UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

Enclosure 1

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

DESIGN CRITERIA FOR LOWER DRYWELL STEEL PLATFORMS AND MISCELLANEOUS STEEL

BROWNS FERRY NUCLEAR POWER PLANT, UNITS 1, 2, AND 3

DOCKET NOS. 50-259, 50-260, AND 50-296

1.0 BACKGROUND

To support restart of the Browns Ferry Nuclear Plant (BFN) Unit 2, the NRC staff reviewed interim operability criteria for drywell steel platforms and miscellaneous steel. This review is documented in a safety evaluation (SE) issued on July 26, 1988. In this SE, the staff requested TVA to address the adequacy of applying the 1978 edition of AISC Specification since the original Final Safety Analysis Report (FSAR) criteria were based on the 1963 version. This request was repeated in NUREG-1232, Volume 3, Supplement 2, dated January 23, 1991. In addition, the July 26, 1988 SE stated that the staff would review the design criteria to determine if they conform with the FSAR.

By letter dated June 12, 1991, the Tennessee Valley Authority (TVA) addressed these two BFN Unit 2 post-restart action items, providing the long-term design criteria for drywell steel platforms and miscellaneous steel for staff review. These criteria are being applied to design and modifications supporting continued operation of BFN Unit 2 and the eventual restart of BFN Units 1 and 3. The proposed criteria constitute Attachment F to BFN General Design Criteria BFN-50-C-7100, "Design of Civil Structures," Revision 2, dated May 15, 1991.

2.0 EVALUATION

Comparison of criteria provided in the June 12, 1991 letter with the previously reviewed interim criteria shows that they are generally identical, except for the application of ductility ratio for steel design in conjunction with thermal loads. The staff has evaluated these criteria, and has found, with the exceptions noted below, that the criteria conform to the standards described by the Standard Review Plan (SRP), NUREG-0800, and are therefore acceptable.

The staff determined that the load combinations in the proposed criteria conform with those of the SRP. The proposed allowable stresses associated with the load combinations given in Tables 4.3.1 and 4.3.2 of the proposed criteria are equivalent to or below the corresponding values specified in the staff SRP. However, as noted below, the staff does not believe the proposed limit on critical buckling stress provides sufficient margin. Also as noted below, the staff requires additional information to determine whether the proposed shear stress limit increase is acceptable. The design criteria as proposed are acceptable with the exceptions of ductility ratio, critical buckling stress limit, and shear stress limit. A staff discussion on the ductility ratio is provided in Section 2.3. Furthermore, the licensee should modify items regarding dynamic load combinations and upper limit stress as discussed in the Sections 2.4 and 2.5 below.

2.1 Comparison of 1978 AISC Specification with 1963 AISC Specification

The current BFN FSAR references the 1963 version of AISC Specification "Manual of the American Institute of Steel Construction," while the proposed long-term design criteria are based on the 1978 AISC specification. The differences between the two versions of AISC specification have been identified and justified by the licensee in its June 12, 1991 submittal. In particular, the increase in allowable stresses in the 1978 edition was based on the fact that the shape factors of the beam cross sections have been improved. There has also been a large body of test data that support the increased allowable stresses. The staff found that the licensee's justification of the use of the 1978 version of AISC specification was satisfactory. The staff believes that, in general, the 1978 AISC specification is an improvement over the 1963 edition. Therefore, the staff concludes that this issue has been resolved.

2.2 Conformance with the FSAR

In their June 12, 1991 submittal, TVA states: "TVA has demonstrated compliance of the design criteria with the FSAR requirements." The staff does not agree with this statement for the following reasons:

1. Note 5 of Tables 4.3.1 and 4.3.2 in the June 12, 1991 submittal refers to Section 4.2.2 of the design criteria. In this section, it is stated that the shear stress is limited to 0.52 F_y. The limit in the FSAR is 0.4 F_y. Here, F_y denotes for material yield stress in tension. Section 2.5.3 provides a staff discussion on this disparity.

2. Application of a ductility ratio in the criteria is not consistent with the implicit FSAR assumption of maintaining stresses below yield in all cases.

For these reasons, the staff concludes the criteria do not fully conform with those of the FSAR. TVA stated in a letter dated February 6, 1992, that the FSAR would be amended to reflect the changes in the steel design criteria. The staff will review these FSAR changes when they become available. TVA's adoption of the proposed design criteria into the FSAR would ensure compliance of the design criteria with the FSAR, provided that the criteria are modified to incorporate the staff comments in this evaluation.

2.3 Ductility Ratio

In the criteria proposed in the June 12, 1991 letter, a ductility ratio was formally introduced for various load combinations. Ductility ratio usage had been presented during the staff inspections of the interim design criteria. The staff had approved ductility ratios as high as 3 on a case-by-case basis, but only for BFN Unit 2 restart. After review of the final design criteria, the staff has concluded that applying ductility ratios is not acceptable for long-term applications on a generic basis. The primary reason for not accepting the proposed ductility ratio is a lack of physical data supporting

the proposal. This staff position is discussed in a letter from NRC to TVA dated March 18, 1992.

2.4 Dynamic Load Combinations

In the July 26, 1988 SE, the staff expressed a concern regarding the use of phase relationship of various dynamic forces. TVA had agreed to use absolute sum of the forces, eliminating a need to evaluate phase relationships. The proposed criteria do not address this item. This may lead to confusion; therefore, the staff requests that the use of absolute sum of individual dynamic forces be clearly stated in the proposed criteria.

2.5 Upper Limit to the Allowable Stresses

2.5.1 FSAR Clarification

In the proposed criteria it is stated that "The upper stress limit in the bending and tensile stresses shall be 0.9 F_y. Compressive stresses shall be limited to 0.9 times the critical buckling stress. Shear stresses shall be limited to 0.52 F_y." TVA informed the staff that the use of the upper limit is to maintain the stresses below the material yield stress in the Category I steel structures. The staff recognizes that this is a sound approach noting that there exist possibilities for the stress to go beyond the material yield stress when load factors are considered in some of the staff SRP load combinations. However, the licensee should clarify the FSAR to document that the proposed upper limit should be used only when the allowable stresses provided in the SRP for the load combinations exceed the proposed upper limits. Otherwise, the SRP allowable stresses control the design.

2.5.2 Critical Buckling Stress

The use of 0.9 of the critical buckling stress as a limiting stress is not acceptable because, unlike tension or bending, critical buckling stress is the level of stress at which a sudden collapse of the structure may occur. In case of bending and tension, there is a certain degree of margin to the failure after the specified 0.9 F_y limit is reached. This is not the case for buckling. The proposed limit of 0.9 times critical buckling stress means there exists only 10 percent margin to a failure. This margin is too small for the Category I structures especially for the service loads. Therefore, the licensee should provide a lower limit for buckling stress.

2.5.3 Shear Stress Limit

The proposed increase of the shear stress limit from 0.4 F_y to 0.52 F_y is not explained in the June 12, 1991 submittal. A justification should be provided in terms of margin to failure when a steel member reaches the recommended limiting value.

3.0 CONCLUSION

The proposed criteria are generally acceptable with the exceptions discussed above. Section 3.8.4 of the SRP may be used to evaluate thermal stresses in the steel. The staff plans to review future amendments of the FSAR that relate to the steel design criteria. The staff will provide a supplemental safety evaluation of information submitted to address the open items described in sections 2.4, 2.5.1, 2.5.2, and 2.5.3.

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