UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
TEXAS UTILITIES ELECTRIC COMPANY, et al.	)	Docket Nos. 50-445 50-446
	)	
(Comanche Peak Steam Electric Station, Units 1 and 2)	)	

AFFIDAVIT OF DAVID TERAO ON AWS AND ASME CODE PROVISIONS ON WELD DESIGN

I, David Terao, do depose and state as follows:

Q1. Mr. Terao, by whom are you employed and what is the nature of the work you perform?

A1. My name is David Terao. I am a mechanical engineer assigned to the Mechanical Engineering Branch, Division of Engineering of the U.S. Nuclear Regulatory Commission ("NRC").

Q2. Have you prepared a statement of your professional qualifications?

A2. Yes, a statement of my professional qualifications is attached to my affidavit.

Q3. Have you reviewed the "Applicants' Motion for Summary Disposition of Certain CASE Allegations Regarding AWS and ASME Code Provisions Related to Design Issues", and the accompanying "Affidavit of J. C.

Finneran, R. C. Iotti and J. D. Stevenson Regarding Allegations Involving AWS vs. ASME Code Provisions" ("Applicants' Affidavit")?

A3. Yes, I have read and reviewed these materials. Applicants' Affidavit addresses four welding design concerns raised by CASE: (1) multiplication and reduction factors for skewed T-joint welds; (2) skewed T-joint angularity limits; (3) punching shear; and (4) tube-to-tube joints with betas equal to 1. I will address each of these areas separately.

Multiplication and Reduction Factors for Skewed T-Joint Welds

Q4. Mr. Terao, please describe the open issue regarding skewed T-joint welds.

A4. CASE alleges that the ASME Code does not contain sufficient information to design a welded joint for pipe supports, since Appendix B to the AWS D1.1 "Structural Welding Code ("AWS Code") sets forth multiplication and reduction factors for the calculation of effective throats of fillet welds in skewed T-joints, but the ASME Code does not provide multiplication and reduction factors for skewed T-joints. CASE's Proposed Findings of Fact and Conclusions of Law (Walsh/Doyle Allegations) (August 22, 1983) ("CASE's Proposed Findings"), pp. V.3-4.

Q5. What are multiplication and reduction factors for skewed T-joints?

A5. The multiplication and reduction factors represent the geometric ratio of the effective throat of 90° fillet weld to the effective throat of a skew T-joint weld.

Q6. Are there provisions in the 1975 AWS and 1974 ASME Code addressing the multiplication factor and reduction factor for skewed T-joint welds?

A6. Prior to 1977, Appendix B of the AWS Code provided only a diagrammatic explanation of how to determine the effective throat of a weld. Multiplication and reduction factors for skewed T-joint welds were introduced in tabular form in the 1977 Revision to Appendix B of the AWS Code. The table is used to determine the required leg size for a skewed T-joint which would be equivalent to a 90° fillet weld of a given size, based on the increase or decrease of the effective throat of the skewed T-joint weld.

The 1974 ASME Code, Section III, Appendix XVII, Paragraphs 2452.4 and 2452.5, provides that the effective throat thickness of a fillet weld shall be the shortest distance from the root to the face of the diagrammatic weld, and the effective area of the fillet weld shall be considered as the effective length multiplied by the effective throat thickness. The ASME Code requirements are equivalent to the multiplication and reduction factors provided in the AWS Code.

Q7. How have Applicants addressed the open issue on T-joint welds?

A7. The Applicants state that a compensatory requirement for the 1975 AWS Code is provided in the 1974 ASME Code, Section III, Appendix XVII, Paragraph 2211(c). Applicants' Affidavit, p. 4; Applicants' Statement of Material Fact, Paragraph 2. The Applicants argue that this ASME Code provision limits the allowable tension stress at the contact surface of a weld, which produces a tension load in the through thickness direction of the base material of one-half the normal tensile allowable. Applicants stated that the ASME-Code was more restrictive than the AWS Code on this factor. Applicants' Affidavit, p. 4, Applicants' Statement of Material Fact, Paragraph 2.

However, Applicants did not discuss whether their three pipe support design groups complied with Paragraph 2211(c). Instead, Applicants represented that "documentation to the QA Group" in August 1982, as set forth in Memorandum CPPA 22,616, reflects that weld designers were using considerations virtually identical to that contained in Appendix B of AWS D1.1. Applicants' Affidavit, p. 6. In response to Staff questions regarding Figure B of Attachment 1 to CPPA 22,616, Applicants stated that the effective throat of obtuse angles is the shortest measured distance from the root to the face of the weld and is calculated based on the leg dimension "s". June 8, 1984 Transcript, p. 48. Applicants also said that prior to 1982, Applicants used the "line" method in calculating the capacity of skewed T-joint welds. June 8, 1984 meeting transcript of, pp. 102-04.

The Applicants also provided the results of a study that showed that a sample of 13 skewed T-joint designs issued prior to 1982 met or exceeded the load capacities required by AWS. The highest stressed weld was stressed to 39 percent of the AWS allowable. Applicants' Affidavit, p. 6; Applicants' Statement of Material Fact, Paragraph 4.

The Applicants also noted that the SIT Report concluded that the design procedures being utilized by the three pipe support design groups for skewed joints are based on sound engineering practice. Applicants' Affidavit, p. 7; Applicants' Statement of Material Fact, Paragraph 5.

Q8. Do you agree with Applicants' conclusion (Applicants' Affidavit, pp. 4-7; Applicants' Statement of Material Facts, Paragraphs 2-4) that the ASME Code Appendix XVII, Paragraph 2211(c) is comparable or identical to the AWS requirements for multiplication and reduction factors for skewed T-joint welds, and that the Applicants' design measures are adequate?

A8. No. I regard Appendix XVII, Paragraphs 2452.4 and 2452.5 of the ASME Code, rather than Paragraph 2211(c), as the comparable requirements for multiplication and reduction factors for skewed T-joint welds.[1/] Paragraphs 2452.4 and 2452.5 of the ASME Code set forth requirements for calculation of the effective throat and effective area of a fillet weld, which are equivalent to the AWS Code's multiplication and reduction factors.

1/ I also note that Appendix XVII, Paragraph 2211(c) was subsequently deleted in the Winter 1978 Addenda, and its deletion has been adopted by the Applicants. Since the Staff does not regard Paragraph 2211(c) to be relevant to the issue of multiplication and reduction factors for skewed T-joint welds, the Staff regards CASE's discussion of Paragraph 2211(c) (CASE's Answer, pp. 3-6) to be irrelevant.

The Staff also does not agree with Applicants' position that they have demonstrated that their design practices appropriately consider skewed T-joint welds. First, even if I assume that Applicants argument regarding Paragraph 2211(c), I still have a concern since Applicants have not presented any evidence showing that they actually considered this ASME Code provision in their design process for pipe supports.

Second, Applicants indicate that for some unspecified time period, the line method was utilized for evaluating the adequacy of skewed welds. The line method is based on the effective throat of 90° fillet welds and does not consider the increase or decrease in the effective throats for skewed T-joint welds. The use of this method can potentially result in an underdesigned weld for obtuse skew T-joints and in an overdesigned weld for acute skew T-joints. The Applicants' basis for using this method is partially based on the fact that when a skew T-joint is welded with both an obtuse and an acute angle welds, the decrease in the effective throat of the obtuse angle weld tends to be offset by the increase in the effective throat of the acute angle weld (June 8, 1984 meeting transcript, p. 102). However, when an obtuse angle weld is present without a compensating acute angle weld, there exists the possibility that the obtuse angle weld may be overstressed. Therefore, the Staff requested the Applicants to review its pipe support drawings, identify those skew T-joint welds where the line method was used, and determine whether an adequate margin of safety exists in the welded connection where an obtuse angle weld was not accompanied by an acute angle weld.

In a letter from H. C. Schmidt (TUGCO) to B. J. Youngblood (NRC) dated July 16, 1984, the Applicants provided additional information to address the Staff's concern. Applicants stated that they reviewed 201 randomly selected pipe supports which utilized skewed T-joints and found that four design approaches which were utilized in the evaluation of skewed T-joint weld capacity: (1) the reduced effective throat was considered (39 instances), (2) the obtuse and/or acute welds were neglected and only side welds were considered (83 instances), (3) engineering judgment was used (e.g., because of low loads) (6 instances), or (4) the reduced effective throat was not considered (5 instances). Consideration of the reduced effective throat (design approach (1) above), and consideration of side welds only (design approach (2) above) are equivalent to or more conservative than the requirements of ASME Section III, Appendix XVII-2452.4 and 2452.5. It is acceptable industry practice to assess the acceptability of weld stresses when loads are low (design approach (3) above). It is not acceptable to completely ignore the reduced effective throat (design approach (4) above) without considering whether there are offsetting factors. This apparently was the case for the 5 skewed T-joints with all-around welds. However, Applicants stated that when the actual effective throats for the 5 welds were considered, the weld capacities were acceptable (the weld stress ratios for these five welds were 0.331, 0.033, 0.059, 0.008, and 0.505).

Despite the fact that Applicants' assessment of the 201 pipe supports showed that the welds were acceptable, I cannot concur with Applicants' position that this sample demonstrates that the design approaches utilized by Applicants for evaluating skewed T-joints meet the requirements of Appendix XVII-2452.4 and 2452.5, or that they implicitly satisfy the intent of the AWS provisions for multiplication and reduction factors for skewed T-joints in all cases. First, Applicants' sample of 201 pipe supports showed that 5 skewed T-joint welds were not appropriately assessed. Since there is no indication that these 5 welds represent worst-case situations, there is no assurance that there are not other welds whose capacities may be overstressed. Second, the Staff has determined that Applicants did not have design guidelines or criteria specifying the actual method to be used to calculate the effective throat of obtuse angle welds. In fact, Applicants used at least four different methods to evaluate skewed T-joint weld capacity, one of which was unconservative (non-consideration of the reduced effective throat). The Staff concludes that the Applicants should identify the cause for not considering the reduced effective throat of the obtuse welds in the five cases identified and implement corrective measures which will assure that the reduced effective throats are appropriately considered in all skewed T-joints at CPSES. The effective throat should be calculated in accordance with Section III, Appendix XVII-2452.4 of the ASME Code. Applicants should also demonstrate that they have complied with ASME Code Section III, Appendix XVII-2452.4 and 2452.5 for all skewed T-joint welds at CPSES.[2/]

Limitation on Angularity for Skewed T-Joints

Q9. Please describe the open issue on skewed T-joint angularity.

A9. CASE alleged that the ASME Code does not contain sufficient information to design a welded joint, since the AWS Code sets forth an angularity limit for skewed T-joints, but the ASME Code does not provide such angularity limitations. CASE's Proposed Findings, pp. V.3-4.

Q10. What is the angularity of a skewed T-joint?

A10. The angularity of a skewed T-joint is the dihedral angle formed by the intersection of two non-perpendicular members.

Q11. Are there any 1975 AWS and 1974 ASME Code requirements relevant to this parameter?

A11. The AWS Code up to and including the 1976 revision included a restriction on angularity for prequalified skewed T-joints, but only for acute angles of less than 60 degrees. In the 1977 AWS Code revision, a restriction on prequalified fillet welds with a dihedral angle greater than 135 degrees was added. In the 1979 AWS Code, Table E2 in Appendix E listed those Code provisions which can be changed by

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2/ The significance of: (1) Applicants' use of a non-conservative method for evaluating skewed T-joint weld stresses, and (2) Applicants' mistaken citation to ASME Code Appendix XVII, Paragraph 2211(c), to the programmatic design QA issue will be addressed by the Staff in another affidavit.

procedure qualification tests. Amongst those provisions listed is "Section 2, Part C (Details of Welded Joints)", which includes a limitation on angularity for prequalified skewed T-joints. Thus, the current AWS Code allows both prequalified joints with limitations on angularity, as well as welded joints without angularity limits if the weld procedures for these joints are properly qualified by test.

The 1974 ASME Code does not include any limitation on angularity, provided the criteria established for weld size and allowable stresses are met. However, the 1974 ASME Code requires qualification tests for all welding procedures which will be used by the organization doing the welding. Thus, both the current AWS Code and the 1974 ASME Code do not set forth any limitations on angularity for skewed T-joint welds so long as the weld procedures are properly qualified by test.

Q12. Please describe how Applicants addressed the open issue on skewed T-joint angularity limits.

A12. The Applicants stated that the limitations on angularity for skewed T-joints do not apply to welds qualified by tests, and that both the AWS Code and the ASME Code permit weld procedures without such limitations provided the weld procedure used is qualified by test. Applicants' Affidavit, p. 7; Applicants' Statement of Material Fact, Paragraph 6. Furthermore, the Applicants stated that their practices as set forth in CPPA-22,616 are virtually identical to those set forth in the AWS Code. Applicants' Affidavit, p. 7; Applicants'

Statement of Material Fact, Paragraph 7. Lastly, the Applicants stated that compensatory ASME Code requirements in Appendix XVII-2211(c) assure the adequacy of skew T-joint welds. Applicants' Affidavit, pp. 7-8; Applicants' Statement of Material Facts, Paragraph 8.

Q13. Do you agree with Paragraphs 6-8 of Applicants' Statement of Material Facts that the ASME Code provisions assure the adequacy of skewed T-joint welds, that angularity limits are not necessary when the weld procedure is qualified by test, and that Applicants' design criteria for angularity of T-joint welds are essentially identical to AWS Code requirements?

A13. I agree with Applicants (Applicants' Affidavit, p. 7; Applicants' Statement of Material Fact, Paragraph 6) that the AWS Code's angularity limits are relevent only where prequalified joints are used, and are not applicable when the welding procedures are properly qualified by test.[3/] Thus, the AWS Code is identical to the ASME

3/ In CASE's Answer (p. 11), it is stated, "[T]here has been no documentation . . . to show that the effective throat of a skewed joint is permitted to be qualified by test . . . to be more specific, the AWS section and the ASME Code permit welding procedures to be evaluated by test, but do not discuss evaluation procedures qualified by test." If CASE is contending that analytical procedures ("evaluation procedures") must be qualified by test, the Staff disagrees with CASE. No design code for pipe support or welding design requires such procedures to be "qualified by test". CASE appears to misunderstand the Applicants' position (which is consistent with the Staff) that the AWS Code's requirements for angularity only apply where the weld procedures are prequalified. The ASME Code does not set forth any angularity limits, since it requires all weld procedures to be qualified. Thus, there always will be assurance that the weld procedures qualified by test pursuant to either the ASME or AWS Code will have the capability to produce sound welds.

Code in this regard, since both the AWS and ASME Code do not set forth angularity limits when the weld procedures are qualified by test.

Paragraphs 7 and 8 of Applicants' Statement of Material Facts are not necessary or directly relevant to the issue of angularity limits for skewed T-joints. The Staff's position on these matters are set forth above in the discussion of multiplication and reduction factors for skewed T-joint welds.

Punching Shear for Stepped Tube Connections

Q14. Mr. Terao, what is CASE's concern with regard to punching shear?

A14. CASE alleged that the ASME Code does not contain sufficient information to design welded joints for pipe supports, since the AWS Code provides specific requirements for the design of tubular structures, such as the evaluation of punching shear, whereas the ASME Code does not specifically address punching shear considerations. CASE's Proposed Findings, pp. V.3-4.

Q15. What is punching shear?

A15. Punching shear is a reduction in the shear capacity of the base material in a welded tubular joint. It is a consideration in tube steel design, and is usually not a concern with designs using I-beams.

Q16. What are the 1975 AWS and 1974 ASME Code requirements for consideration of punching shear?

A16. Section 10.5.1 of the AWS Code provides an explicit method for evaluating the potential for local failure in welded tubular connections. The equation for punching shear provides a reduction in the shear allowable to account for: (1) the effect of flange width to thickness ratio; (2) the effect of smaller to larger tube connections (stepped); and (3) a reduction in shear capacity when axial and bending stresses are present in the main (chord) member.

Presently, the ASME Code does not provide guidance specifically for the design of tubular steel members and their welded joint connections. The ASME Code provisions for the calculation of flexural, torsional, and axial stresses are appropriate for tubular sections. However, because the ASME Code does not contain special considerations for punching shear it is incumbent upon the designer to recognize the local effects due to punching shear can be a potential concern when designing with tube steel, and that an appropriate method for its evaluation should be utilized.[4/]

4/ I disagree with CASE's assertion (CASE's Answer, p. 13) that no other valid method exists for evaluating punching shear other than that embodied in the AWS Code. The validity of an analytical method depends on whether it reasonably predicts phenomenon in the real world, and not on whether it has been incorporated into an established industry code. Indeed, 10 C.F.R. Part 50, Appendix A, Criterion I recognizes that existing industry codes may not be sufficient, and requires that they be "modified or supplemented as necessary to assure a quality product." In any case, AWS itself recognizes alternative methods for assessing punching shear. In Section 10.5 of ANSI/AWS D1.2-82,

(FOOTNOTE CONTINUED ON NEXT PAGE)

Q17. Please describe how Applicants addressed this issue.

A17. The Applicants have stated that the AWS punching shear criteria were developed primarily on the basis of research and experience with fixed offshore platforms. Applicants stated that large flange width platform supports used in such offshore platforms are not comparable to the relatively small tubular members used in pipe supports at CPSES. Applicants' Affidavit, p. 8; Applicants' Statement of Material Facts, Paragraph 10.

Applicants also stated that Applicants evaluate punching shear for a given weld joint when the designer believes it to be appropriate. Applicants' Affidavit, p. 8. During the June 8, 1984 meeting with the Applicants, they reiterated that the CPSES engineers are not ignoring local effects due to punching shear but rather are assessing it on a case-by-case basis using alternate methods such as Roark's method (June 8, 1984 meeting transcript, pp. 112-115). Applicants

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(FOOTNOTE CONTINUED FROM PREVIOUS PAGE)

"Commentary on Structural Welding Code - Steel," it is stated that alternative to the punching shear approach for sizing tubular connections can be found in literature. See, e.g., "Hollow Structural Sections - Design Manual for Connections," J. A. Cran, et al. The Steel Company of Canada (STELCO), 1971. In addition, AWS D1.1 states that yield line analysis may be used in lieu of the punching shear method of 10.5.1. Furthermore, in a paper by A. A. Toprac ("Welded Tubular Connections - An Investigation of Stresses in T-joints," Welding Journal, Vol. 45, No. 1, January 1966) correlations between theoretical and experiment studies are discussed in which Bijlaard's equations when compared with several sources of experimental test data are shown to give a reasonable indication of the stresses in a simple T-joint. Also included in the Toprac paper is a discussion of three techniques used prior to AWS D1.1 in which the potential areas of uncertainty are noted. The three techniques are 1) the shear area method, 2) the column analogy, and 3) the Kellogg method.

also provided 12 examples from CASE Exhibit 669B where pipe supports were evaluated for punching shear effects utilizing the AWS Code criteria. The highest ratio of actual stress from punching shear to the AWS allowable was 0.57. Applicants' Affidavit, p. 9; Applicants' Statement of Material Fact, Paragraph 11. Finally, Applicants referenced the SIT's evaluation of 100 vendor-certified pipe support designs as additional evidence that punching shear has been adequately considered at CPSES. Applicants' Affidavit, p. 9; Applicants' Statement of Material Fact, Paragraph 12.

Q18. Mr. Terao, do you agree with Applicants' conclusion (Applicants' Statement of Material Facts, Paragraphs 9-12) that punching shear is not a concern with pipe support designs at CPSES?

A18. I agree with Applicants (Applicants' Affidavit, p. 8; Applicants' Statement of Material Fact, Paragraph 10) that the punching shear design criteria presented in Section 10.5.1 of the AWS Code were developed primarily on the basis of research and experience with fixed offshore drilling platforms where tubular sizes tend to be larger than the sizes used in pipe supports. Nonetheless, punching shear could be a concern where the tube steel utilized has a chord thinness ratio in the range where there could be a significant reduction in the shear capacity of the tube steel. A paper by P. W. Marshall and A. A. Toprac,[5/] which documents the background data

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5/ "Basis for Tubular Joint Design", P. W. Marshall and A. A. Toprac, Welding Journal, Welding Research Supplement, May 1974, referenced in AWS D1.2, "Commentary on Structural Welding Code - Steel."

underlying the AWS D1.1 criteria for tubular joint design, states, "for relatively stocky chord members - thickness greater than 7% of diameter or (gamma) less than 7 - the joints may be said to have a 100% punching shear efficiency, in the sense that the shear strength of the material is fully mobilized on the potential failure surface." Thus, Marshall and Toprac suggest that punching shear may be a concern with chord thinness ratios in excess of 7.

Applicants indicate that the majority of tube steel sizes used at CPSES do not have a chord thinness ratio in the range where there could be a significant reduction in the shear capacity of the tube steel, and that their evaluation of 12 supports from CASE Exhibit 669B with the worst case tube steel sizes showed that a large design margin exists for punching shear. Applicants also represent that punching shear is considered on a case-by-case basis, using several alternate methods. Applicants' Affidavit, pp. 9-11, and Attachment 2. However, as CASE points out in its Answer (p. 17), the twelve supports may not represent the worst-case supports that are present at CPSES.[6/] There could be a few tube steel sizes utilitized at CPSES where a reduction in their shear capacity could potentially

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6/ I concur with CASE's conclusion (CASE's Response, p. 17) that this analysis of 12 supports was not a sufficient basis by itself to conclude that punching shear was not a problem at CPSES.

have a significant effect that has not been explicitly evaluated. The Staff therefore requested Applicants to review the Marshall and Toprac paper, in order to determine its applicability to the designs used at CPSES, and to ensure that an acceptable margin of safety for punching shear exists for all tubular steel pipe supports at CPSES.

In a letter from H. C. Schmidt (TUGCO) to B. J. Youngblood (NRC) dated July 16, 1984, the Applicants provided additional information to address the Staff's questions on punching shear. The Applicants identified all safety-related supports in Unit 1 and common area which utilized tube steel with a chord thinness ratio (D/2t) of 10 or more. One support out of 171 identified supports was found to exceed the AWS local failure allowable. The chord thinness ratio of the tube steel for this support had a value of 16 and was the largest value identified in the 171 supports. Based on reanalysis, the Applicant found no overstress conditions in the piping and supports with this support deleted from the analytical model. Nevertheless, the support is being modified by Applicants. A similar review to identify the steel with chord thinness ratios of 10 or more is being conducted for all Unit 2 pipe support designs.

CASE states that 6 supports which were referenced in Applicants' motion for summary disposition on generic stiffness had chord thinness ratios in the range of concern (i.e., greater than 7). CASE's Answer, p. 17. However, CASE did not indicate whether the punching shear on these supports was unacceptable. Applicants did not supply me with a list of pipe supports included in the sample of 171. If Applicants did include these 6 supports in the sample of 171 supports, I find that the actions being taken by Applicants provide a sufficient basis for concluding that the punching shear is not a safety concern with the pipe supports at CPSES.[7/]

Tube-to-Tube Joints With Beta Equal to 1.0

Q19. Mr. Terao, can you describe CASE's concern on tube-to-tube joints with betas equal to 1.0?

A19. CASE stated that the AWS Code sets forth a provision for calculation of a combined punching shear and web crippling effect in matched tubular connections (i.e., where the beta is equal to 1.0), but that the ASME Code does not contain a similar provision. According to CASE, this is indicative of the inadequacy of the ASME Code for the design of welded joints in pipe supports. CASE's Proposed Findings of Fact, pp. V.3-4.[8/]

Q20. What are the 1975 AWS and 1974 ASME Code requirements for such joints?

7/ I do not address the design QA questions that may be raised as a result of Applicants' identification of 1 out of 171 supports that exceeded the AWS local stress allowable due to punching shear. The significance of this matter to the programmatic design QA issue will be addressed by the Staff in another affidavit.

8/ CASE's discussion of stepped connections (i.e., when the betas are not equal to 1.0) on page 20 of their Answer is irrelevant to the concern with tube-to-tube joints with betas equal to 1.0.

A20. Section 10.5.1.1 of the AWS Code sets forth the design requirements for tube-to-tube joints with beta equal to 1.0. The AWS Code allowable for matched connections is the sum of the load capacity of the main member along the heel and toe welds plus the load capacity of the main member along its sides limited by the web crippling effects. The 1974 ASME Code, Appendix XVII, Paragraph 2261.2 also addresses web crippling effects.

Q21. How did Applicants address the concern with tube-to-tube joints with betas equal to 1.0?

A21. The Applicants compared the AWS Code's equations for matched tube-to-tube connections to the ASME Code Section III, Appendix XVII-2261.2 equation for web crippling. The Applicants concluded that the AWS and ASME Codes' equations for web crippling are similar and stated that the ASME Code provision is a requirement at CPSES. Applicants' Affidavit, pp. 9-11; Applicants' Statement of Material Fact, Paragraphs 13-15.

Q22. Mr. Terao, do you agree with Applicants' conclusion that the ASME Code provisions for these joints are comparable to AWS Code requirements, and are used at CPSES (Applicants' Statement of Material Facts, Paragraphs 13-15)?

A22. Yes. For matched tubular connections, punching shear is limited by the web crippling effect of the tube walls. CASE is correct in stating that the 1974 ASME Code's provision for evaluation of web crippling was formulated primarily for I-beams, and not tube steel. CASE's Answer, pp. 19-20. However, the ASME Code equation for web crippling is conceptually similar to the AWS Code equation for web crippling. The ASME and AWS Codes' equations differ because the AWS web crippling equation accounts for the two webs (walls) of tube steel, whereas the web crippling equation in the ASME Code is based on I-beams with only one web. Applicants indicated to the Staff that they modified the ASME Code equation to account for this difference[9/] and identified one example from CASE Exhibit 669B where web crippling was evaluated using the modified ASME Code equation. While, I do not agree with CASE's assertion (CASE's Answer, pp. 19, 21) that the ASME Code is inadequate for the design of tube-to-tube joints with betas equal to one. I cannot conclusively conclude that Applicants are using their modified ASME Code equation to evaluate web-crippling in tube-to-tube joints with betas equal to 1.0 in all situations where web-crippling may be a design consideration. Accordingly, Applicants should submit additional evidence

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9/ Applicants' Affidavit incorrectly identifies the equation, $F_m = 2t(N + 2k)\ (.75F_y)$, as the ASME Code equation for evaluating web crippling. Applicants' Affidavit, p. 11. In fact, this is the modified equation use for evaluating web crippling. The modification consists of using the term, 2t, instead of the original ASME Code term, t.

showing that they have appropriately used the modified ASME Code web-crippling equation.

The above statements are true and correct to the best of my knowledge and belief.

David Terao

David Terao

Subscribed and sworn to before me
this 2nd day of November, 1984

Malinda L. McDonald
Notary Public

My Commission expires: 7/1/86

David Terao
Professional Qualifications

I am a Mechanical Engineer in the Mechanical Engineering Branch of the U.S. Nuclear Regulatory Commission. I am responsible for the review and evaluation of the structural integrity and functional capability of safety-related mechanical equipment, piping systems, components and their supports for nuclear power plants.

I graduated from the University of Illinois (Urbana) in 1972 with a Bachelor of Science degree in aeronautical and astronautical engineering. In 1980, I completed the PWR Technology Course offered by the NRC.

From 1974 to 1980, I was employed at Sargent & Lundy Engineers in Chicago, Illinois, holding various positions in the field of nuclear piping design and analysis. Project assignments included several boiling water reactor plants (Dresden 2 & 3, Quad Cities 1 & 2, Bailly N-1, and Zimmer 1).

During 1976-77, I participated with the BWR Mark II Owners Group in the development of the technical justification for using the square-root-of-the-sum-of-the-squares (SRSS) method of combining dynamic responses in piping systems in BWR Mark II plants. In 1979-80, as project engineer, I was responsible for directing the reassessment of the piping systems in the Zimmer-1 plant for the Mark II hydrodynamic loads and load combinations.

I joined the NRC in July 1980. My responsibilities as a technical reviewer include overseeing contracts with a DOE laboratory for the review of the final safety analysis reports for plants under construction in the area relating to the design and analysis of mechanical components and component supports, and the preparation of safety evaluation reports. The operating license applications reviewed under my responsibility included the following plants: Waterford-3, LaSalle 1 & 2, Fermi-2, Wolf Creek 1 & 2, Callaway 1 & 2, Shoreham, Palo Verde 1, 2 & 3, Clinton 1, Grand Gulf 1 & 2, Susquehanna 1 & 2, Perry 1 & 2, Seabrook, Catawba, River Bend, Shearon Harris, Millstone-3, Beaver Valley-2, Hope Creek 1 & 2, and Nine Mile Point-2. As part of the licensing review, I oversaw the independent piping analyses performed for each of the above plants by the NRC's contract laboratory. Additionally, I am also working as technical reviewer for a contract involving the review of various nuclear power design specifications and design reports as required by the ASME Boiler and Pressure Vessel Code for nuclear components and component supports. Other responsibilities include providing technical assistance to the NRC regional offices when needed.

I am a member of the American Society of Mechanical Engineers (ASME) and an alternate representative to the ASME Working Group on Piping.

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In the Matter of TEXAS UTILITIES ELECTRIC COMPANY, *et al.* (Comanche Peak Steam Electric Station, Units 1 and 2)	)))))))	Docket Nos. 50-445 50-446

CERTIFICATE OF SERVICE

I hereby certify that copies of "NRC STAFF RESPONSE TO APPLICANTS' MOTION FOR SUMMARY DISPOSITION ON AWS AND ASME CODE PROVISIONS ON WELD DESIGN" have been served on the following by deposit in the United States mail, first class, or, as indicated by an asterisk, through deposit in the Nuclear Regulatory Commission's internal mail system, this 2nd day of November, 1984:

Peter B. Bloch, Esq., Chairman*
Administrative Judge
Atomic Safety and Licensing Board
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dr. Kenneth A. McCollom
Administrative Judge
Dean, Division of Engineering, Architecture and Technology
Oklahoma State University
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Dr. Walter H. Jordan
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