. P. Childs

R P Childs
Date: 02/26/96

L B Elrod

L B Elrod
Date: 02/28/96



Sketch 1

FOR INFORMATION ONLY

3.1.3 Comparison of In-Structure SSE Spectra with Reference Spectrum (Turbine Building)

The SSE in-structure demand spectra for all of the relevant floor elevations in the Turbine Building are compared to the reference spectrum in this section.

The demand spectra are taken as the in-structure spectra at each floor elevation for the Turbine Building given in Figures A-165 through A-168 of Ref. 7. Those response spectra are given at 2% oscillator damping.

If the enclosure under analysis can be included in the GIP equipment class (as described in Section 3.1.1), then the capacity of the enclosure is given by the reference spectrum (see Section 3.1.2).

The enclosure structure can be considered seismically qualified if the capacity spectra fully envelope the demand spectra. Comparisons between demand and capacity spectra were made at 2% oscillator damping.

A comparison between the reference spectrum and the SSE in-structure spectra for the N/S, E/W, and vertical excitation directions for Elevation 796 is given in Figure 3.1.3.1. From that figure it can be shown that the demand spectra exceeds the capacity spectra at approximately 5.8 Hz. The GIP, Section 4.2, allows a narrow band exceedance if "...the average ratio of the demand spectra to the capacity spectrum does not exceed unity when computed over a frequency range of 10%". In other words, the total area of exceedance must be equal to or less than the total area not exceeding over the 10% frequency range as shown in Figure 3.1.3.1A (bottom slide). Figure 3.1.3.1B shows a blown up view of the peak exceedance and the total area of exceedance for the E/W direction at EL. 796; which shows that all of the area is exceeding over the 10% frequency range. Therefore, using the GIP criteria, the peak exceedance would be unacceptable.

For the given response spectra the GIP is overly conservative. Qualitative analysis will be used to demonstrate the acceptability of the peak exceedance. Figure 3.1.3.1C shows the GIP reference spectrum plotted against the Turbine Building demand spectrum at EL. 796 for the E/W excitation direction at 5% damping. The reference spectrum in Figure 3.1.3.1C has much broader frequency content and energy than the narrow peaks of the Turbine Building demand spectrum. For example, if a shake table test was performed on an enclosure using each of the curves given in Figure 3.1.3.1C as input, more energy would be input to the enclosure by the reference spectrum even though the peak spectral acceleration for the Turbine Building demand spectrum is higher.

In addition, the reference spectrum is used for the capacity spectrum of the cabinet in all three excitation directions N/S, E/W, and vertical (2/3 of reference spectrum for vertical).

However, only the E/W demand spectrum exceeds the capacity spectrum; both the N/S and vertical demand spectra are less than the corresponding capacity spectra.

Another form of conservatism exists based on the input time history (EL Centro scaled to 0.1g) used for the design basis Turbine Building analysis that generated the in-structure demand spectra. Figure 3.1.3.1D shows the design basis ground response spectrum from Ref. 7 versus the response spectrum computed from the EL Centro time history. The peak acceleration for the ground response spectrum is approximately 0.15g, whereas, the peak of the response spectrum computed from the time history is approximately 0.3g.

Therefore, the demand spectrum peak exceedance for the E/W direction at EL. 796 is acceptable based on qualitative analysis.

Enclosures included in the equipment class mounted in the Turbine Building at Elevation 796 are seismically qualified in the horizontal direction based on the GIP.

A comparison between the reference spectrum and the SSE in-structure spectra for the N/S and E/W excitation directions for Elevation 822 is given in Figure 3.1.3.2. From that figure it can be shown that the demand spectra exceeds the capacity spectra at frequencies less than approximately 2.0 Hz. This exceedance is acceptable based on the guidance given in Section 4.2 of the GIP on capacity spectra exceedance. The GIP allows the demand spectra to be greater than the capacity spectra in the lower frequency range if it can be shown that the conservatively determined lowest natural frequency of the enclosure is greater than the frequency where the exceedance occurs. The fundamental natural frequency for floor mounted enclosures is expected to be greater than 2.0 Hz, therefore, enclosures included in the equipment class mounted in the Turbine Building at Elevation 822 are seismically qualified in the horizontal direction based on the GIP.

The vertical in-structure response spectra for the Turbine Building at any floor elevation is equal to the full value of the horizontal response spectrum as given by Section 4.4 of Ref. 7. The ground response spectrum is given in Figure 2 of Ref. 7. A comparison of Fig 2 of Ref. 7 with the reference spectrum is given in Section 3.1.5 as Figure 3.1.5.1. The vertical capacity spectrum fully envelopes the demand spectrum at all frequency points, therefore, enclosures included in the equipment class mounted in the Turbine Building at all Elevations are seismically qualified in the vertical direction based on the GIP..

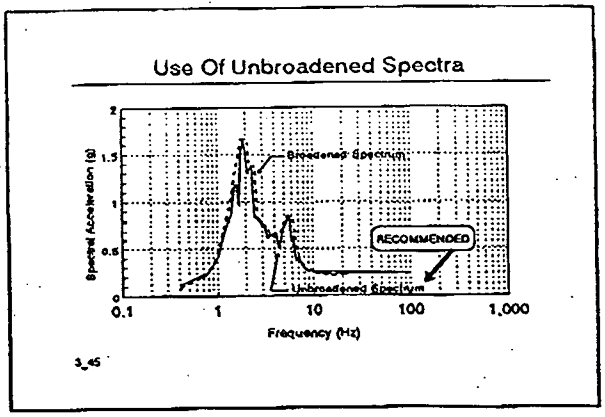
037

Capacity vs. Demand

Recommend using unbroadened spectra. Displays highly amplified peaks.

Uncertainty in structures natural frequency handled by shifting peaks.

Percent shift: determined from plant's licensing basis criteria.



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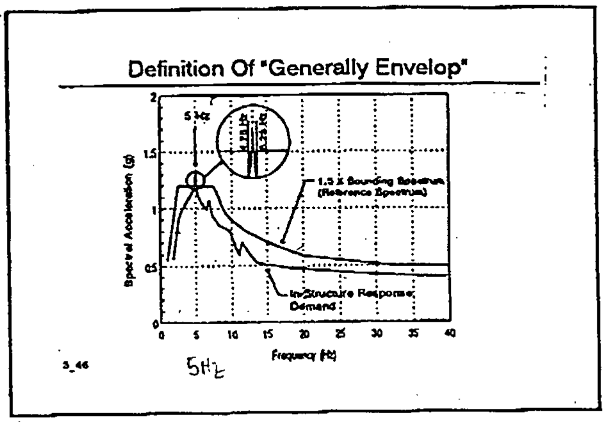
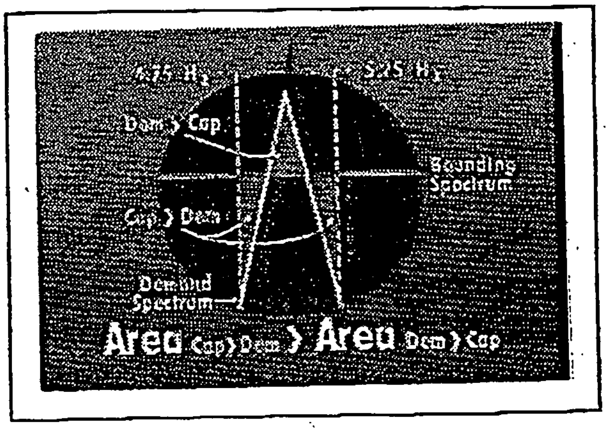
Peaks in In-Structure Spectra will not be as amplified in real earthquakes as predicted with linear structural models.

Highly amplified peaks are not as damaging as a broader frequency input.

If (demand/capacity) < 1 over a 10% frequency range -- OK.



TWO AREAS BELOW HAVE TO EXCEED ONE AREA ABOVE.



07-06-1995 09:41AM FROM OCONEE CIVIL ENGINEERING TO 8382393 P.01

TAKEN FROM GIP TRAINING MANUAL.

Cal# OSC-5085
By: RLL Date 2/14/96
Ck: Date
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FIGURE 3.1.3.1 A

AVERAGE PEAK FREQ. = 5.8 Hz.

10% OF 5.8 Hz = 0.58 Hz.
½ OF 0.58 Hz = 0.29 Hz EACH SIDE

MIN. FREQ. = 5.80 − 0.29 = 5.5 Hz

MAX. FREQ. = 5.8 + 0.29 = 6.1 Hz.

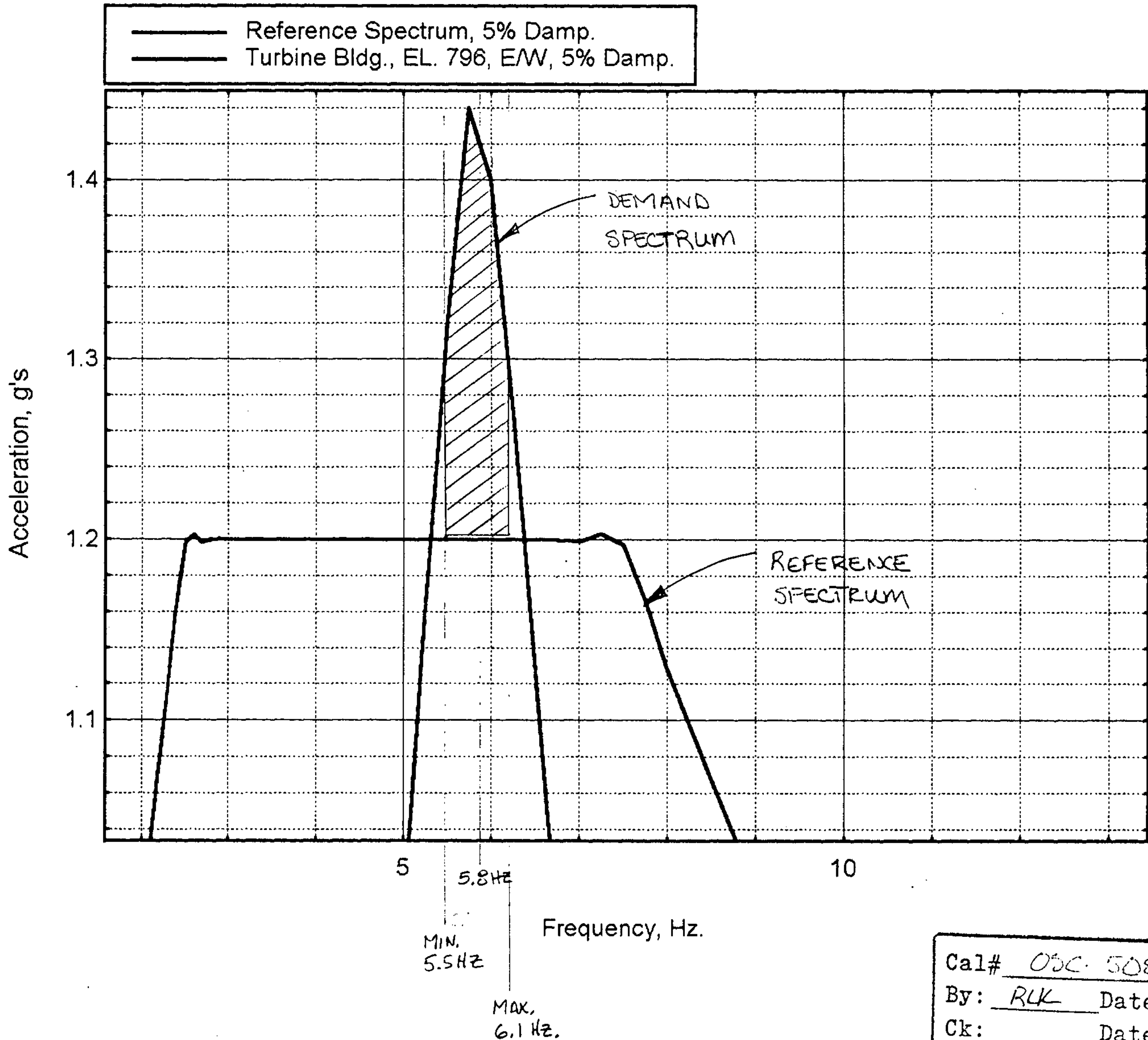

FIGURE 3.1.3.1 B

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Cal# OSC-5085	
By: RLK	Date 2/14/96
Ck:	Date
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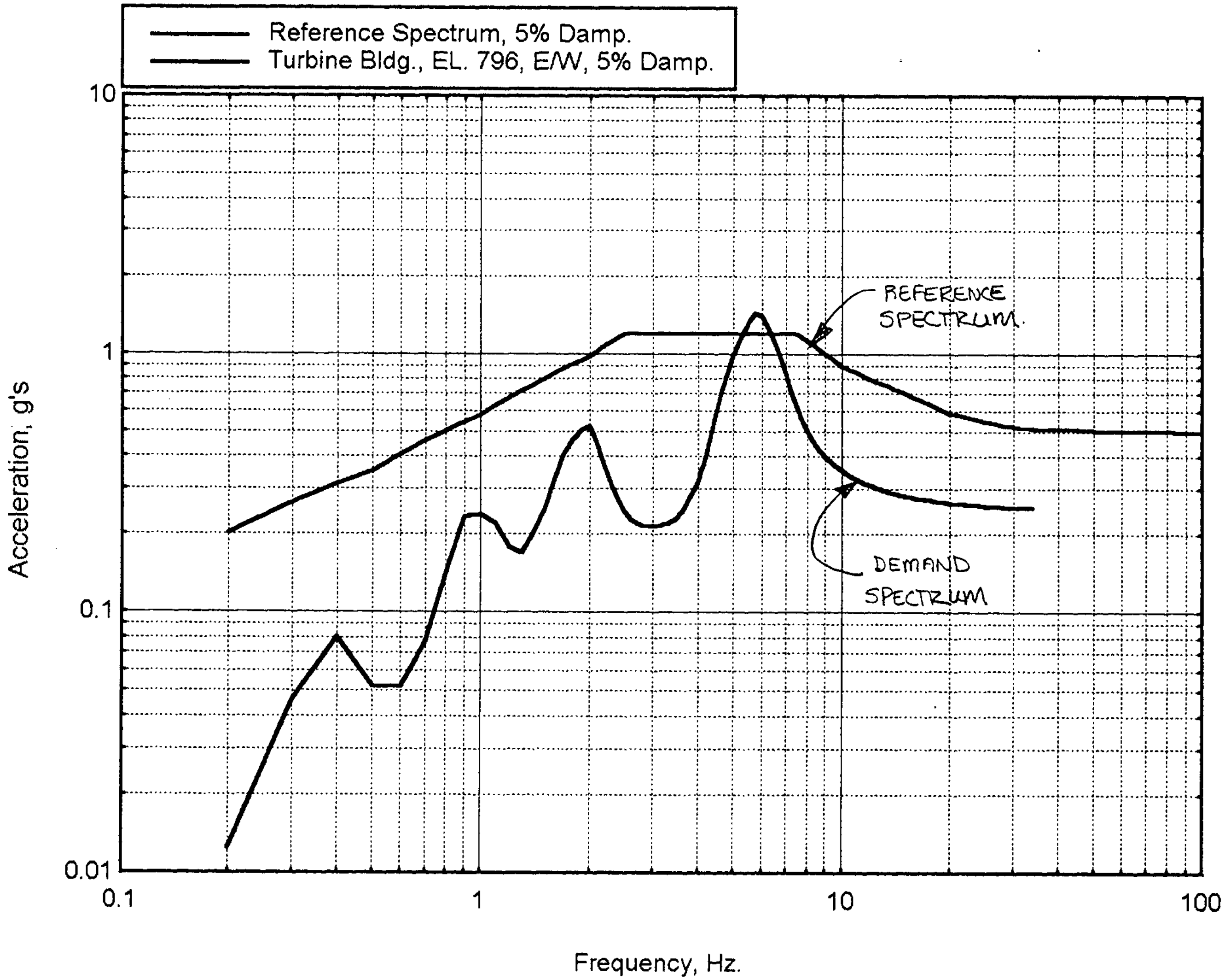

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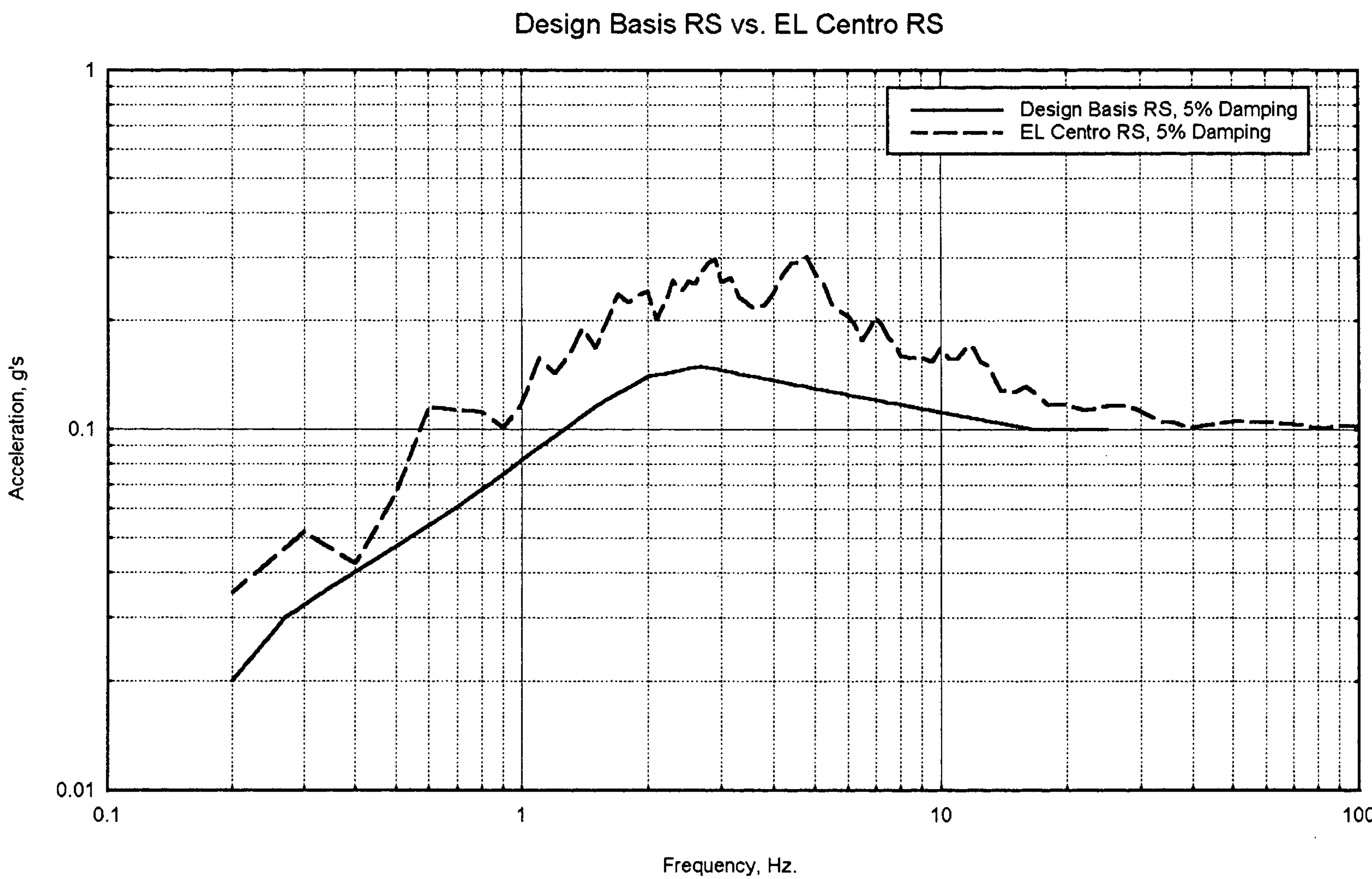
FIGURE 3.1.3.1 C.

Cal# OSC-5085
By: BLK Date 2/14/96
Ck: ______ Date ______
Page 1.34 Rev 4

040



FOR INFORMATION ONLY

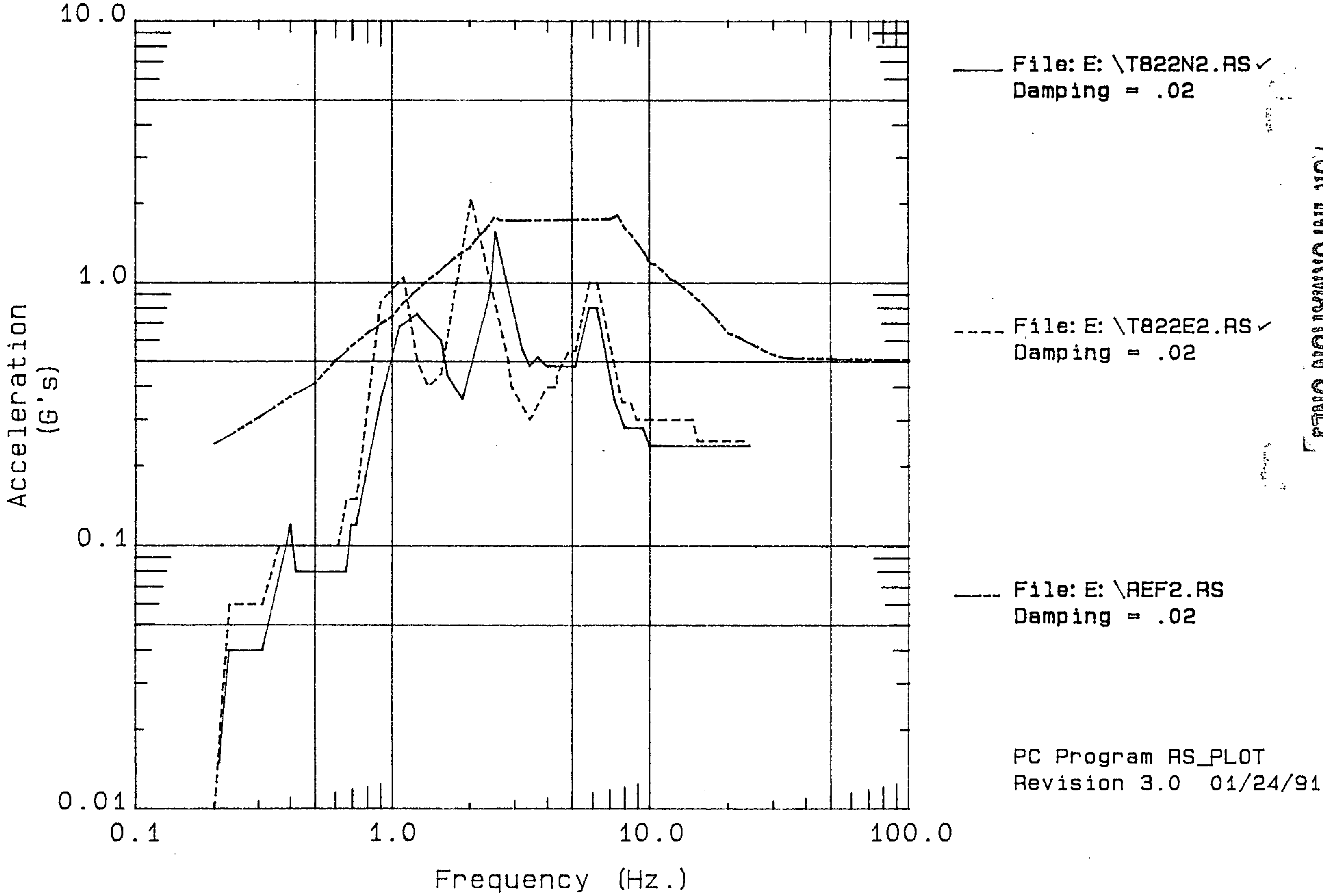
Cal# OSC-5085
By: BLK Date 3/14/96
Ck: Date
Page 1.35 Rev 4

FIGURE 3.1.3.1 D

041

Turbine Building, EL. 822, N/S and E/W RS vs. Reference Spectrum

2% Oscillator Damping



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Cal# OSC-5085
By: BCK Date 2/14/96
Ck: Date
Page 136 Rev 4

FIGURE 3.1.3.2

Attachment RAI 106.2

Revision 2, Corrected, 6/28/91
Status Y N U
Sheet 1 of ______
Rev. 1

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 1PA

Location: Bldg. TB Floor El. 796'+6" Room, Row/Col ______

Manufacturer, Model, Etc. (optional) SOLID STATE CONTROLS

SEISMIC CAPACITY VS DEMAND

1. Elevation where equipment receives seismic input 796'+6"
2. Elevation of seismic input below about 40' from grade [Y] N U
3. Equipment has fundamental frequency above about 8 Hz Y N [U] N/A
4. Capacity based on: Existing Documentation DOC
   Bounding Spectrum BS
   1.5 x Bounding Spectrum [ABS]
   GERS GERS
5. Demand based on: Ground Response Spectrum GRS
   1.5 x Ground Response Spectrum AGRS
   Conserv. Des. In-Str. Resp. Spec. CRS
   Realistic M-Ctr. In-Str. Resp. Spec. [RRS]

Does capacity exceed demand? Y [N] U *

CAVEATS - BOUNDING SPECTRUM (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in earthquake experience equipment class [Y] N U N/A
2. Solid state type [Y] N U N/A
3. For floor-mounted, transformer positively anchored and mounted near base, or load path is evaluated [Y] N U N/A
4. Base assembly of floor-mounted unit properly braced or stiffened for lateral forces [Y] N U N/A
5. For wall-mounted units, transformer supports and bracing provide adequate load path to the rear cabinet wall Y N U [N/A]
6. All latches and fasteners in doors secured [Y] N U N/A
7. Anchorage adequate (See checklist below for details) [Y] N U N/A
8. Relays mounted on equipment evaluated [Y] N U N/A
9. Have you looked for and found no other adverse concerns? [Y] N U N/A

Is the intent of all the caveats met for Bounding Spectrum? [Y] N U N/A

CAVEATS - GERS (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in generic seismic testing equipment class Y N U N/A
2. Meets all Bounding Spectrum caveats Y N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 1PA

CAVEATS - GERS (Cont'd)

3.	Silicon-Controlled Rectifier (SCR) power controls; wall- or floor-mounted NEMA-type enclosure	Y	N	U	N/A			
4.	Within range of battery charger ratings;							
	24-250 VDC	Y	N	U	N/A			
	120-480 VAC	Y	N	U	N/A			
	25-600 amps	Y	N	U	N/A			
	150-2850 pounds (floor-mounted)	Y	N	U	N/A			
	150-600 pounds (wall-mounted)	Y	N	U	N/A			
5.	Within range of inverter ratings;							
	120 VDC only	Y	N	U	N/A			
	120-480 VAC	Y	N	U	N/A			
	0.5-15 KVA	Y	N	U	N/A			
	300-2000 pounds	Y	N	U	N/A			
6.	Heavy components are located in lower half of cabinet and are supported from base or rear panel with no panel cutouts adjacent to attachment	Y	N	U	N/A			
Is the intent of all the caveats met for GERS?					Y	N	U	N/A

ANCHORAGE

1.	Appropriate equipment characteristics determined (mass, CG, natural freq., damping, center of rotation)	[Y]	N	U	N/A			
2.	Type of anchorage covered by GIP	[Y]	N	U	N/A			
3.	Sizes and locations of anchors determined	[Y]	N	U	N/A			
4.	Adequacy of anchorage installation evaluated (weld quality and length, nuts and washers, expansion anchor tightness, etc.)	[Y]	N	U	N/A			
5.	Factors affecting anchorage capacity or margin of safety considered: embedment length, anchor spacing, free-edge distance, concrete strength/condition, and concrete cracking	[Y]	N	U	N/A			
6.	For bolted anchorages, gap under base less than 1/4-inch	[Y]	N	U	N/A			
7.	Factors affecting essential relays considered: gap under base, capacity reduction for expansion anchors	[Y]	N	U	N/A			
8.	Base has adequate stiffness and effect of prying action on anchors considered	[Y]	N	U	N/A			
9.	Strength of equipment base and load path to CG adequate	[Y]	N	U	N/A			
10.	Embedded steel, grout pad or large concrete pad adequacy evaluated	[Y]	N	U	N/A			
Are anchorage requirements met?					[Y]	N	U	*

INTERACTION EFFECTS

1.	Soft targets free from impact by nearby equipment or structures	[Y]	N	U	N/A
2.	If equipment contains sensitive relays, equipment free from all impact by nearby equipment or structures	[Y]	N	U	N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 1PA

INTERACTION EFFECTS (Cont'd)

3.	Attached lines have adequate flexibility	[Y] N U N/A
4.	Overhead equipment or distribution systems are not likely to collapse	[Y] N U N/A
5.	Have you looked for and found no other adverse concerns?	[Y] N U N/A

Is equipment free of interaction effects? [Y] N U

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

COMMENTS

Covers 1PB, 2PA, and 2PB also. Rev 1 extended evaluation to Unit 2. Inspected chargers were newly installed.

COMMENTS FROM SEISMIC CAPACITY VS DEMAND
Does capacity exceed demand? RRS exceeds Reference Spectra between 5.5 - 6.5 Hz

COMMENTS OF ANCHORAGE
Are anchorage requirements met? ANCHORAGE IS ACCEPTABLE BY COMPARISON TO CALCULATION IN FILE FOR 3PA/BC. CHARGERS FOR UNITS 1 & 2 ARE NEWLY INSTALLED. CHARGERS FOR UNITS ARE OLD MODELS THAT WILL BE REPLACED IN NEAR TERM. SEE PORTION OF ANCHORAGE CALCULATION FOR 3PA/BC & 3PB/BC LABELED "NEW CHARGERS"

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 1PA

RELAY WALKDOWN

1. Does spot check of essential relays indicate relays present and properly mounted? [Y] N U N/A

2. Are essential relays required to function during earthquake screened out? Y [N] U N/A

   If no, attach list of relays with locations in cabinet and general dimensions, thicknesses and details of mounting plates that support relays for later analysis.

3. No other relay concerns? [Y] N U N/A

Requirements for relays satisfied? Y [N] U N/A

SYSTEMS INTERACTION EFFECTS?

1. No potential sources could flood or spill onto cabinet? [Y] N U N/A

IS EQUIPMENT FREE OF NEED FOR FURTHER INVESTIGATION, EXCLUDING RELAY CHATTER?

YES X NO ___

IS EQUIPMENT FREE OF NEED FOR FURTHER RELAY CHATTER INVESTIGATION? YES ___ NO X

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 1PA

Evaluated by:

Robert V Hester

R V Hester
Date: 04/12/95

R W McAuley

R W McAuley
Date: 04/12/95

Sketch 1

Attachment RAI 10b.3

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

Location: Bldg. TB Floor El. 796'+6" Room, Row/Col ______

Manufacturer, Model, Etc. (optional) EXIDE USF-130-3-150

SEISMIC CAPACITY VS DEMAND

1. Elevation where equipment receives seismic input — 796'+6"
2. Elevation of seismic input below about 40' from grade — [Y] N U
3. Equipment has fundamental frequency above about 8 Hz — Y N [U] N/A
4. Capacity based on:
   - Existing Documentation — DOC
   - Bounding Spectrum — BS
   - 1.5 x Bounding Spectrum — [ABS]
   - GERS — GERS
5. Demand based on:
   - Ground Response Spectrum — GRS
   - 1.5 x Ground Response Spectrum — AGRS
   - Conserv. Des. In-Str. Resp. Spec. — CRS
   - Realistic M-Ctr. In-Str. Resp. Spec. — [RRS]

Does capacity exceed demand? Y [N] U *

CAVEATS - BOUNDING SPECTRUM (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in earthquake experience equipment class — [Y] N U N/A
2. Solid state type — [Y] N U N/A
3. For floor-mounted, transformer positively anchored and mounted near base, or load path is evaluated — [Y] N U N/A
4. Base assembly of floor-mounted unit properly braced or stiffened for lateral forces — [Y] N U N/A
5. For wall-mounted units, transformer supports and bracing provide adequate load path to the rear cabinet wall — Y N U [N/A]
6. All latches and fasteners in doors secured — [Y] N U N/A
7. Anchorage adequate (See checklist below for details) — [Y] N U N/A
8. Relays mounted on equipment evaluated — [Y] N U N/A
9. Have you looked for and found no other adverse concerns? — [Y] N U N/A

Is the intent of all the caveats met for Bounding Spectrum? [Y] N U N/A

CAVEATS - GERS (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in generic seismic testing equipment class — Y N U N/A
2. Meets all Bounding Spectrum caveats — Y N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

CAVEATS - GERS (Cont'd)

3. Silicon-Controlled Rectifier (SCR) power controls; wall- or floor-mounted NEMA-type enclosure	Y N U N/A
4. Within range of battery charger ratings;	
24-250 VDC	Y N U N/A
120-480 VAC	Y N U N/A
25-600 amps	Y N U N/A
150-2850 pounds (floor-mounted)	Y N U N/A
150-600 pounds (wall-mounted)	Y N U N/A
5. Within range of inverter ratings;	
120 VDC only	Y N U N/A
120-480 VAC	Y N U N/A
0.5-15 KVA	Y N U N/A
300-2000 pounds	Y N U N/A
6. Heavy components are located in lower half of cabinet and are supported from base or rear panel with no panel cutouts adjacent to attachment	Y N U N/A
Is the intent of all the caveats met for GERS?	Y N U N/A

ANCHORAGE

1. Appropriate equipment characteristics determined (mass, CG, natural freq., damping, center of rotation)	[Y] N U N/A
2. Type of anchorage covered by GIP	[Y] N U N/A
3. Sizes and locations of anchors determined	[Y] N U N/A
4. Adequacy of anchorage installation evaluated (weld quality and length, nuts and washers, expansion anchor tightness, etc.)	[Y] N U N/A
5. Factors affecting anchorage capacity or margin of safety considered: embedment length, anchor spacing, free-edge distance, concrete strength/condition, and concrete cracking	[Y] N U N/A
6. For bolted anchorages, gap under base less than 1/4-inch	[Y] N U N/A
7. Factors affecting essential relays considered: gap under base, capacity reduction for expansion anchors	[Y] N U N/A
8. Base has adequate stiffness and effect of prying action on anchors considered	[Y] N U N/A
9. Strength of equipment base and load path to CG adequate	[Y] N U N/A
10. Embedded steel, grout pad or large concrete pad adequacy evaluated	[Y] N U N/A
Are anchorage requirements met?	[Y] N U *

INTERACTION EFFECTS

1. Soft targets free from impact by nearby equipment or structures	[Y] N U N/A
2. If equipment contains sensitive relays, equipment free from all impact by nearby equipment or structures	[Y] N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

INTERACTION EFFECTS (Cont'd)

3. Attached lines have adequate flexibility [Y] N U N/A
4. Overhead equipment or distribution systems are not likely to collapse [Y] N U N/A
5. Have you looked for and found no other adverse concerns? [Y] N U N/A

Is equipment free of interaction effects? [Y] N U

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

COMMENTS

Covers 3PB also.

COMMENTS FROM SEISMIC CAPACITY VS DEMAND
Does capacity exceed demand? RRS exceeds Reference Spectra between 5.5 - 6.5 Hz

COMMENTS OF ANCHORAGE
Are anchorage requirements met? See calculation in file. See portion of anchorage calculation labeled "Existing Chargers"

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

RELAY WALKDOWN

1. Does spot check of essential relays indicate relays present and properly mounted? [Y] N U N/A

2. Are essential relays required to function during earthquake screened out? Y [N] U N/A

   If no, attach list of relays with locations in cabinet and general dimensions, thicknesses and details of mounting plates that support relays for later analysis.

3. No other relay concerns? [Y] N U N/A

Requirements for relays satisfied? Y [N] U N/A

SYSTEMS INTERACTION EFFECTS?

1. No potential sources could flood or spill onto cabinet? [Y] N U N/A

IS EQUIPMENT FREE OF NEED FOR FURTHER INVESTIGATION, EXCLUDING RELAY CHATTER?

YES X NO ___

IS EQUIPMENT FREE OF NEED FOR FURTHER RELAY CHATTER INVESTIGATION? YES ___ NO X

SCREENING EVALUATION WORK SHEET (SEWS)

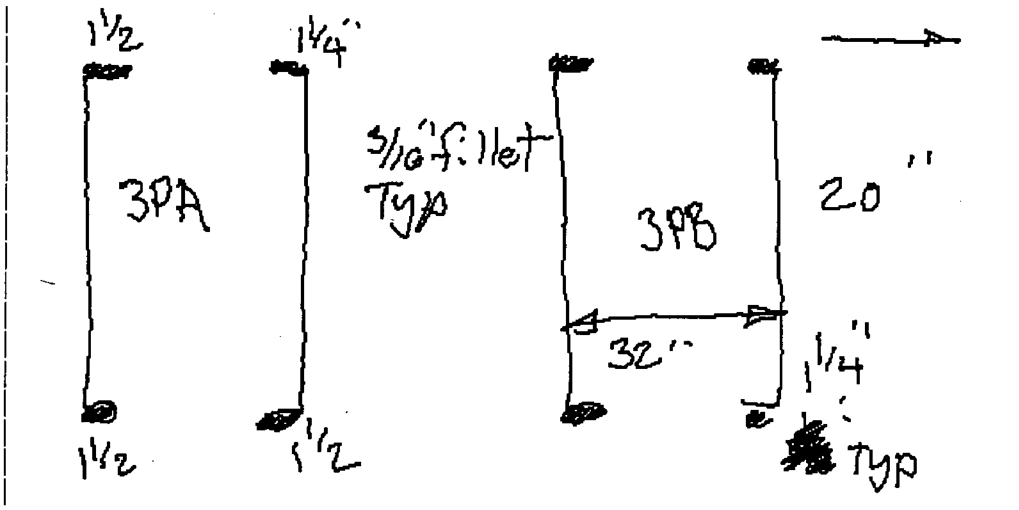
Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

Evaluated by:

R W McAuley
Date: 03/02/95

R V Hester
Date: 03/02/95



Sketch 1

Attachment RAI 10b.3

SCREENING EVALUATION WORK SHEET (SEWS)

Revision 2, Corrected, 6/28/91
Status Y N U
Sheet 1 of ______
Rev. 0

Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

Location: Bldg. TB Floor El. 796'+6" Room, Row/Col ______

Manufacturer, Model, Etc. (optional) EXIDE USF-130-3-150

SEISMIC CAPACITY VS DEMAND

1. Elevation where equipment receives seismic input — 796'+6"
2. Elevation of seismic input below about 40' from grade — [Y] N U
3. Equipment has fundamental frequency above about 8 Hz — Y N [U] N/A
4. Capacity based on: Existing Documentation — DOC
   Bounding Spectrum — BS
   1.5 x Bounding Spectrum — [ABS]
   GERS — GERS
5. Demand based on: Ground Response Spectrum — GRS
   1.5 x Ground Response Spectrum — AGRS
   Conserv. Des. In-Str. Resp. Spec. — CRS
   Realistic M-Ctr. In-Str. Resp. Spec. — [RRS]

Does capacity exceed demand? — Y [N] U *

CAVEATS - BOUNDING SPECTRUM (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in earthquake experience equipment class — [Y] N U N/A
2. Solid state type — [Y] N U N/A
3. For floor-mounted, transformer positively anchored and mounted near base, or load path is evaluated — [Y] N U N/A
4. Base assembly of floor-mounted unit properly braced or stiffened for lateral forces — [Y] N U N/A
5. For wall-mounted units, transformer supports and bracing provide adequate load path to the rear cabinet wall — Y N U [N/A]
6. All latches and fasteners in doors secured — [Y] N U N/A
7. Anchorage adequate (See checklist below for details) — [Y] N U N/A
8. Relays mounted on equipment evaluated — [Y] N U N/A
9. Have you looked for and found no other adverse concerns? — [Y] N U N/A

Is the intent of all the caveats met for Bounding Spectrum? — [Y] N U N/A

CAVEATS - GERS (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1. Equipment is included in generic seismic testing equipment class — Y N U N/A
2. Meets all Bounding Spectrum caveats — Y N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

RELAY WALKDOWN

1. Does spot check of essential relays indicate relays present and properly mounted? [Y] N U N/A

2. Are essential relays required to function during earthquake screened out? Y [N] U N/A

   If no, attach list of relays with locations in cabinet and general dimensions, thicknesses and details of mounting plates that support relays for later analysis.

3. No other relay concerns? [Y] N U N/A

Requirements for relays satisfied? Y [N] U N/A

SYSTEMS INTERACTION EFFECTS?

1. No potential sources could flood or spill onto cabinet? [Y] N U N/A

IS EQUIPMENT FREE OF NEED FOR FURTHER INVESTIGATION, EXCLUDING RELAY CHATTER?

YES X NO ___

IS EQUIPMENT FREE OF NEED FOR FURTHER RELAY CHATTER INVESTIGATION? YES ___ NO X

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

CAVEATS - GERS (Cont'd)

3. Silicon-Controlled Rectifier (SCR) power controls; wall- or floor-mounted NEMA-type enclosure — Y N U N/A
4. Within range of battery charger ratings;
   - 24-250 VDC — Y N U N/A
   - 120-480 VAC — Y N U N/A
   - 25-600 amps — Y N U N/A
   - 150-2850 pounds (floor-mounted) — Y N U N/A
   - 150-600 pounds (wall-mounted) — Y N U N/A
5. Within range of inverter ratings;
   - 120 VDC only — Y N U N/A
   - 120-480 VAC — Y N U N/A
   - 0.5-15 KVA — Y N U N/A
   - 300-2000 pounds — Y N U N/A
6. Heavy components are located in lower half of cabinet and are supported from base or rear panel with no panel cutouts adjacent to attachment — Y N U N/A

Is the intent of all the caveats met for GERS? — Y N U N/A

ANCHORAGE

1. Appropriate equipment characteristics determined (mass, CG, natural freq., damping, center of rotation) — [Y] N U N/A
2. Type of anchorage covered by GIP — [Y] N U N/A
3. Sizes and locations of anchors determined — [Y] N U N/A
4. Adequacy of anchorage installation evaluated (weld quality and length, nuts and washers, expansion anchor tightness, etc.) — [Y] N U N/A
5. Factors affecting anchorage capacity or margin of safety considered: embedment length, anchor spacing, free-edge distance, concrete strength/condition, and concrete cracking — [Y] N U N/A
6. For bolted anchorages, gap under base less than 1/4-inch — [Y] N U N/A
7. Factors affecting essential relays considered: gap under base, capacity reduction for expansion anchors — [Y] N U N/A
8. Base has adequate stiffness and effect of prying action on anchors considered — [Y] N U N/A
9. Strength of equipment base and load path to CG adequate — [Y] N U N/A
10. Embedded steel, grout pad or large concrete pad adequacy evaluated — [Y] N U N/A

Are anchorage requirements met? — [Y] N U *

INTERACTION EFFECTS

1. Soft targets free from impact by nearby equipment or structures — [Y] N U N/A
2. If equipment contains sensitive relays, equipment free from all impact by nearby equipment or structures — [Y] N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

INTERACTION EFFECTS (Cont'd)

3. Attached lines have adequate flexibility [Y] N U N/A
4. Overhead equipment or distribution systems are not likely to collapse [Y] N U N/A
5. Have you looked for and found no other adverse concerns? [Y] N U N/A

Is equipment free of interaction effects? [Y] N U

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

COMMENTS

Covers 3PB also.

COMMENTS FROM SEISMIC CAPACITY VS DEMAND
Does capacity exceed demand? RRS exceeds Reference Spectra between 5.5 - 6.5 Hz

COMMENTS OF ANCHORAGE
Are anchorage requirements met? See calculation in file. See portion of anchorage calculation labeled "Existing Chargers"

SCREENING EVALUATION WORK SHEET (SEWS)

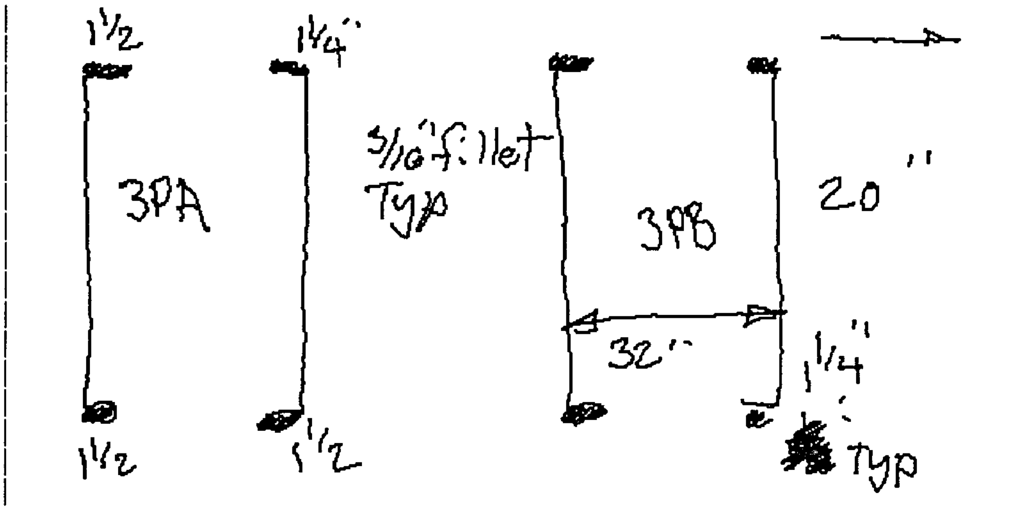
Equip. ID No. 3PA/BC Equip. Class 16 - Battery Chargers & Invertors

Equipment Description PWR BATT CHGR 3PA

Evaluated by:

R W McAuley
Date: 03/02/95

R V Hester
Date: 03/02/95



Sketch 1

Attachment RAI 106.4

SCREENING EVALUATION WORK SHEET (SEWS)

Revision 2, Corrected, 6/28/91
Status Y N U
Sheet 1 of ______
Rev. 1

Equip. ID No. 1MVC3 Equip. Class 01 - Motor Control Centers

Equipment Description 250V MCC 1MVC3

Location: Bldg. TB Floor El. 775'+0" Room, Row/Col ______

Manufacturer, Model, Etc. (optional) CLARK/AO SMITH(SINGLE DEPTH) N/A

SEISMIC CAPACITY VS DEMAND

1.	Elevation where equipment receives seismic input		775'+0"
2.	Elevation of seismic input below about 40' from grade		[Y] N U
3.	Equipment has fundamental frequency above about 8 Hz		Y N [U] N/A
4.	Capacity based on:	Existing Documentation	[DOC]
		Bounding Spectrum	BS
		1.5 x Bounding Spectrum	ABS
		GERS	GERS
5.	Demand based on:	Ground Response Spectrum	GRS
		1.5 x Ground Response Spectrum	AGRS
		Conserv. Des. In-Str. Resp. Spec.	CRS
		Realistic M-Ctr. In-Str. Resp. Spec.	[RRS]

Does capacity exceed demand? Y [N] U *

CAVEATS - BOUNDING SPECTRUM

(Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1.	Equipment is included in earthquake experience equipment class	Y [N] U N/A *
2.	600 V rating or less	[Y] N U N/A
3.	Adjacent cabinets which are close enough to impact, or sections of multi-bay cabinets, are bolted together if they contain essential relays	[Y] N U N/A
4.	Attached weight (except conduit) less than about 100 lbs per cabinet assembly	[Y] N U N/A *
5.	Externally attached items rigidly anchored	Y N U [N/A]
6.	General configuration similar to NEMA Standards	[Y] N U N/A
7.	Cutouts in lower half less than 6 in. wide and 12 in. high	Y N U [N/A]
8.	All doors secured by latch or fastener	[Y] N U N/A
9.	Natural frequency relative to 8 Hz limit considered	[Y] N U N/A
10.	Anchorage adequate (See checklist below for details)	[Y] N U N/A
11.	Relays mounted on equipment evaluated	[Y] N U N/A
12.	Have you looked for and found no other adverse concerns?	[Y] N U N/A

Is the intent of all the caveats met for Bounding Spectrum? Y [N] U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

p. ID No. 1MVC3 Equip. Class 01 - Motor Control Centers

Equipment Description 250V MCC 1MVC3

CAVEATS - GERS (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1.	Equipment is included in generic seismic testing equipment class	Y N U N/A
2.	Meets all Bounding Spectrum caveats	Y N U N/A
3.	Floor mounted cabinet	Y N U N/A
4.	Average weight per section less than 800 pounds	Y N U N/A
5.	Base anchorage utilizing MCC base channels	Y N U N/A
6.	Adequate strength and stiffness in load transfer path from anchorage to base frame (only for "function after" GERS)	Y N U N/A
7.	Essential relays have GERS > 4.5g (only for "function during" GERS)	Y N U N/A
8.	Able to reset starters (only for "function after" GERS)	Y N U N/A
	Is the intent of all the caveats met for GERS?	Y N U N/A

ANCHORAGE

1.	Appropriate equipment characteristics determined (mass, CG, natural freq., damping, center of rotation)	
	Type of anchorage covered by GIP	[Y] N U N/A
	Sizes and locations of anchors determined	[Y] N U N/A
4.	Adequacy of anchorage installation evaluated (weld quality and length, nuts and washers, expansion anchor tightness, etc.)	Y N U [N/A]
5.	Factors affecting anchorage capacity or margin of safety considered: embedment length, anchor spacing, free-edge distance, concrete strength/condition, and concrete cracking	[Y] N U N/A
6.	For bolted anchorages, gap under base less than 1/4-inch	[Y] N U N/A
7.	Factors affecting essential relays considered: gap under base, capacity reduction for expansion anchors	Y N U [N/A]
8.	Base has adequate stiffness and effect of prying action on anchors considered	[Y] N U N/A Y N U [N/A]
9.	Strength of equipment base and load path to CG adequate	[Y] N U N/A
10.	Embedded steel, grout pad or large concrete pad adequacy evaluated	[Y] N U N/A
	Are anchorage requirements met?	[Y] N U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

ip. ID No. 1MVC3 Equip. Class 01 - Motor Control Centers

Equipment Description 250V MCC 1MVC3

INTERACTION EFFECTS

1.	Soft targets free from impact by nearby equipment or structures	Y N U [N/A]
2.	If equipment contains sensitive relays, equipment free from all impact by nearby equipment or structures	[Y] N U N/A *
3.	Attached lines have adequate flexibility	[Y] N U N/A
4.	Overhead equipment or distribution systems are not likely to collapse	[Y] N U N/A
5.	Have you looked for and found no other adverse concerns?	[Y] N U N/A *

Is equipment free of interaction effects? [Y] N U

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

COMMENTS

Rev.1 addresses interaction concerns for relays(starters).

COMMENTS FROM SEISMIC CAPACITY VS DEMAND
Does capacity exceed demand? See 14" MCC outlier resolution calculation contained in Miscallaneous section of A-46/IPEEE calculation.

MENTS OF CAVEATS - BOUNDING SPECTRUM
1 DEPTH OF CABINET IS 14"
4 Small tray attached. Not massive enough to impact cabinet or anchorage.

COMMENTS OF INTERACTION EFFECTS
2 Rev.1: Nearby valve control chains are credible but not significant.
5 THE TOP OF THE MCC HAS SOME ELECTRAY ATTACHED, BUT THIS HAS NEGLIGLE WEIGHT. THE ELECTRAY CONNECTS TO ADJACENT MCC 1XC, BUT
TRAY WILL NOT AFFECT ANCHORAGE LOADING.

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1MVC3 Equip. Class 01 - Motor Control Centers

Equipment Description 250V MCC 1MVC3

RELAY WALKDOWN

1. Does spot check of essential relays indicate relays present and properly mounted? [Y] N U N/A

2. Are essential relays required to function during earthquake screened out? [Y] N U N/A

   If no, attach list of relays with locations in cabinet and general dimensions, thicknesses and details of mounting plates that support relays for later analysis.

3. No other relay concerns? [Y] N U N/A

Requirements for relays satisfied? [Y] N U N/A

SYSTEMS INTERACTION EFFECTS?

1. No potential sources could flood or spill onto cabinet? [Y] N U N/A

   SEE NOTE FOR 3XC

IS EQUIPMENT FREE OF NEED FOR FURTHER INVESTIGATION, EXCLUDING RELAY CHATTER?

YES ___ NO X__

IS EQUIPMENT FREE OF NEED FOR FURTHER RELAY CHATTER INVESTIGATION? YES X__ NO ___

SCREENING EVALUATION WORK SHEET (SEWS)

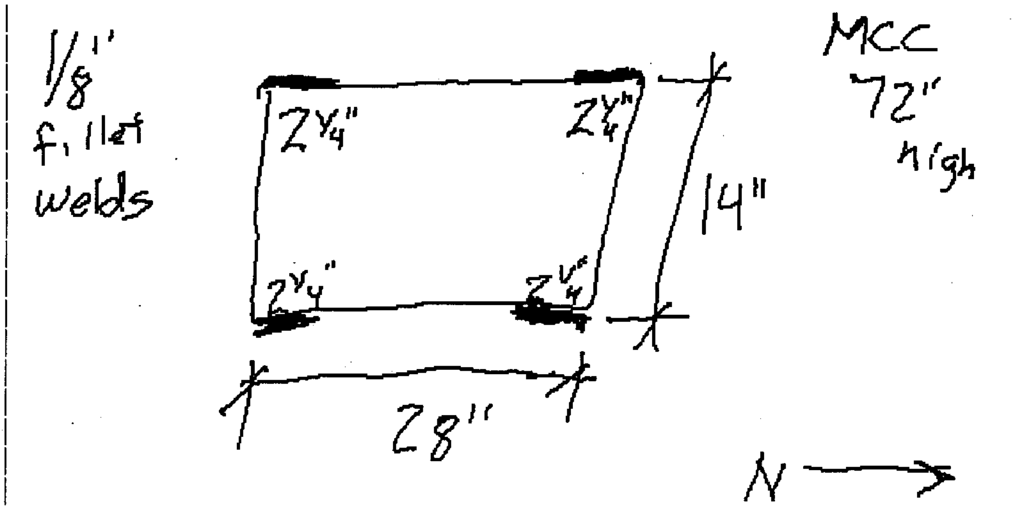
Equip. ID No. 1MVC3 Equip. Class 01 - Motor Control Centers

Equipment Description 250V MCC 1MVC3

Evaluated by:

R P Childs
Date: 08/19/96

L B Elrod
Date: 08/26/96

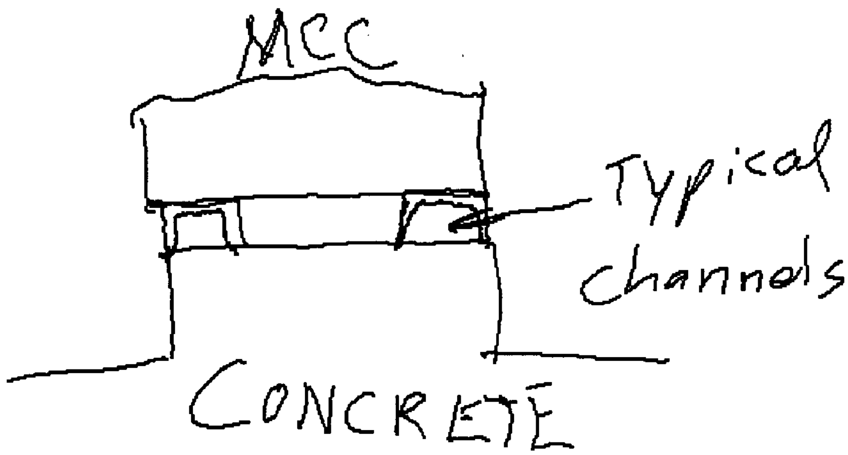


Sketch 1

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 1MVC3 Equip. Class 01 - Motor Control Centers

Equipment Description 250V MCC 1MVC3



Sketch 2

Sketch 3

Sketch 4

Revision 2, Corrected, 6/28/91
Status Y N U
Sheet 1 of ______
Rev. 3

SCREENING EVALUATION WORK SHEET (SEWS)

ip. ID No. 3XS3 Equip. Class 01 - Motor Control Centers

Equipment Description MCC 3XS3

Location: Bldg. AB Floor El. 796'+6" Room, Row/Col EQ. ROOM

Manufacturer, Model, Etc. (optional) CLARK/AO SMITH(SINGLE DEPTH) N/A

SEISMIC CAPACITY VS DEMAND

1.	Elevation where equipment receives seismic input		796'+6"
2.	Elevation of seismic input below about 40' from grade		[Y] N U
3.	Equipment has fundamental frequency above about 8 Hz		Y N [U] N/A
4.	Capacity based on:	Existing Documentation	[DOC]
		Bounding Spectrum	BS
		1.5 x Bounding Spectrum	ABS
		GERS	GERS
5.	Demand based on:	Ground Response Spectrum	GRS
		1.5 x Ground Response Spectrum	AGRS
		Conserv. Des. In-Str. Resp. Spec.	CRS
		Realistic M-Ctr. In-Str. Resp. Spec.	[RRS]

Does capacity exceed demand? Y [N] U *

CAVEATS - BOUNDING SPECTRUM (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and ain the reason for this conclusion in the COMMENTS section below)

	Equipment is included in earthquake experience equipment class	Y [N] U N/A *
2.	600 V rating or less	[Y] N U N/A
3.	Adjacent cabinets which are close enough to impact, or sections of multi-bay cabinets, are bolted together if they contain essential relays	[Y] N U N/A
4.	Attached weight (except conduit) less than about 100 lbs per cabinet assembly	Y N U [N/A]
5.	Externally attached items rigidly anchored	Y N U [N/A]
6.	General configuration similar to NEMA Standards	[Y] N U N/A
7.	Cutouts in lower half less than 6 in. wide and 12 in. high	[Y] N U N/A
8.	All doors secured by latch or fastener	[Y] N U N/A
9.	Natural frequency relative to 8 Hz limit considered	[Y] N U N/A
10.	Anchorage adequate (See checklist below for details)	Y [N] U N/A
11.	Relays mounted on equipment evaluated	[Y] N U N/A
12.	Have you looked for and found no other adverse concerns?	[Y] N U N/A

Is the intent of all the caveats met for Bounding Spectrum? Y [N] U N/A

SCREENING EVALUATION WORK SHEET (SEWS)

ip. ID No. 3XS3 Equip. Class 01 - Motor Control Centers

Equipment Description MCC 3XS3

CAVEATS - GERS (Identify with an asterisk (*) those caveats which are met by intent without meeting the specific wording of the caveat rule and explain the reason for this conclusion in the COMMENTS section below)

1.	Equipment is included in generic seismic testing equipment class	Y N U N/A
2.	Meets all Bounding Spectrum caveats	Y N U N/A
3.	Floor mounted cabinet	Y N U N/A
4.	Average weight per section less than 800 pounds	Y N U N/A
5.	Base anchorage utilizing MCC base channels	Y N U N/A
6.	Adequate strength and stiffness in load transfer path from anchorage to base frame (only for "function after" GERS)	Y N U N/A
7.	Essential relays have GERS > 4.5g (only for "function during" GERS)	Y N U N/A
8.	Able to reset starters (only for "function after" GERS)	Y N U N/A

Is the intent of all the caveats met for GERS? Y N U N/A

ANCHORAGE

1.	Appropriate equipment characteristics determined (mass, CG, natural freq., damping, center of rotation)	
	Type of anchorage covered by GIP	[Y] N U N/A
	Sizes and locations of anchors determined	[Y] N U N/A
4.	Adequacy of anchorage installation evaluated (weld quality and length, nuts and washers, expansion anchor tightness, etc.)	[Y] N U N/A
5.	Factors affecting anchorage capacity or margin of safety considered: embedment length, anchor spacing, free-edge distance, concrete strength/condition, and concrete cracking	[Y] N U N/A
6.	For bolted anchorages, gap under base less than 1/4-inch	[Y] N U N/A
7.	Factors affecting essential relays considered: gap under base, capacity reduction for expansion anchors	Y [N] U N/A *
8.	Base has adequate stiffness and effect of prying action on anchors considered	[Y] N U N/A * [Y] N U N/A
9.	Strength of equipment base and load path to CG adequate	[Y] N U N/A
10.	Embedded steel, grout pad or large concrete pad adequacy evaluated	Y N U [N/A]

Are anchorage requirements met? Y [N] U N/A *

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3XS3 Equip. Class 01 - Motor Control Centers

Equipment Description MCC 3XS3

INTERACTION EFFECTS

1.	Soft targets free from impact by nearby equipment or structures	[Y] N U N/A
2.	If equipment contains sensitive relays, equipment free from all impact by nearby equipment or structures	Y [N] U N/A *
3.	Attached lines have adequate flexibility	[Y] N U N/A
4.	Overhead equipment or distribution systems are not likely to collapse	[Y] N U N/A
5.	Have you looked for and found no other adverse concerns?	[Y] N U N/A
	Is equipment free of interaction effects?	[Y] N U

IS EQUIPMENT SEISMICALLY ADEQUATE Y [N] U

COMMENTS

Rev 1 resolved existence of gaps under equipment base and deleted all reference to relays since none are present. Rev 2 resolved depth issue. Rev.3 addresses the presence of essential relays. Interaction concern exist between cable shoe and cable tray. Repair1) trim cable tray to provide sufficient clearance with cable shoe on MCC.

COMMENTS FROM SEISMIC CAPACITY VS DEMAND
Does capacity exceed demand? See 14" MCC outlier resolution calculation contained in Miscallaneous section of A-46/IPEEE calculation.

COMMENTS OF CAVEATS - BOUNDING SPECTRUM
1 14" depth less than typical values for MCC's. Outlier due to depth of cabinet(14.5"<18")

COMMENTS OF ANCHORAGE
6 See sketch for location of gaps in excess of 1/4". Anchorage calculation accounted for this gap.
7 Gap under base is a concern for anchorage only. No significant banging will occur due to this gap. Gap is addressed in anchorage calculation.
Are anchorage requirements met? See calculation in file for 3XS3

COMMENTS OF INTERACTION EFFECTS
2 A cablt shoe on the East side is within 1/4" of cable tray steel.

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3XS3 Equip. Class 01 - Motor Control Centers

Equipment Description MCC 3XS3

RELAY WALKDOWN

1. Does spot check of essential relays indicate relays present and properly mounted? [Y] N U N/A

2. Are essential relays required to function during earthquake screened out? [Y] N U N/A

   If no, attach list of relays with locations in cabinet and general dimensions, thicknesses and details of mounting plates that support relays for later analysis.

3. No other relay concerns? [Y] N U N/A

Requirements for relays satisfied? [Y] N U N/A

SYSTEMS INTERACTION EFFECTS?

1. No potential sources could flood or spill onto cabinet? [Y] N U N/A

IS EQUIPMENT FREE OF NEED FOR FURTHER INVESTIGATION, EXCLUDING RELAY CHATTER?

YES ___ NO X

IS EQUIPMENT FREE OF NEED FOR FURTHER RELAY CHATTER INVESTIGATION? YES X NO ___

SCREENING EVALUATION WORK SHEET (SEWS)

Equip. ID No. 3XS3 Equip. Class 01 - Motor Control Centers

Equipment Description MCC 3XS3

Evaluated by:

R P Childs
Date: 08/20/96

L B Elrod
Date: 08/26/96

---Sketch 1---

OSC-6040 Duke Power Company FOR INFORMATION ONLY

1227.1

Station Oconee	Unit 2 Rev.	File No.	Sheet	Of
Subject Outlier Evaluation of 14" MCC's				
		By R. V. Hester	Date 6/26/96	
Equip No.		Checked By R. [illegible]	Date 7/1/96	

The equipment class of Motor Control Centers(Equipment Class 1) includes MCC's which are typically 20 to 24 inches wide, 90 inches tall, and 18 to 24 inches deep, with a weight per section less than about 650 pounds[1].Oconee's Clark/AO Smith MCC's 1,2,3DCA and DCB, 1MVC2 and MVC3, 1,2,3XB, 2XE, 1,2XF, 1,2,3XI, 1,2,3XJ, 1XK, 1,2,3XL, 1,2,3XN, 1,2,3XS3, and 3XT Motor Control Centers which must be considered outliers since these cabinets are 14 inches deep[1]. 14 inch MCC cabinets bolted back-to-back are ~~also considered outliers but are~~ evaluated elsewhere in this calc. (See page 1224) 5

Rev. 5 By: R. [illegible] 10/13/98 ck: B [illegible] 10/21/98

The basis of the seismic adequacy of this class of equipment is the Summary of the Seismic Adequacy of Twenty Classes of Equipment Required for the Safe Shutdown of Nuclear Plants[2]. Ref 3 includes cabinet depths as low as 12 inches, and examined 160 examples subjected to 16 earthquakes. The examples were subjected to PGA's ranging from .20g to .60g. The only damage to a cabinet structure was failure of screws attaching the rear panel to each section in the case of the Fertimex Fertilizer Plant during the 1985 Mexico Earthquake. This was in the longitudinal direction and not a function of cabinet depth(Ref 3 Section 1).

The 14 inch deep MCC's included in the SSEL at Oconee are typical of a loaded cabinet 14 inches deep, 90 inches high and 20 inches wide, anchored by two 1/2" bolts, which was tested for Duke Power Company by the manufacturer, A O Smith Corporation, at their Exide Power Systems Division facility in Raleigh, NC[3]. The tests were conducted August 4 & 5, 1970. The Seismic Test Facility used consisted of a hydraulically driven suspension platform which displaced simultaneously horizontally and vertically resulting in a 45^0 (from horizontal or vertical) application of simulated seismic acceleration. Twenty tests were run, the first four explicitly for the observation of the structure and its mounting. The cabinet was subjected to a 1.2g maximum base acceleration at a frequency of 2 Hz, a 2g maximum base acceleration at 20 Hz, and a 1.96 g maximum base acceleration in a sine sweep of 2 to 20 Hz. There was no evidence of structural failure, chipping, or loosening of parts. Subsequent testing of electrical components contained in the cabinets subjected the structure to 6g maximum base acceleration in a sweep of frequencies of 1 to 10 Hz without detrimental effects.

Cabinets anchored by welds to embedded steel will have natural frequencies different from the test cabinet. However, the sine sweep test from 2 to 20 Hz ensures the cabinet experienced its maximum dynamic respose to the 1.96 g base acceleration while anchored with bolts. No other anchorage type or arrangement can produce a more severe dynamic loading. The 1.96 g base acceleration corresponds to and envelopes the ZPA at any given cabinet location. The only concerns are whether the anchorage and load path are adequate which are addressed in the anchorage evaluations and SEWS for each cabinet.

OSC-6040 Duke Power Company FOR INFORMATION

Station Oconee Unit 2 Rev. ____ File No. ____ Sheet ____ Of ____

Subject Outlier Evaluation of 14" MCC's

By R. V. Hester Date 6/26/96

Equip No. ____ Checked By R [illegible] Date 7/1/96

While the testing was not in accordance with IEEE-344 1971 or 1975, IEEE-344 1975 permits sine sweep testing and notes that for this type of test "maximum response is obtained separately at every frequency in the test range"[4] .

The natural frequency of these cabinets and the structures in which they are mounted is estimated to be within the range of testing, and the maximum floor spectra ZPA is .24g[5] .

Therfore it is concluded that the seismic testing which was performed is adequate to demonstrate a seismic capacity of 14 inch deep MCC's far exceeeding demand for the Oconee A-46 program. Anchorage for each MCC is evaluated separately on an individual basis.

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[1] GIP page B.1-2
[2] EPRI NP-7149-D
[3] OM-308-0372-001
[4] IEEE-344 1971 & 1975
[5] OSS-027B.00-00-0002