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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

REGARDING RESOLUTION OF IEB 79-14 INSPECTION ISSUES

SOUTH CAROLINA ELECTRIC & GAS COMPANY

VIRGIL C. SUMMER NUCLEAR STATION, UNIT NO. 1

DOCKET NO. 50-395

INTRODUCTION

Inspection and Enforcement Bulletin (IEB) 79-14, "Seismic Analysis for As-Built Safety-Related Piping Systems," was issued on July 2, 1979, to ensure conformance between the as-built safety-related piping configurations and the associated seismic analyses. The bulletin was revised on July 18, 1979, and subsequently supplemented on August 15, and September 7, 1979.

As a result of inspections recently conducted at various facilities, the Nuclear Regulatory Commission (NRC) staff had indications that the actions requested by IEB 79-14 may not have been properly completed by some licensees. Consequently, the NRC staff decided to review, on a sampling basis, implementation of this bulletin by selected plants. The Virgil C. Summer Nuclear Station, Unit No. 1 (V. C. Summer), was the second plant selected for this review. The inspection took place on November 27 through December 1, 1989, and then December 11 through 15, 1989.

South Carolina Electric and Gas Company (SCE&G), the licensee, addressed IEB 79-14 by contracting with Gilbert/Commonwealth, Incorporated (G/C) to perform the technical work required to address this bulletin. G/C was also the original architect-engineer for V. C. Summer. SCE&G subsequently contracted with Impell and Teledyne Engineering Service (TES) to assist G/C.

As a result of the inspection, a number of deficiencies were identified by the NRC inspection team; some were considered significant while others will considered minor. Among those significant deficiencies, four were considered to be generic and required follow-up detailed evaluation. These four generic issues are:

1. Zero Period Acceleration (ZPA): TES did not consider it while both G/C and Impell did;

2. Seismic Anchor Movements (SAMs): Directional responses of SAMs for adjacent structures were combined by the root-sum-square (RSS) method as opposed to the absolute sum method. Also, the 1/8 inch absolute displacement criteria between adjacent buildings may be non-conservative;

3. Containment Growth: Containment penetration movements were not considered in the piping analyses for the effects of post-accident pressurization or steady state thermal growth; and

4. Decoupling Ratio: A decoupling ratio of 15% was used as a criteria, as opposed to 6%, for determining whether some branch lines and instrument connections would be modeled with run pipes in piping analyses.

The staff has reviewed the licensee's submittal of June 29, 1990, which addressed the above issues. Our evaluation is presented in the following sections.

EVALUATION

1. Zero Period Acceleration

The licensee stated that V. C. Summer had no requirement for the inclusion of ZPA in any piping analysis problems. G/C's and Impell's modeling techniques automatically included ZPA, while TES's modeling technique did not. The analyses performed by G/C and Impell had additional conservatism beyond that required by the original design basis. Bounding analyses were performed on the TES analyses to demonstrate acceptable results with the effects of ZPA included as described in the following.

Of the total piping analysis scope, TES performed 33 analyses for which ZPA was not considered. Those analyses, and thus the rigid piping/support subsystems most susceptible to the effects of ZPA, were identified based on the lowest mass participation (0 to 33 HZ) associated with the largest corresponding ZPA values. Of the 33 subsystems analyzed by TES, EF-02 and RC-03C were selected as the two most susceptible to the effects of ZPA.

The licensee performed the analyses for the two identified worst-case subsystems to account for the effects of ZPA. The approach of screening for the larger of seismic inertia and ZPA was used. The analyses resulted in some support load and pipe stress increases. However, calculations performed have demonstrated that sufficient margin exists to accommodate these increases.

Also, the original analysis for IEB 79-14 performed by TES has inherent conservatisms due to the method used by G/C in developing the response spectra curves. A damping value of 2% was used for operating basis earthquake (OBE) and the resulting response spectra was scaled up for safe

shutdown earthquake (SSE). Regulatory Guide 1.61 allows the use of damping values of 4% and 7% for OBE and SSE, respectively, for reinforced concrete structures. Using curves based on 2% structural damping provides for additional conservatism in pipe stresses and support reactions.

Based on the results from the two bounding analyses and the inherent conservatism in the response spectra, the staff agrees with the licensee's conclusion that the inclusion of ZPA effects in the seismic analysis of the 33 subsystems analyzed by TES would produce pipe stresses and support loads below that allowable.

2. Seismic Anchor Movements

2.1 Evaluation of SAMs Between Buildings

"Piping Stress Analysis Data," Revision 2, December 13, 1985 (G/C Report No. 2439), states that absolute displacements between adjacent buildings of less than 1/8 inch can be neglected. This displacement, instead of the general industry practice of 1/16 inch, was not accepted by the NRC staff during the inspection without the licensee providing a quantitative technical basis.

The licensee presented the required technical justifications in its submittal of June 29, 1990, which states that the 1/8 inch threshold for considering building SAMs was acceptable based on the following:

(a) A fatigue evaluation accounting for the 1/8 inch SAM in combination with a 1/8 inch of containment growth shows ample margin with respect to fatigue life.

(b) A review of piping attached to essential equipment reveals that relevant SAMs were included in the analysis of the piping system and found to produce no unwanted reactions at the equipment. Among the cases reviewed were those where SAMs were of inconsequential magnitude because all connected piping was supported from the same building. In other cases, SAM loads generated at building interfaces could not reach the equipment due to the isolating effect of multiple restraints between the building boundaries and the equipment.

(c) A review of rigid piping crossing building boundaries shows that pipe stresses and support reactions are acceptable for SAMs in the range of 1/16 inch to 1/8 inch. The lines selected for demonstration are the 32-inch main steam line, an 18-inch feedwater line, and a 12-inch residual heat removal line. The staff finds the licensee's assessments to be acceptable. For smaller piping, SAMs exceeding 1/8 inch were included in the piping analysis. Although significant increases in pipe stress and support reaction occurred, they are below those allowable.

2.2 Combination of Adjacent Structure SAMs

In G/C Report No. 2439, the effects of adjacent structure SAM movements in the three global directions were combined by the RSS method rather than by the absolute sum method. In responding to the staff request for justification, SCE&G noted that modal frequencies and dominant modes differ for the different structures and, therefore, the likelihood of simultaneous maximum opposite seismic displacements was very low, which justifies the RSS combination method. The licensee further stated that the V. C. Summer FSAR does not address requirements for combining SAMs between buildings. At the time of design, construction and plant licensing, combining SAMs by the RSS method was an industry accepted practice. Besides, a deterministic time history calculation using a direct integration program has been made for a sample system consisting of two single degree-of-freedom oscillators simulating the Reactor Building and Intermediate Building. This calculation verifies the acceptability of the SAM directional response combination by the RSS method.

The staff finds the licensee's justification to be acceptable.

3. Containment Growth

The NRC IEB 79-14 follow-up inspection identified that containment penetration movements were not considered in the piping analyses and support design for the effects of post-accident pressurization and steady state thermal growth. These issues are evaluated in the following sections.

3.1 Thermal Growth of Containment

Calculations were performed by the licensee to predict the maximum thermal growth of the containment building under winter and summer startup and shutdown conditions. It was found that the maximum value is close to 1/8 inch which is considered insignificant based on the previous evaluation in Section 2.1.

The licensee also performed calculations for thermal growth of containment due to a loss-of-coolant accident (LOCA) and found it to be negligible. This is because of the short duration of the temperatures spikes and the small difference in the mean temperatures. This assessment also holds true for a main steam line break accident.

3.2 Growth of Containment Due to LOCA Pressure

The growth of containment due to LOCA pressure was calculated by considering results from the Structural Acceptance Test (SAT) based on the maximum pressure for a LOCA (46 psi). The maximum calculated displacement, which is in the radial direction, is approximately 1/8 inch.

The effect of this movement does not have to be evaluated, however, because LOCA is considered to be a faulted plant condition and only primary stress equations apply per design specifications and the FSAR. Additional confidence that the secondary stress produced by LOCA pressure displacements will not create operability problems or cause loss of pressure boundary is provided by the significant margin demonstrated by the previous fatigue evaluation (see Section 2.1).

3.3 Effects of Steady State Thermal Growth Coupled with 1/8 Inch SAM

The fatigue evaluation in Section 2.1 includes effects of SAM and thermal growth of containment. As was indicated, ample margin exists for the combined movement due to a 1/8 inch SAM and steady state thermal growth of containment.

3.4 Support Reactions

American Society of Mechanical Engineers (ASME) Code, Section NF-3221.1, of the Winter 1973 Addenda of the 1971 Code, provides clear direction that the support loading component due to containment growth from LOCA pressure does not have to be considered in an emergency condition. In addition, it permits a design allowable stress of 3 S_m (allowable stress intensity), which for A36 steel is 58 ksi. This allowable stress provides ample margin for any increased support loads due to steady-state thermal growth of containment. For example, 0.66 F_y (yield stress) is generally used for an allowable stress under primary loading, which equates to 23.8 ksi for A36 steel. Assuming a support is fully stressed with other loading components, a margin of 34.2 ksi is available for the secondary loading components being addressed here. It is unlikely that increased support stresses due to these secondary loadings would exceed the remaining margin of 34.2 ksi for A36 steel.

Based on the above information, the staff finds the licensee's resolution of the containment growth issues to be acceptable and that the containment growth has inconsequential effects on the integrity of piping and pipe supports.

4. Decoupling Criteria

According to G/C Report No. 2439, branch lines and instrument connections may be decoupled from the analysis model of the main pipe system provided the moment of inertia ratio of the two lines is equal to or less than 15 percent. The NRC inspection team questioned this engineering assumption because the industry practice has been to use a decoupling ratio in the range of 6 percent.

The licensee performed a review to determine the extent of decoupling. The number of pipes in decoupled situations, as well as the number of the decouplings in the range of 6 percent to 15 percent, was identified. It was revealed that in 912 locations where lines were decoupled, 571 cases were safety-related. Of the total number of the corresponding safety-related decoupled lines, two were found to have decoupling ratios in the range of 6 to 15 percent. The licensee has documented the analyses of the above two decoupled situations. In both cases, the branch lines were first modeled with significant portions of the run line. The lines were then decoupled and analyzed separately.

A comparison was made of pipe stresses and support reactions for the combined and decoupled models. The licensee arrived at the following conclusions:

(a) The run line stresses in the combined model are within 10% of those obtained from the decoupled model.

(b) The support reactions on the run line correlate closely between the coupled and decoupled models.

(c) On the branch lines, some pipe stress increases were noted in the combined model; however, all stresses are within code allowables.

(d) Likewise, some increases were also noted on branch line support reactions, primarily due to higher seismic induced loads; however, all support reactions were found to be acceptable.

Based on the above, the staff finds that for the two lines which have been identified as having decoupling ratios greater than 6%, the results are acceptable. Therefore, the decoupling ratio criteria of 15% as used for V. C. Summer does not have any impact on the plant piping and support design.

CONCLUSION

Based on the above evaluation, the staff concurs with the licensee's assessment that the current approaches for the issues discussed are technically acceptable and no procedural changes or rework are necessary.

For future analysis work, the licensee will require the evaluation of ZPA (Issue 1) for all new analysis problems. For the other issues (Issues 2 through 4) in the future, detailed reanalysis programs

such as snubber reduction, evaluation will be made on a case-by-case basis dependir on the adequacy of the original plant design practice and the current industry practice and standards.

The staff finds the above to be acceptable and considers all of the four issues identified during the above mentioned NRC inspection to be resolved.

Dated:

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