CP&L

Carolina Power & Light Company

AUG 07 1992

SERIAL: NLS-92-224

United States Nuclear Regulatory Commission
ATTENTION: Document Control Desk
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 & 50-324/LICENSE NOS. DPR-71 & DPR-62
MISCELLANEOUS STEEL VERIFICATION PROGRAM

Gentlemen:

On July 7-8, 1992, representatives of the Nuclear Regulatory Commission staff visited the Brunswick Steam Electric Plant to discuss the miscellaneous steel design basis documentation program. During the meeting, Carolina Power & Light Company agreed to provide the information requested by the staff in two submittals. The company's initial response was submitted by letter dated July 27, 1992 (Serial: NLS-92-203). Enclosure 1 provides a listing summarizing the information being provided in this submittal. Enclosure 2 provides the information requested by the staff.

Please refer any questions regarding this submittal to Mr. W. R. Murray at (919) 546-4661.

Yours very truly,

for D. C. McCarthy
Manager
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WRM/wrm (steel-2.WPF)

Enclosures

cc: Mr. S. D. Ebneter
Mr. R. H. Lo
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ENCLOSURE 1

BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2
NRC DOCKET NOS. 50-325 & 50-324
OPERATING LICENSE NOS. DPR-71 & DPR-62
MISCELLANEOUS STEEL VERIFICATION PROGRAM

The miscellaneous steel programmatic and technical issues listed below have been identified for inclusion in CP&L's August 7, 1992 response:

**PROGRAMMATIC**

1. Discuss the root causes.

2. Provide the Phase II procedure.

3. Address miscellaneous steel in other Category I structures.

**TECHNICAL**

1. Compare long-term acceptance criteria with Updated FSAR and provide justification for any deviations (include use of AISC 8th edition).

2. Provide justification for not considering tornado loads.

ENCLOSURE 2

BRUNSWICK STEAM ELECTRIC PLANT, UNITS 1 AND 2
NRC DOCKET NOS. 50-325 & 50-324
OPERATING LICENSE NOS. DPR-71 & DPR-62
MISCELLANEOUS STEEL VERIFICATION PROGRAM

**PROGRAMMATIC ISSUES**

**ITEM 1:**

Discuss the root causes.

**RESPONSE:**

Carolina Power & Light Company is currently working with United Engineers & Constructors and Brown & Root to prepare a formal root cause assessment. However, additional information is being received from the walkdowns and must be reviewed prior to finalizing a formal root cause. Although the root cause assessment is still in progress, preliminary assessments point to initial safety classification and construction practice as causal factors.

**ITEM 2:**

Provide the Phase II procedure.

**RESPONSE:**

The Phase II Procedure is included as Attachment 2.

**ITEM 3:**

Address miscellaneous steel in other Category I structures.

**RESPONSE:**

The initial effort of the Miscellaneous Steel Verification Program is to concentrate on the miscellaneous steel in the reactor buildings and drywells for several reasons:

a. The verification i  ue was initiated because of concerns related to the design and construction of reactor building structural steel.

b. The major portion of the miscellaneous steel is located in the reactor buildings and drywells. Although some miscellaneous steel can be found in some of the other Category I buildings, the quantity is relatively small, as compared with the reactor building and drywell.

c. Although the miscellaneous steel may perform important functions in other Category I structures, in general, the more critical functions for the miscellaneous steel are in the reactor buildings and the drywells.

However, the results from the verification of the miscellaneous steel in the reactor buildings and drywells will be evaluated to identify issues which are generic in nature. An engineering walkdown will be conducted in other Category I structures to the extent necessary to evaluate the effect that the generic issues may have on the performance of the miscellaneous steel in these structures.

## TECHNICAL ISSUES

### ITEM 1:

Compare long-term acceptance criteria with Updated FSAR and provide justification for any deviations (include use of AISC 8th edition).

### RESPONSE:

The design of the steel included in the Miscellaneous Steel Verification Program was based on the 6th Edition of the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings. According to original FSAR commitments, the allowable stresses included in that Specification can be increased by 1.5 when considering the Design Basis Earthquake. No detailed listing of specific load cases are included. The Updated FSAR imposes the same criteria with the following exceptions:

1. Specific load cases are identified, and included in Attachment 1 for easy reference. These load cases do not alter original FSAR commitments. Rather, they provide more specificity.

2. The use of 8th Edition of the AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings is allowed for current work.

In summary, the only difference between the long-term criteria and the original FSAR commitments is the use of a more recent version of the AISC Specification. Attachment 1 provides additional input regarding justification for some of the more significant changes.

### ITEM 2:

Provide justification for not considering tornado loads.

### RESPONSE:

The Miscellaneous Steel Verification Program for the reactor building is limited to steel below the 117 foot elevation. Below this elevation, the structure consists of reinforced concrete exterior walls designed to resist the effects of tornado winds. The portion of the structure above the 117 foot elevation, which is not part of the Miscellaneous Steel Verification Program, has external steel siding. This siding is designed to remain attached to the structure on the windward side during a tornado, but is allowed to be blown away on the other sides. Blowout panels are provided in the concrete slab at the 117 foot elevation to relieve excess internal pressure due to the depressurization of air surrounding the structure. Stairways, hatches, and other openings are used to vent interior spaces. Likewise, concrete slabs at the 80 foot, 50 foot, and 20 foot elevations also have stairways, hatches, and other openings which relieve pressure from depressurization.

The Miscellaneous Steel Verification Program for the reactor buildings consists of two distinct classes of steel. The miscellaneous steel outside the drywells, and the platforms inside the drywells. The miscellaneous steel outside the drywells consists primarily of open horizontal members separated by several feet at various elevations which, in general, provides no defined barrier to form an internal compartment. Therefore, no defined mechanism exists to create a measurable differential pressure. Because the lower portion of the reactor buildings are vented from above (117 foot elevation), any amount of differential pressure that would be imposed on the beams would result in a net upward pressure, which will reduce the dead load.

The effects of wind or depressurization are factors precluded for the drywell platforms by the design of the drywell, which is sealed for pressures much higher than 3 psi.

In general the miscellaneous steel consists of open sections, thus precluding any differential pressure within the member. If tubular sections are identified, they will be checked to assure either venting capability exists or the member is sufficiently strong to withstand the postulated differential pressure along with other necessary loads.

In summary, tornado loads are not a factor for the verification of the miscellaneous steel in the reactor buildings and drywells below the 117 foot elevation.

ATTACHMENT 1

Use of AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings

The basic philosophy of the Specification is that the primary load carrying mechanism of the structural steel (i.e. beams) is, in general, through bending. This is particularly true for structural components such as those included in the Miscellaneous Steel Verification Program. Therefore, it is appropriate that the stresses associated with bending establish the basic margins of safety in a structure. A basic allowable stress of 0.6 Fy (where Fy is the minimum specified yield strength) is selected which results in a minimum factor of safety of 5/3 = 1.67 against a collapse load. This factor of safety accounts for various unknown or unquantified factors, such as variations in loading, environmental effects, fatigue, deflection and limitations in design, analysis and construction procedures. All other stress considerations, such as compression, shear and stresses associated with connections and other discontinuities are generally given a highur factor of safety (Reference 1). These higher factors of safety are warranted either because of the nature of the failure associated with that particular stress component, limitations in commonly utilized stress analysis or construction techniques, or by the economics of the issue.

The use of the 1978 Specification has been accepted for general use by the NRC staff as specified in the Standard Review Plan (SRP), Section 3.8.3 and has commonly been used on plants licensed since it was issued. Many more plants have used the 1970 Specification, which has allowable stresses similar to those of the 1978 version for fillet welds and weak axis bending. In general the design of these plants are based on the load combinations included in the SRP Section 3.8.3 which are similar, and in some cases are slightly less conservative than those imposed on the Miscellaneous Steel Verification Program.

There are three differences between the 1963 and 1978 Specification that are of primary interest and will have the greatest effect of the miscellaneous steel verification effort. These include the following:

- Fillet Welds - As discussed in the Commentary to the 1970 AISC Specification, Section 1.5.3, "In earlier editions of the AISC Specification, working stresses were not given for fillet welds made with electrodes stronger than the E70 classification. The stresses that were given were known to be overly conservative for their recommended use with an E70 classification. Based upon tests (Reference 2), the allowable stress on fillet welds, deposited on 'matching' base metal or steel having mechanical properties higher than those specified for such base metal, is now given in terms of the specified tensile strength of the base metal."

  As indicated in the commentary, there was no change specified in the design procedure, material specification or construction techniques and practices to utilize these higher values, just the recognition that "overly conservative" allowable stresses existed in the earlier specification which was corrected in later editions. An indication of the conservatism that exists for fillet welds based on the 1978 AISC Specification allowable stresses, is shown in the attached Figure 1, taken from the Steel Manual, 8th Edition, Page 4-73. This figure represents the results from a series of tests. As shown, the 1978 Specification fillet weld allowable stresses have a minimum factor of safety, as compared with the minimum yield value, of approximately two (2). Compared to the basic factor of safety for structural steel of 1.67, included in both the 1963 and 1978 Specifications, the 1978 Specification maintains excess safety margins for fillet welds. The higher fillet weld allowable strasses will not control the overall margin of safety of the lower drywell platforms.

- Bolting - As discussed in the Commentary to the AISC Specification for Structural Joints, Section C4, included in the 8th Edition of the Steel Construction Manual: " in the current Edition of this Specification, significant increases have been made in the recommended working stresses for proportioning connections which function by resisting the transfer of shear between the connected parts in friction or bearing. While the research which supports the new provisions has been published from time to time in individual papers (some of it more than a decade ago), it was felt that the updating of working stresses, unchanged since initial adoption, should not be piecemeal. Therefore, a review looking toward a systematic presentation of the accumulated information within a single volume was initiated in 1970, under the direction of the Council. In restudying the research reported during the past two decades, the completed publication (Reference 3) has had as its goal the more reliable prediction of the behavior of various bolted connections under various kinds of loading."

  "With the wealth of available data at hand, it has been possible, through statistical analyses, to adjust allowable working stresses to provide uniform reliability for all loading and joint types. The design of connections still is more conservative than that of the connected members of buildings and bridges by a substantial margin, in the sense that failure load of the fasteners is substantially in excess of the maximum serviceability limit (yield) of the connected material."

  The allowable stresses included in the Specification for Structural Joints are consistent with those included in the 1978 AISC Specification for the Design, Fabrication and Erection of Structural Steel for Buildings. As indicated in the Commentary, this increase in allowable stresses does not require any change to the design approach, material specifications, or construction techniques and/or practices that would have been used for designs made to the 6th Edition Steel Manual. Figure 2 shows test data (taken from Reference 3) indicating that, based upon the 1978 Specification, the Factors of Safety for the bolting continues to exceed the allowable factor of safety for major axis bending. Therefore, increases in bolting allowable stresses through use of the 1978 Specification will not reduce the controlling margins of safety.

- Weak Axis Bending of Doubly-symmetrical Compact Sections - A concise explanation for this increase is included in the Commentary of the 1970 Specification which is worth repeating:

  "The 25% increase in allowable bending stress for compact sections and solid rectangular bars bent about their weak axis, as well as for square and rectangular bars, is based upon the favorable shape factor present when these sections are bent about their weaker axis, and the fact that, in this position, they are not subject to lateral-torsional buckling." Thus the application of a consistent increase factor to this load takes into account the added strength of the section due to the favorable shape factor and as a result does not reduce the effective margins specified in the Final Safety Analysis Report.

Other differences between the 1963 and 1978 specifications have been reviewed and found to be of much less significance. Justification for these changes are generally included in the Commentary to the 1978 AISC specification.

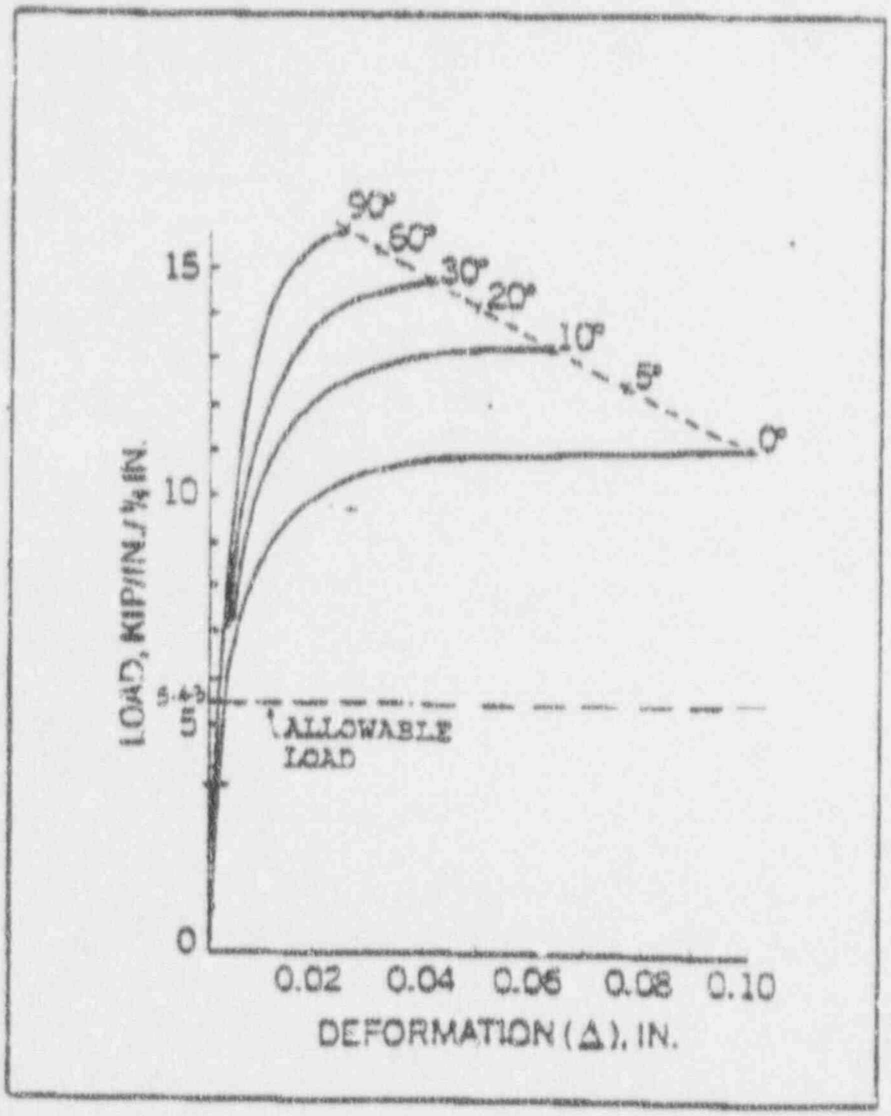
In summary, overall margins are not adversely affected by the use of the 1973 AISC Specification for Design, Fabrication and Erection of Structural Steel for Buildings.

References:

1. Structural Steel Design, Beedle, et.al, The Ronald Press, 1964

2. Higgens, T. R. and Preece, R. R. Proposed Working Stresses for Fillet Welds in Building Construction, Welding Journal Research Supplement, Oct., 1968

3. Kulak, G. L., Fisher, J. W., and J. H. A. Struik, Guide to Design Criteria for Bolted and Riveted Joints, 2nd Edition, John Wiley & Sons, New York, 1987




GENERAL PERFORMANCE CURVES FOR WELDS

FIGURE 1

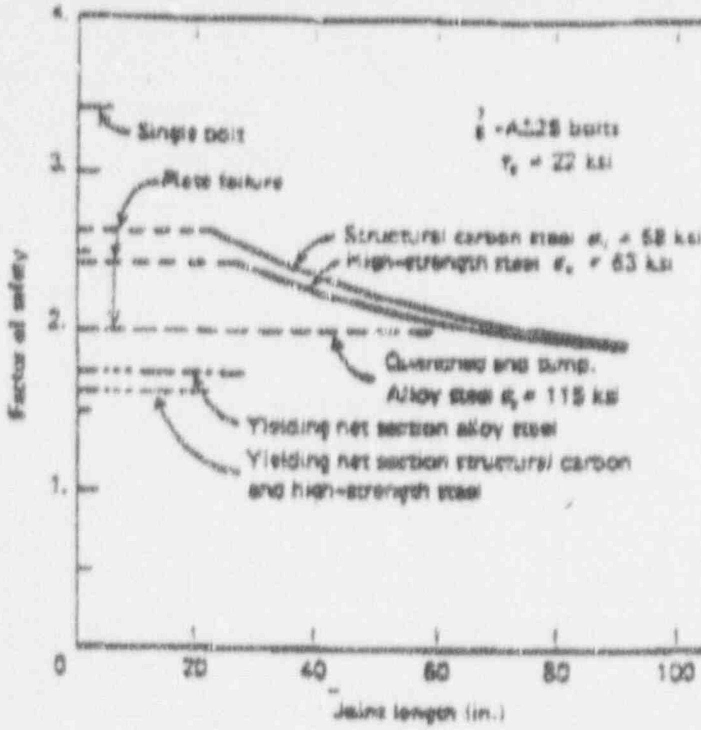
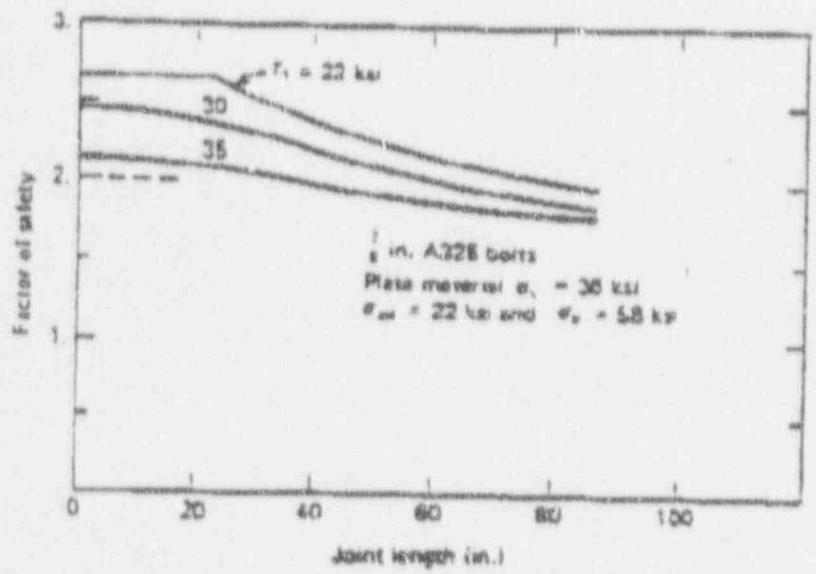



Fig. 5.48. Factor of safety versus joint length for A325 .




FACTOR OF SAFETY FOR CARBON STEEL JOINTS

FASTENED BY 325 JOINTS

FIGURE 2

ATTACHMENT 2

Phase II Walkdown Procedure