July 26, 2000

Mr. David A. Christian
Senior Vice President - Nuclear
Virginia Electric and Power Company
5000 Dominion Blvd.
Glen Allen, Virginia 23060

SUBJECT: SURRY POWER STATION, UNITS 1 AND 2 - REVIEW OF SEISMIC ADEQUACY OF MECHANICAL AND ELECTRICAL EQUIPMENT, GENERIC LETTER (GL) 87-02 AND UNRESOLVED SAFETY ISSUE (USI) A-46 (TAC NOS. M69484 AND M69485)

Dear Mr. Christian:

The purpose of this letter is to provide the results of our evaluation of your response to GL 87-02 and USI A-46 related to seismic adequacy of mechanical and electrical equipment for Surry Power Station, Units 1 and 2. The NRC staff concludes that you have adequately addressed these issues, and we have closed our review activities.

In documents dated February 1987, February 14, 1992, November 20, 1992, and September 11, 1999, NRC staff identified a generic concern with seismic adequacy of mechanical and electrical equipment (GL 87-02 and USI A-46) and corresponded with you regarding resolution of the concern. You established a USI A-46 program in response to GL 87-02, which was associated with a 10 CFR 50.54(f) letter. In letters dated September 18, 1992, November 26, 1997, and January 5, 1999, you provided information responsive to GL 87-02 and USI A-46. Subsequent to the completion of our formal review activities, you submitted a letter dated February 4, 2000, which stated that the resolution of outliers is now complete.

We have reviewed your evaluation, corrective actions, and completed physical modifications for resolution of outliers and determined that this will result in safety enhancements which, in certain aspects, are beyond the original licensing basis, and as a result, provide sufficient basis to close our USI-A46 review at Surry. Your USI A-46 program has, in general, met the purpose and intent of our criteria for the resolution of USI A-46. We also conclude that your USI A-46 program has adequately addressed the purpose of our earlier 10 CFR 50.54(f) request.

We have completed our review activities and are closing TAC Nos. M69484 and M69485. Your activities related to the USI A-46 implementation may be inspected at a future time.

Sincerely,

/RA/

Gordon E. Edison, Senior Project Manager, Section 1
Project Directorate II
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-280 and 50-281

Enclosure: Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

EVALUATION OF VIRGINIA ELECTRIC AND POWER COMPANY

RESPONSE TO SUPPLEMENT NO. 1

TO GENERIC LETTER 87-02

SURRY UNITS 1 AND 2

DOCKET NOS. 50-280 AND 50-281

1.0 BACKGROUND

In December 1980, the NRC designated "Seismic Qualification of Equipment in Operating Plants" as Unresolved Safety Issue (USI) A-46. The safety issue of concern was that equipment in nuclear plants for which construction permit applications had been docketed before about 1972 had not been reviewed according to the 1980-81 licensing criteria for the seismic qualification of equipment, such as Regulatory Guide 1.100 (Reference 1), IEEE Standard 344-1975 (Reference 2), and Section 3.10 of the Standard Review Plan (NUREG 0800, July 1981) (Reference 3). To address USI A-46, affected utilities formed the Seismic Qualification Utility Group (SQUG) in 1982.

The NRC staff issued Generic Letter (GL) 87-02 in February 1987 (Reference 4) to provide guidance for the resolution of USI A-46. It concluded that the seismic adequacy of certain equipment in operating nuclear power plants should be reviewed against seismic criteria not in use when these plants were being constructed. In 1987, SQUG, representing its member utilities, committed to develop a Generic Implementation Procedure (GIP) for implementing the resolution of USI A-46. SQUG requested a deferment of the 60-day response period, as requested in GL 87-02, until after the NRC issues its final safety evaluation report (SER) on the final version of the GIP.

On May 22, 1992, the staff issued Supplement No. 1 to GL 87-02, which transmitted its final SER (SSER No. 2, Reference 5) on the then final version of GIP (GIP Revision 2, as corrected on February 14, 1992, or simply GIP-2, Reference 6). In the supplement to GL 87-02, the staff requested that USI A-46 licensees who are members of SQUG either provide a commitment to use both the SQUG commitments and the implementation guidance described in GIP-2, as supplemented by the staff's SSER No. 2, or else provide an alternative method for responding to GL 87-02. In a letter dated September 18, 1992 (Reference 7), the Virginia Electric and Power Company (VEPCO), the licensee for Surry 1 and 2 and a member of SQUG, committed to the implementation of GIP-2 for resolving USI A-46 at the Surry plant. The NRC subsequently approved the licensee’s approach and schedule in a letter dated November 20, 1992 (Reference 8).

By letter dated November 26, 1997 (Reference 9), the licensee submitted a report summarizing the results of its USI A-46 implementation program, in accordance with the commitments made in its 120-day response (Reference 7) to NRC's SSER-2 on GL 87-02 (Reference 5). The staff reviewed the report and issued a request for additional information (RAI) on September 11, 1998 (Reference 10). The licensee subsequently submitted its response to the RAI in a letter dated January 5, 1999 (Reference 11). A teleconference between NRC staff and VEPCO was subsequently held on September 15, 1999. In this teleconference, the licensee provided the staff with the latest status of outlier resolution. This report provides the staff evaluation of the licensee's USI A-46 implementation program based on the staff's review of the summary report, supplemental information, and clarification provided by the licensee in its response to the staff's RAI.

2.0 DISCUSSION AND EVALUATION

The staff's review of the Surry USI A-46 summary report (Reference 9) consisted of a screening-level review of specific sections of the licensee's program, with emphasis placed on identification and resolution of outliers, i.e., equipment items which did not readily pass GIP-2 screening and evaluation criteria. The report identifies a safe shutdown equipment list (SSEL) and contains the screening verification and walkdown of mechanical and electrical equipment. The report also contains relay evaluations and the evaluation of the seismic adequacy for tanks and heat exchangers, cable and conduit raceways, and the identification and resolution of outliers, including the proposed resolution schedule.

2.1 Seismic Demand Determination (Ground Spectra and In-structure Response Spectra)

The licensee stated, in Reference 9, that the design-basis earthquake (DBE) was a modified Housner spectral shape with a peak horizontal ground acceleration of 15% of gravity. In the frequency range between 0.3 Hz and 2 Hz, the Housner's average spectrum was normalized to a maximum ground velocity of about 9 in/sec, and for frequencies higher than about 2 Hz, the Housner spectral shape is unchanged. The vertical component of motion is taken as two-thirds of the horizontal ground motion. Dynamic analyses using the Taft recorded time history of the Kern County earthquake as input ground motion were performed in 1971 for the containment and other structures, modeled as a coupled, lumped-mass soil-structure assemblies. The resulting in-structure response spectra (IRS) were peak broadened plus/minus 50%. In 1979, IRS were developed for the Updated Final Safety Analysis Report (UFSAR) DBE, with structures modeled by three dimensional multi-degree-of-freedom lumped mass representations and peak broadened by plus/minus 15%. However, IRS at 3% and 5% damping were not obtained for the service building, emergency diesel generator enclosure, safeguard building, and containment spray pump house in the 1979 analyses. Therefore, the licensee performed another analysis in 1992 to obtain these IRS. The 1992 analyses used synthetic time histories as free field ground motions, with the spectra at 5% damping closely matching the corresponding UFSAR horizontal and vertical spectra for Surry. Soil and structures were modeled in detail. Peak broadening of plus/minus 15% was used for the IRS. These IRS were considered as conservative design response spectra (Reference 8).

The staff has previously evaluated the seismic input motions and the method for developing the IRS and found them acceptable, as documented in Reference 8. Based on the above, the staff finds that the licensee's determination of seismic demand is adequate for the resolution of USI A-46.

2.2 Seismic Evaluation Personnel

The screening verification, walkdown, and outlier identification were performed by a seismic review team (SRT) comprised of seismic capability engineers as defined in GIP-2. GIP-2 describes the responsibilities and qualifications of the individuals who will implement this generic procedure. For a complete resolution of the USI A-46 issue, the seismic evaluation personnel should include individuals with sufficient expertise to identify the safe shutdown equipment, perform the plant walkdowns, verify the seismic adequacy of equipment and cable/conduit raceway systems, and perform the relay screening and evaluation. This involves a number of plant and engineering disciplines including structural, mechanical, electrical, system, earthquake, and plant operations. Based on the information provided in Appendix C and Appendix E to the seismic evaluation report, the staff concludes that the qualifications of the individuals responsible for implementing the resolution of the USI A-46, including the third party reviewers, meet the criteria of GIP-2 and the staff's SSER No. 2, and are, therefore, acceptable.

2.3 Safe Shutdown Path

GL 87-02 specifies that the licensees should be able to bring the plant to, and maintain it in, a hot shutdown condition during the first 72 hours following a safe shutdown earthquake (SSE). To meet this provision, the licensee addressed, in its submittal of November 26, 1997 (Reference 9), the following plant safety functions: reactor reactivity control, pressure control, inventory control, and decay heat removal. The licensee identified primary and alternate safe shutdown success paths with their support systems and instrumentation for each of these safety functions to ensure that the plant is capable of being brought to, and maintained in, a hot shutdown condition for 72 hours following an SSE. The licensee provided the safe shutdown paths in Figures 2-1 through Figures 2-4 of Appendix A to Reference 9. They also provided the SSEL in Appendix A.

The reactor decay heat removal function is accomplished in two stages by secondary heat removal. The first stage of secondary heat removal would be accomplished by relieving steam from the steam generators (SGs) to the atmosphere through the steam dump valves, which are throttled open to admit steam to the condenser. The steam would be released to the atmosphere through a condenser rupture disc. In the event of a failure of steam dump valves due to the loss of condenser vacuum, the steam would be discharged to the atmosphere through the code safety valves, which have staggered setpoints. Makeup water to the SGs would be supplied by the auxiliary feedwater system (AFW), which takes suction from the emergency condensate storage tank (ECST). The ECST can provide sufficient inventory to maintain a hot shutdown condition. Another water source which can be used for makeup water to the SGs is the condensate storage tank (CST). If the CST is not available, then the fire main can be aligned to the suction of the AFW pumps. The second stage of secondary heat removal would be accomplished by the operation of the residual heat removal (RHR) system when the reactor coolant system pressure and temperature are below the RHR entry limits. In this method, decay heat is removed from the reactor coolant to the component cooling water (CCW) system via the RHR heat exchangers. The heat from the CCW is then rejected to the service water system via the CCW heat exchangers.

The plant operations department reviewed the equipment listed in Appendix A against the plant

operating procedures and operator training and concluded that the plant operating procedures and operator training were adequate to establish and maintain the plant in a safe shutdown condition following an SSE.

The staff concludes that the approach to achieve and maintain a safe shutdown for 72 hours following a seismic event is acceptable.

2.4 Seismic Screening Verification and Walkdown of Mechanical and Electrical Equipment

The staff's evaluation focused primarily on the licensee's identification and resolution of equipment outliers, i.e., equipment items which do not comply with all of the screening guidelines provided in GIP-2. GIP-2 screening guidelines are intended to be used as a generic basis for evaluating the seismic adequacy of equipment. If an item of equipment fails to pass these generic screens, it should be declared an outlier. However, outliers may still be shown to be adequate by additional evaluations.

2.4.1 Equipment Seismic Capacity Compared to Seismic Demand

The licensee stated in Reference 9 that the GIP-2 method A was not used for any item of equipment in the A-46 program. The licensee, instead, used two other methods of GIP-2 to verify the seismic capacity of the SSEL equipment. The first method, which was used more extensively, is comparing the amplified bounding spectrum (ABS), which equals 1.5 times the bounding spectrum, with the conservative design, in-structure SSE response spectrum (CRS) at 5% damping. The licensee stated in Reference 9 that for all buildings and elevations where SSEL equipment is located, the ABS enveloped the CRS, with the exception of a slight exceedance near 2 Hz in a very narrow frequency range, for the turbine building (TB). In Reference 11, the licensee provided graphs for ABS and CRS where SSEL equipment items are located. The staff reviewed these graphs, and found that the ABS enveloped the CRS by a significant amplitude over the entire frequency range except near 2 Hz at elevation 62 ft. of the main steam valve house and at elevation 64 ft. of the TB, where the CRS exceeds the ABS by a maximum of 15%. The staff considers this exceedance to be insignificant. On this basis, the staff concurred with the licensee that the SSEL equipment evaluated based on this methodology meets the intent of GIP-2, and, therefore, is seismically adequate. The second method used by the licensee is to compare the CRS to the equipment seismic capacity available in existing seismic qualification documents. The licensee stated that many equipment components, especially those which were installed after 1980, have been qualified to IEEE Standard 344-1975. For these equipment components, the existing documents were used to determine the seismic capacity. In limited cases, other available test data or analysis documents were also used to determine the equipment seismic capacity. Although the second method is not included in GIP-2, the staff finds it acceptable.

The staff found that the licensee used the provisions of GIP-2, or methods that were developed more recently and were considered to be more conservative. Based on the above, the staff finds the licensee’s evaluation to be adequate for the resolution of USI A-46 at Surry.

2.4.2 Assessment of Equipment Caveats

As a second screening guideline, the licensee verified the seismic adequacy of an item of mechanical or electrical equipment by confirming that (1) the equipment characteristics are generally similar to the earthquake experience equipment class or the generic seismic testing equipment class, and (2) the equipment meets the intent of the specific caveats for the equipment class. This review is necessary only when the bounding spectrum, ABS, or the general equipment ruggedness spectrum is used to represent the seismic capacity of equipment. If equipment-specific seismic qualification data is used instead, then only the specific restrictions applicable to that equipment-specific qualification data need be applied.

The “caveats” are defined as a set of inclusion and exclusion rules, which are established to represent specific characteristics and features particularly important for seismic adequacy of a particular class of equipment. Appendix B of GIP-2 contains a summary of the caveats for the earthquake experience equipment class and for the generic seismic testing equipment class.

Another aspect of verifying the seismic adequacy of equipment included within the scope of this procedure is explained by the "rule of the box" (ROB) criteria. For the equipment included in either the earthquake experience equipment class or seismic testing equipment class, all of the components mounted on or inside this equipment are considered to be part of that equipment and do not have to be evaluated separately. ROB components were inspected for mounting, seismic spatial interaction, and any special vulnerability.

The licensee identifies 20 unique equipment classes. Tanks and heat exchangers are classified as Class 21. Equipment that is on the SSEL, but not in any of these classes, is defined as Class “0" and is considered an outlier by definition. The plant walkdown for Surry indicated that the dampers, 1-VS-SAD-22A, 1-VS-SAD-22B, and 1-VS-SAD-22C, are Class “0" items of equipment that are not covered by GIP-2. These equipment items are, therefore, identified as outliers. The licensee indicated in its January 5, 1999, submittal, that this issue remains to be resolved. Subsequently, in the teleconference of September 15, 1999, the licensee indicated that guidelines provided by SQUG for this type of equipment have been reviewed, and the equipment was assessed to be adequate. The outliers are, therefore, resolved based on the licensee’s application of the GIP-2 methodology.

2.4.3 Equipment Anchorages

GIP-2 requires an inspection of the adequacy of anchorage installation and a determination of the adequacy of anchorage capacity. The licensee stated in Reference 9 that, during field inspections, the SRT focused on anchorage attributes, such as equipment characteristics, type, size and location of anchorage, concrete conditions, as well as spacing, edge distance and gap of anchors. The typical types of anchorage used for the SSEL equipment include concrete expansion anchor bolts, cast-in-place bolts, and welds to embedded steel, such as channels, angles, and Unistrut. The types of expansion anchor bolts observed were Hilti Kwik bolts, Philips Redhead self-drilling anchor bolts, and Maxi bolts. The SRT reviewed load paths, and when it could not conclude the adequacy of the load path during the field inspection, the SRT gathered the load path details for further analysis. The licensee also stated that a tightness check was performed for almost all accessible expansion bolts, and in almost all the

cases, the tightness of the expansion anchor bolts was adequate. This is documented on the

screening evaluation work sheets (SEWS). In some cases, a tug test, instead of a tightness check, was performed for lightweight components where the anchorage appeared robust. Existing calculations were used to verify anchorage adequacy. If the existing calculations were used, the SRT ensured that anchorage configuration noted in the field was the same as analyzed and that appropriate seismic accelerations were used. If there was no existing calculation, an anchorage calculation was performed for all SSEL components with the exception of few cases where a tug test was performed or where anchorage was judged to be robust by the SRT. Information collected during the walkdowns as well as existing documents were used in the verification of the equipment anchorage. In the process of verification, the minimum embedment depth listed in Appendix C of GIP-2 was assumed for expansion anchor bolts. The actual embedment depths of bolts from the existing plant documents were found to be greater than those listed in the GIP-2. The licensee stated in Reference 9 that, in general, equipment anchorage was quite adequate, and that a few were modified or enhanced. Those that did not meet the GIP-2 screening criteria were classified as outliers and were designated for modification as appropriate.

The licensee has followed the GIP-2 procedures for verifying the anchorage adequacy. Therefore, the equipment anchorage evaluation is adequate for the resolution of USI A-46 at the Surry plant.

2.4.4 Seismic Spatial Interaction Evaluation

As a part of the screening provision for verifying the seismic adequacy of an item of mechanical or electrical equipment, the licensee addressed potential spatial interaction effects for the equipment in Section 6.5 of the seismic evaluation report. This serves to ensure that there is no adverse seismic spatial interaction between the equipment under consideration and nearby equipment, systems, and structures which could cause the equipment to fail to perform its intended safe shutdown function. The interactions of concern are (1) proximity effects, (2) structural failure and falling, and (3) flexibility of attached lines and cables. Guidelines for judging potential interaction effects, when verifying the seismic adequacy of equipment, are presented in Appendix D of GIP-2.

During the walkdowns, the SRTs reviewed the potential for seismic interaction with nearby equipment, systems, or structures. Using the guidelines of Section II.4.5 and Appendix D of GIP-2, the SRT documented on the SEWS) all credible and significant interaction concerns. If simple modifications were possible, station personnel were informed and corrections were made. Typically, deficiency cards or work requests were issued to correct these type of concerns.

The licensee identified seismic concerns that were not easily corrected as outliers. The licensee subsequently resolved these outliers by performing plant modifications. An example of this was connecting together adjacent electrical cabinets that contain essential relays. This is reflected in Table 11.2-1 of Reference 9, and later in the updated Table 11.2-1 of Reference 11.

The staff found that the licensee has followed the GIP-2 procedures for the evaluation of seismic spatial interaction and the implementation is, therefore, acceptable for the resolution of USI A-46 at Surry.

2.5 Tanks and Heat Exchangers

The licensee stated in Reference 9 that tanks and heat exchangers were reviewed in accordance with Section II-7 of the GIP-2 for the resolution of USI A-46, except for two component charging regenerative heat exchangers, which are located in a locked room, in the containment, due to high radiation. These two heat exchangers were evaluated through the videodisc information management system and existing documents. A total of 105 Class 21 components (tanks and heat exchangers) were identified in the SSEL. Field walkdowns and analyses were performed and outliers were identified. The licensee initially listed the outliers and their resolution in Section 11 of Reference 9, and later updated their resolution in Reference 11.

In the resolution of three types of outlier tanks (charging pump seal cooling tanks, ECSTs, and refueling water storage tanks) in Reference 9, the licensee had used the methodology described in the IPEEE and/or EPRI report NP-6041. The staff requested that the licensee provide additional information and justifications for the methods it had used. The licensee provided the needed information and justifications in Reference 11. For the charging pump seal cooling tanks, the licensee revised the calculation to the GIP-2 methodology and found the results acceptable. For the ECSTs, the licensee stated that it initially performed the calculations in accordance with the GIP-2 methodology and found that the overturning capacity of the tank was unacceptable. A revised overturning capacity was found acceptable when it incorporated the fluid hold-down provision of the EPRI Report NP-6041. The staff considers the inclusion of the fluid hold-down provision to be realistic. For the refueling water storage tanks, the licensee stated that it performed the calculations in accordance with the GIP-2 methodology and found that the tanks met the GIP-2 criteria, with the exception of the freeboard height. The licensee stated that the sloshing force that acts on the roof is expected to be small, and therefore, the tanks are seismically adequate. This is based on the fact that the calculated sloshing height is small and that the seismic database has not indicated any failure of tank roofs. The licensee further stated that the ability of the tank to contain water will not be impaired after an earthquake even if the tank roof failed. The staff found the licensee's arguments reasonable.

In the resolution of two tank outliers (underground fuel oil storage tanks and emergency condensate make-up tanks), the only justification provided by the licensee in Reference 9 was that the buried tanks are not sensitive to seismic inertia effect. The staff did not consider the justification acceptable, and requested that the licensee provide sufficient technical bases to verify the adequacy of these tanks taking into account the effects of seismic wave passage and the resulting soil pressure. The licensee provided the technical bases in Reference 11. For the underground fuel oil storage tanks, the licensee performed a new analysis and found the tanks acceptable. For the emergency condensate make-up tanks, the licensee described the tanks and their restraint system in detail. The licensee stated that the tanks are heavy, stiff, and

half-embedded in the ground, and therefore, are strong and stable during an earthquake event. The staff found that the information, justifications, and technical bases provided by the licensee are reasonable and acceptable.

The licensee also stated in Reference 9 that for all Class 21 components, especially large flat-bottom and vertical tanks, they had verified that the attached piping had adequate flexibility to accommodate vessel displacements.

The staff reviewed the licensee's evaluation results and found them adequate for the resolution of USI A-46 at Surry.

2.6 Cable and Conduit Raceway Supports

The licensee stated that the raceway review was performed as specified in GIP-2, Section 8. Accordingly, the review consists of two parts: a plant walkdown, and an analytical check of some selected worst-case supports using a set of limited analytical review guidelines.

The licensee stated in Reference 9 that a seismic verification global walkdown was performed for all cable tray and conduit raceway support systems. The walkdown included the use of photographs and preparation of walkdown sketches. The walkdown addressed the inclusion rules, seismic performance concerns, and seismic interaction issues as identified in GIP-2, Section 8. The length of all unsupported spans between adjacent supports was verified to ensure that they did not exceed the limits set in GIP-2. Where the allowable length was exceeded, the licensee verified the structural integrity of the raceway system including the supports. In cases where conduit support spans were excessive and not acceptable based on analytical evaluation, the licensee installed additional supports. Based on walkdown results and drawing reviews, the licensee did not find conduit or cable tray supports with rigid boot-type connections and cast iron anchor embedments. The licensee found the cable tray and conduit supports to be well anchored, with their seismic capacity exceeding the seismic demand. No visible cracks were found in concrete at the location of anchorage. The licensee noted corrosion of conduit support clamps and conduits in some locations where general dampness exists, such as in the service water pump house and the auxiliary feedwater pump house. For these, work requests had been issued to remove the rust. Generally, the licensee did not observe excessive sag of conduit or cable trays. Where noticeable sag in conduits was found, additional supports were added to these conduits. The licensee revealed several broken and missing components of the conduit and cable tray and their supports, and the deficiencies were corrected. The licensee also evaluated the condition of a raceway system with broken or missing components, and determined, based on engineering judgment, that it did not constitute an operability concern. In cable trays that have vertical drops, the licensee found all cables to be adequately restrained. In most cases, the licensee found plastic-type cable ties to adequately connect cable to cable trays and the ties were in good condition and did not exhibit any deterioration. The licensee found the plastic cable ties broken at two places and they were replaced. One potential hard spot in the conduit run was noticed, and it was reviewed as part of the limited analytical review, which the licensee determined not to be a concern. No other hard spots were identified.

The licensee selected 22 worst-case raceway supports for the limited analytical review. These supports included a fixed-end rod hanger trapeze support, floor-to-ceiling supports, and base-mounted supports. In the limited analytical review, the licensee included ductile and non-ductile supports. The results of the review indicated that most supports met the three times dead load check. For those supports which could not meet the three times dead load check, the licensee

performed additional checks on the lateral load and redundancy, and found them acceptable. The licensee also performed fatigue evaluation on rod hung supports and the results indicated that they are acceptable.

The staff concludes that the licensee's evaluation of the cable and conduit raceways is adequate for the resolution of the USI A-46 program at Surry, as it meets the provisions of GIP-2.

2.7 Essential Relays

A review of relays associated with safe shutdown equipment is required as part of the resolution of the USI A-46 program. The purpose of the relay review is to determine if the plant's safe shutdown systems could be adversely affected by relay malfunction in the event of an SSE.

According to Appendix B of the seismic evaluation report (Reference 9), the licensee applied a methodology for evaluating the seismic functionality of relays that relies on a three part screening and evaluation process. The first part of the screening process identifies a set of plant systems that are required to function to maintain the plant in a safe shutdown condition during and immediately after an earthquake. This screening process resulted in a subset of plant systems and associated electrical relays which are considered essential to plant safety in an earthquake, and therefore, reduced the number of relays whose seismic functionality have to be demonstrated. As a result, the licensee screened out non-essential relays, e.g., those whose temporary malfunction (contact chatter or change of state) would not prevent safe shutdown of the plant or cause other unacceptable actions. The second part of the evaluation process utilizes system and circuit evaluations to further reduce the number of relays that are considered essential. The third part of the screening and evaluation process is to assess the seismic ruggedness of the essential relays.

The licensee further provided the details of the process of identifying and evaluating the relays essential to safely shut down Surry Units 1 and 2 in the event of an SSE, as follows:

1. Identify safe shutdown systems, including those specific components which must operate in order for the systems to meet their functional requirements, or whose malfunction could interfere with meeting system functional requirements. The relays which affect operation of this set of systems and associated components are the relays that must be evaluated.

2. Evaluate the relays/circuits that affect the safe shutdown system equipment. Screen from further consideration those relays, or complete circuits of relays, whose malfunction will not prevent system/component functionality or cause other unacceptable conditions. Checks were also made for generically rugged devices (solid state relays and mechanically actuated contacts) and for a small group of relays and

devices considered vulnerable to minor impact. Relays that could be screened through operator action are discussed in Section 2.8 of this Safety Evaluation. Those relays that the licensee could not screen out by the above evaluation are designated "essential" and required evaluation to determine if they have adequate seismic ruggedness for their specific application.

3. Evaluate the seismic adequacy of the essential relays by comparison of the specific

relay types and their seismic requirements (i.e, plant-specific seismic demand) with relay seismic ruggedness data.

4. Identify the need for corrective actions where screening and evaluations were unsuccessful.

5. Prepare evaluation documentation that provides a traceable record that all relays (including contact devices) or groups (i.e., circuits) of relays which affect the operation of the safe shutdown components have been examined.

For the Surry plant, all safe shutdown equipment relays are located lower than 40 feet above grade. In addition, most of the relays affecting safe shutdown equipment are common types and have moderate to high seismic capacity for the configurations and modes used. The cabinets housing the relays are generally standard types. This combination of plant and relay features resulted in only three relays requiring corrective action. The licensee determined the other relays affecting Surry safe shutdown equipment to be satisfactory because of adequate seismic capacity, chatter acceptability, inherent ruggedness, or operator action. Evaluation of operator action is discussed in Section 2.8 of this Safety Evaluation.

In accordance with the relay evaluation guidelines of GIP-2, walkdowns were performed by the relay review team and subsequently by the SRT. The walkdowns verified the seismic adequacy of the cabinets, and included spot checking of relays for appropriate mounting and verification of the relay types and locations within the cabinets. Nothing was discovered by the relay review team or the SRT that would indicate inappropriate relay mounting, with the exception of two outliers: one W-BFD relay was found hanging by one clip; and two screws in Agastat relay 2-1 MV in relay rack (2-EE-MRR-1) were missing. The licensee corrected these mounting deficiencies as stated in Section 11.1.3 of the Seismic Evaluation Report.

Cabinets containing essential relays were evaluated in accordance with the GIP-2 guidelines. The relay evaluation concluded that those essential relays that were not screened out have peak and ZPA capacities after accounting for in-cabinet amplification higher than their corresponding seismic demand. One outlier identified was the Westinghouse SV relay model in the emergency diesel generator (EDG) control panels, which is a low ruggedness relay. The licensee indicated in its January 5, 1999, submittal that the relay had been replaced by a seismically qualified Wilmar relay in cabinet 2-AP-CC-35-2 (EDG No. 2). The SV relay in cabinet 1-AP-CC-35-1 (EDG No. 1) was not yet replaced at the time. In the teleconference of September 15, 1999, the licensee indicated that the required physical modification has since been completed, and the outlier is resolved.

In addition to the above issues, the licensee found several cabinets containing essential relays which were not connected to the adjacent cabinets. This has a potential for causing relay chatter due to side-to-side impact. The licensee indicated in Reference 11 that most of these cabinets have now been connected together. A few remaining cabinets have since been connected based on the latest status of outlier resolution provided by the licensee in the teleconference of September 15, 1999.

Based on the above, the staff finds the licensee's relay evaluation to be acceptable.

2.8 Human Factors Aspects

GIP-2 described the use of operator action as a means of accomplishing those activities required to achieve safe shutdown. Section 3.2.7, "Operator Action Permitted," states, in part, that timely operator action is permitted as a means of achieving and maintaining a safe shutdown condition provided procedures are available and the operators are trained in their use. Additionally, Section 3.2.6, "Single Equipment Failure," states that manual operator action of equipment which is normally power operated is permitted as a backup operation provided that sufficient manpower, time, and procedures are available. Section 3.2.8, "Procedures," states, in part, that procedures should be in place for operating the selected equipment for safe shutdown and operators should be trained in their use. It is not necessary to develop new procedures specifically for compliance with the USI A-46 program.

In Section 3.7, "Operations Department Review of SSEL," of GIP-2, SQUG also described three methods for accomplishing the operations department reviews of the SSEL against the plant operating procedures. Licensees were to decide which method or combination of methods were to be used for their plant-specific reviews. These methods included:

1. A "desk-top" review of applicable normal and emergency operating procedures.

2. Use of a simulator to model the expected transient.

3. Performing a limited control room and local in-plant walk-down of actions required by plant procedures.

The staff's evaluation of the SQUG approach for the identification and evaluation of the SSEL, including the use of operator actions, was provided in Section 11.3 of the staff's SSER on GIP-2. The evaluation concluded that the SQUG approach is acceptable.

The staff's review focused on verifying that the licensee had used one or more of the GIP-2 methods for conducting the operations department review of the SSEL, and had considered aspects of human performance in determining what operator actions could be used to achieve and maintain safe shutdown (e.g., resetting relays, manual operation of plant equipment).

The licensee provided information which outlined the use of the "desk-top" and local in-plant walkdown methods by the operations department to verify that existing normal, abnormal and emergency operating procedures are adequate to mitigate the postulated transient and that operators could place and maintain the plant in a safe shutdown condition. The licensee

determined that the systems and equipment selected for seismic review in the USI A-46 program are those for which normal, abnormal, and emergency operating procedures are available to bring the plant from a normal operating mode to a cold shutdown condition. The shutdown paths selected were reviewed by the Surry operations staff and they determined that the procedures would provide adequate guidance to the operators in response to a seismic event. The licensee provided assurance that ample time existed for operators to take the required actions to safely shut down the plant. This had been accomplished during validation of

the pertinent plant operating procedures during the Appendix R fire protection evaluations and A-46 in-plant walkdown reviews.

The staff verified that the licensee had considered its operator training programs and verified that its training was sufficient to ensure that those actions specified in the procedures could be accomplished by the operating crews. The operations department verified that all actions necessary to safely shut down the plant were included in existing normal, abnormal, and emergency operating procedures. The licensee verified that the only additional operator actions, beyond those associated with the Appendix R scenarios that must be performed to bring the plant from a normal operating mode to a cold shutdown condition, are those specifically associated with the vibratory motion of the SSE. The specific areas where operator actions might be required included:

1. Operator action may be required to re-open the main steam non-return valves if the valves close due to postulated relay chatter.

2. Operator action may be required to reset a tripped chiller unit.

3. Operator action may be required to manually start the diesel engines for the emergency service water pumps after 30 minutes following the seismic event.

The specific actions associated with these issues were reviewed by the operations department during the relay screening process and in-plant review to ensure that the actions could be performed in the required amount of time with normally available resources. The results of the review of these operator actions by the operations department verified that each of the actions was adequately covered by procedural guidance, and that adequate resources, including time, were available to take such actions.

In addition, the staff requested verification that the licensee had adequately evaluated potential challenges to operators, such as lost or diminished lighting, harsh environmental conditions, potential for damaged equipment interfering with the operators tasks, and the potential for placing an operator in unfamiliar or inhospitable surroundings. The licensee provided information to substantiate that potential challenges to the operator were explicitly reviewed during validation of the pertinent plant operating procedures related to the licensee’s Appendix R fire protection evaluations, and as part of the USI A-46 in-plant walkdown reviews. In addition, the licensee explicitly evaluated the potential for local failure of architectural features and the potential for adverse spatial interactions in the vicinity of safe shutdown equipment where local operator action may be required as part of the GIP-2 process.

As a result of the review, a potential control room interaction source was identified associated with the suspended ceiling light diffuser panels. The licensee stated that the issue is scheduled for evaluation/modification by the end of the second unit refueling outage from the time of the A-46 summary report submittal, currently scheduled for September 2000. The licensee performed seismic interaction reviews that eliminated any concerns with the plant components and structures located in the immediate vicinity of the components that had to be manipulated. Therefore, the potential for physical barriers resulting from equipment or structural earthquake

damage that could inhibit operator ability to access plant equipment was considered and eliminated as a potential barrier to successful operator performance.

The licensee has provided the staff with sufficient information to demonstrate conformance with the NRC-approved review methodology outlined in the GIP-2 and is, therefore, acceptable for resolution of USI A-46 at Surry.

2.9 Outlier Identification and Resolution

An outlier is defined as an item of equipment that does not meet GIP-2 screening guidelines. An outlier may be shown to be adequate for seismic loadings by performing an additional evaluation using alternate methods or seismic qualification techniques acceptable to the staff. Based on the screening criteria stated in Section 2.4, a number of equipment items were identified by the SRT as outliers during the walkdowns. A list of outstanding outliers for mechanical/electrical equipment and essential relays, together with their description, was first provided in Table 11.2-1 of the Seismic Evaluation Report (Reference 9).

In Reference 11, the licensee provided an updated Table 11.2-1, which details the resolution status of outliers for mechanical/electrical equipment and essential relays. Of the 14 items (related to 35 components) that were unresolved at the time of the November 26, 1997, submittal (Reference 9), 7 were completely resolved and 7 were in progress or remained to be addressed. During the teleconference on September 15, 1999, the licensee provided the current status of those remaining outliers. The licensee stated that only three outliers now remain to be resolved. These are related to control room ceiling panels, fuel oil level indicator sight tube, and some housekeeping issues (Items 12 through 14, in Table 11.2-1, Reference 11).

As for the status of cable and conduit raceway system outliers, the licensee stated in Reference 11 that several conduit covers were missing in the cable vault and tunnel area and in the service building and turbine building. Some anchor bolts were missing in base plate supports for conduits in the turbine building. To resolve these deficiencies, work requests were issued to the Station. Approximately half of these deficiencies have been corrected and verified as of January 5, 1999. During the above teleconference, the licensee also indicated that, to date, only six minor items, which involve mostly replacing condulet covers, remain to be addressed. The licensee stated in Reference 11 that a verification will be performed upon completion of the work to ensure that the deficiencies are satisfactorily resolved.

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

The licensee indicated in Reference 9 that all the identified outlier issues for Surry 1 and 2 are not considered to be significant, and none of the outliers is considered to be a safety concern. The licensee contends that its schedule commitment for resolving the remaining unresolved outliers will not lead to a potential impact on plant safety. Based on the above rationale, the staff found the licensee's schedule for outlier resolution acceptable.

The peer review report for the Surry A-46 program is provided in Appendix C to the Seismic

Evaluation Report. Dr. Robert P. Kennedy, the peer reviewer, preselected about 12% of the items from the Surry Unit 1 and Unit 2 USI A-46 SSELs representing all classes of equipment. Approximately 150 components were walked down. Among them, approximately 30 electrical and instrumentation & control equipment items, and motor control centers were opened to inspect anchorages and internals. The peer reviewer also reviewed SEWS and a few anchorage calculations.

Based on his review, the peer reviewer concluded that the SRTs conducted the walkdowns in a thorough manner. The peer reviewer has identified in its report a few minor exceptions, which were partly due to the fact that the peer review walkdown was conducted before all the Surry USI A-46 work was completed. The intent of walkdown timing by the peer reviewer was to ensure that any deficiencies identified by the peer reviewer could be corrected before the SRTs completed their work. In its response to the staff's RAI (Reference 10), the licensee stated in Reference 11 that each of the concerns noted in the peer reviewer's report has since been reviewed and dispositioned. In many cases, a subsequent walkdown, evaluation or analysis was performed to satisfactorily resolve the issues.

The licensee stated that the major peer review issues that remained open, as of the time of November 27, 1997, submittal, were listed together with the rest of outliers in Table 11.2-1 of the Seismic Evaluation Report. The licensee also stated in Reference 11 that some of the issues, such as the tightness of the nuts for the bolts connecting transformer coils to base channel, have been resolved since the transmittal of Reference 9. Resolution of other issues, such as control room ceiling diffuser panels, gaps between battery cells, and housekeeping issues, were either in progress or yet to be addressed. As stated previously, all the outstanding issues and installation deficiencies will be resolved no later than the end of the Surry Unit 2 outage, scheduled to commence in September 2000. This is acceptable to the staff.

In Section 10 of the Seismic Evaluation Report, the licensee indicated that the seismic margin assessment methodology, including the high-confidence-of-low-probability of failure capacity, as described in the EPRI report, NP-6041 (Reference 12), was used to verify the seismic adequacy of some equipment items, including tanks and heat exchangers. The staff had indicated in its RAI of September 11, 1998 (Reference 10), that the methodology may yield analytical results that are not as conservative as those obtained by following GIP-2 guidelines. Because of the uncertainty of its conservatism, the methodology has not been endorsed by the staff for the analysis of safety-related systems and components, including the resolution of mechanical, electrical, and structural component outliers in the USI A-46 program. The licensee responded in its January 5, 1999, submittal (Reference 11), that for the vast majority of components, especially for large components, explicit calculations in accordance with the GIP-2 methodology were performed during the USI A-46 implementation. The only exceptions are for the evaluation of charging pump seal cooling surge tanks, ECSTs, and the refueling

water storage tanks, which as discussed in Section 2.5, were found to be justifiable. Other than these three tanks, no element of EPRI Report NP-6041 was used to verify the seismic adequacy of an USI A-46 equipment item. The licensee stated that, for the resolution of the remaining outstanding outliers, only evaluation methodologies that are acceptable to the staff will be used. The staff found the licensee's response to be acceptable.

3.0 SUMMARY OF MAJOR STAFF FINDINGS

Based on the information provided by the licensee, the staff found that the licensee's USI A-46

program has, in general, followed GIP-2 guidelines, and that no programmatic or significant deviations from the guidelines were made during the USI A-46 resolution process at Surry 1 and 2. As stated in Section 2.9, the licensee has adequately resolved all the identified outliers, with the exception of three items, which are listed as Items 12 through 14 in the revised Table 11.2-1 (Reference 11). The licensee stated that their complete resolution will be achieved prior to the end of the Surry Unit 2 refueling outage, scheduled to commence in September 2000.

4.0 CONCLUSIONS

In general, the licensee conducted the USI A-46 implementation in accordance with GIP-2. The licensee's USI A-46 implementation program did not identify any instance where the operability of a particular system or component was called into question. The staff's review of the licensee's implementation program did not reveal any significant findings that would suggest inadequacy of the licensee's USI A-46 program in light of the GIP-2 guidelines.

The staff concludes that the licensee's USI A-46 implementation program has, in general, met the purpose and intent of the criteria in GIP-2 and the staff's SSER No. 2 for the resolution of USI A-46. The staff has determined that the licensee's already completed actions will result in safety enhancements which, in certain aspects, are beyond the original licensing basis. As a result, the licensee's actions provide sufficient basis to close the USI A-46 review at the facility. The staff also concludes that the licensee's implementation program to resolve USI A-46 at the facility has adequately addressed the purpose of the 10 CFR 50.54(f) request. Licensee activities related to the USI A-46 implementation may be subject to NRC inspection.

Regarding future use of GIP-2 in licensing activities, the licensee may revise its licensing basis in accordance with the guidance in Section I.2.3 of the staff's SSER No. 2 on SQUG/GIP-2, and the staff's letter to SQUG's Chairman, Neil Smith, on June 19, 1998 (Reference 13). It should be noted that the primary consideration in the staff's determination to permit the licensee to incorporate GIP-2 in the licensing basis is the licensee's completion of all the identified outliers, in accordance with the GIP-2 requirements. Where plants have specific commitments in the licensing basis with respect to seismic qualification, these commitments should be carefully considered. The overall cumulative effect of the incorporation of the GIP-2 methodology, considered as a whole, should be assessed in making a determination under 10 CFR 50.59. An overall conclusion that no unresolved safety questions (USQ) is involved is acceptable so long as any changes in specific commitments in the licensing basis have been thoroughly evaluated in reaching the overall conclusion. If the overall cumulative assessment leads a licensee to conclude a USQ is involved, incorporation of the GIP-2 methodology into the licensing basis would require the licensee to seek an amendment under the provisions of 10 CFR 50.90.

5.0 REFERENCES

1. Regulatory Guide 1.100, "Seismic Qualification of Electric and Mechanical Equipment for Nuclear Power Plants," Revision 2, 1977

2. IEEE Standard 344-1975, "IEEE Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations," dated January 31, 1975

3. NRC SRP (NUREG-0800), Section 3.10, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment," Revision 2, July 1981

4. NRC GL 87-02, “Verification of Seismic Adequacy of Mechanical and Electrical Equipment in Operating Reactors, Unresolved Safety Issue (USI) A-46,” February 1987

5. NRC “Supplemental Safety Evaluation Report No. 2 on Seismic Qualification Utility Group’s Generic Implementation Procedure,” Revision 2, corrected February 14, 1992

6. ”Generic Implementation Procedure (GIP) for Seismic Verification of Nuclear Power Plant Equipment,” Revision 2, corrected February 14, 1992, Seismic Qualification Utility Group

7. Letter, VEPCO to Document Control Desk (NRC), “Response to Supplement 1 to Generic Letter 87-02, SQUG Resolution of USI A-46,” dated September 18, 1992

8. Letter, NRC to VEPCO, “Safety Evaluation of NAPS Units 1 and 2, SPS Units 1 and 2, 120-Day Response to Supplement No. 1 to Generic Letter 87-02,” dated November 20, 1992

9. Letter, VEPCO to Document Control Desk (NRC), “Surry Power Station, Units 1 and 2, Summary Report for Resolution of Unresolved Safety Issue (USI) A-46,” dated November 26, 1997

10. Letter, NRC to VEPCO, dated September 11, 1999

11. Letter, VEPCO to Document Control Desk (NRC), dated January 5, 1999

12. EPRI Report NP-6041-SL, “A Methodology for Assessment of Nuclear Power Plant Seismic Margin (Revision 1),” dated August 1991

13. Letter, B. W. Sheron (NRC) to Neil Smith (SQUG), dated June 19, 1998

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