UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

REBUTTAL TESTIMONY OF W. E. BAKER, M. D. MUSCENTE, AND M. N. BRESSLER REGARDING ALLEGATIONS INVOLVING AWS AND ASME CODE PROVISIONS

Q1. Panel, please state your full names, residences, job titles, and educational and professional qualifications.

A1. (Baker) My name is William E. Baker. I reside in Granbury, Texas. I am the Senior Project Welding Engineer employed by Brown & Root, Inc. at Comanche Peak. My educational and professional qualifications are attached to Applicants' Rebuttal Testimony Regarding Allegations of D. Stiner and H. Stiner Concerning Weave Welding, Welding of Misdrilled Holes, Downhill Welding, and Weld Rod Control, previously filed in this proceeding.

(Muscente) My name is Matthew D. Muscente. I reside in Houston, Texas. I am the manager of Materials Engineering for Brown & Root, Inc. My educational and professional

qualifications are attached to Applicant's Rebuttal Testimony Regarding Allegations of D. Stiner and H. Stiner Concerning Weave Welding, Welding of Misdrilled Holes, Downhill Welding, and Weld Rod Control, previously filed in this proceeding.

(Bressler) My name is Marcus N. Bressler, I reside in Knoxville, Tennessee. I am the Staff Specialist of Codes and Materials for the Division of Engineering Design, Tennessee Valley Authority.[1] My educational and professional qualifications are attached. (Attachment A).

Q2. Panel, in overview fashion please describe the major steps in making acceptable welds.

A2. (Panel) The process of making acceptable welds entails at least three distinct but interrelated activities, <u>viz.</u>, (1) design of the weld joint, (2) development and qualification (testing) of a welding procedure to assure that the weld joint (and others with similar important parameters) can be welded so as to meet the design strength requirements, and (3) training and qualification of welders to assure that they are capable of welding with the procedure developed.

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1 The Tennessee Valley Authority, a federal agency, generally does not allow its employees to testify in NRC proceedings involving other licensees. Mr. Bressler is the Chairman of the ASME Work Group on Component Support and has significant expertise on the issues addressed in this testimony. Accordingly, Applicants will request that Mr. Bressler be subpoenaed, if necessary, to adopt this testimony and to testify further in this proceeding.

With regard to design of the weld, both the AWS and ASME Codes contain some requirements in this area (e.g., AWS D1.1 Code Section 2, Design of Welded Connections, and ASME Code, Appendix XVII). However, neither code provides all the details necessary to design a weld joint, and both codes rely heavily on the designer to assure that the weld joint is designed to meet the design and operating loads. To do this, the designer uses numerous reference sources and his skill as an engineer to provide a proper design which, pursuant to Appendix B to 10 CFR Part 50 and other regulatory requirements, goes through several review and approval stages before acceptance. It must be understood that the ASME and AWS Codes are primarily fabrication codes and not design codes. Thus, specific and complete design details are not included in either code.

After the weld joint is designed, a procedure to perform the weld must be developed or obtained. This process is discussed in detail later in this testimony.

Finally, the welder must be capable of welding the joint using the procedure. This entails a training and qualification process in conformance with applicable Code requirements to assure that the welder is qualified.

Q3. Panel, what is the purpose of this testimony?

A3. (Panel) This testimony will respond, in part, to CASE's allegations that the AWS Code contains ten specific provisions regarding welding design or welding procedures not addressed in the ASME Code or used at CPSES, and accordingly, that welding at CPSES in accordance with the ASME Code is unacceptable. Specifically, this testimony will address those provisions which relate primarily to weld procedure application, as opposed to weld joint design. Those provisions which specifically relate to weld joint design will be addressed in later testimony regarding design. In addition, this testimony addresses a related concern raised by the Board regarding downhill welding, weave welding, preheat requirements and cap welding.

Q4. Panel, please explain the basic philosophies of the ASME and AWS Codes as they apply to developing welding procedures?

A4. (Panel) Both the AWS and ASME Codes include requirements for welding procedures that will result in welds that are adequate for their intended uses.

The ASME Code requires that all welding procedures used for the fabrication and installation of components and their supports be qualified by test pursuant to the requirements of Section IX of the ASME Code. In order to satisfy these ASME requirements, each manufacturer or installer performing Code welding must conduct tests necessary to qualify each welding procedure.

On the other hand, the AWS Code provides for the use of either prequalified welding procedures (i.e., not requiring qualification testing prior to their use) or welding procedures which are qualified by test. In short, the ASME Code allows welding only with procedures based on qualification testing, while the AWS Code allows welding with welding procedures qualified by testing or with prequalified procedures.

The difference in philosophy between the AWS Code and ASME Code stems from the fact that the AWS Code covers structural welding in general along with specific requirements for use in the construction of buildings, bridges and architectural tubular structures. Thus, although its provisions for prequalification are generally applicable to any steel structure, the drafters of the AWS Code have acknowledged the limitations of that Code in stating that "when using the Code for other structures, owners, architects and engineers should recognize that not all of its provisions may be applicable or suitable to their particular structure." (AWS D1.2, Commentary on Structural Welding Code, Section 1.1.) (It should be noted that in any event, the AWS Code is not applicable to pressure retaining boundaries such as pressure vessels or piping systems. (AWS D1.1, Section 1.1.1).)

Thus, with the prequalified procedures in the AWS Code, welding may be performed without qualification testing. However, the AWS Code recognizes that if prequalified procedures are not applicable, then the user may qualify procedures by test instead of using the prequalified procedures.

Q5. Panel, please describe the process of weld procedure qualification as allowed by both the ASME and AWS Code and used at CPSES.

A5. (Panel) In qualifying welding procedures in accordance with the requirements of Section IX of the ASME Code (as well as Section 5 of the AWS D1.1 Code), a draft welding procedure is first written describing the precise status of certain variables specified in Section IX of the ASME Code (essentially the same specified in the procedure qualification section of the AWS Code). A test plate or pipe is prepared and welded in strict accordance with the draft welding procedures. Mechanical tests are then performed in accordance with the requirements of QW-140, Section IX of the ASME Code to determine if the weldment process and parameters are acceptable and adequate to produce welds that will withstand design and operating loads.

The tests are performed using specimens removed from the test plate or pipe. Each test has a separate purpose in determining whether the weld produced using the welding procedure is structurally sound and capable of withstanding design and operating loads. The tests required by the ASME Code, Section IX (which are essentially the same as endorsed by AWS) are as follows:

1. Tension tests, used to determine ultimate tensile strength, yield strength and ductility (reported as % elongation and/or % reduction of area);

2. Guided bend tests, used to determine the degree of soundness and ductility of groove weld joints;

3. Charpy V-Notch Impact or Drop Weight tests, used to determine the notch-toughness of the weldment (these tests are only performed when fracture toughness is specified in NF-2311, or for integral attachments, when required by other sections of the ASME Code); and

4. Fillet-weld tests, used to determine the size, contour, and degree of soundness of fillet welds (This test is used to qualify welding procedures when only fillet welds are to be produced using that procedure).

If acceptable results are obtained from the testing, the procedure has been qualified and a Procedure Qualification Record (PQR) is prepared listing the specified parameters used for the welding in the form of essential and non-essential variables. ASME Section IX specifies essential and non-essential variables for each welding process. An essential variable is a change in a welding condition which will affect the mechanical properties of the

weldment (for example, a change in base metals, welding process, filler material or weld rod, and preheat requirements). If an essential variable is changed, then new welding procedure qualification tests must be performed. A non-essential variable is a change in a welding condition which will not affect the mechanical properties of a weldment (such as joint design, and cleaning). A change in a non-essential variable would not require requalification of the procedure, but the procedure would have to be evaluated, and, if appropriate, amended to include this change.

Q6. Mr. Baker, do all welding procedures qualified by test pursuant to the ASME Code for use at CPSES follow the requirements of Section IX of the ASME Code?

A6. (Baker) Yes. Section IX of the ASME Code is employed to assure that all procedures used have been properly qualified. This includes following requirements regarding test procedures, essential and non-essential variables, testing of specimens, and all other aspects which could affect the procedure qualification process.

Q7. Panel, if a welding procedure is qualified by test in accordance with each provision of Section IX of the ASME Code, will use of that procedure produce welds that are structurally sound and as adequate for their intended use as

welds produced using either prequalified procedures of the AWS Code or procedures qualified by test in accordance with the AWS Code?

A7. (Panel) Yes. The ASME Code and its qualification test procedures were developed only after thorough, rigorous and complete review, testing analyses and study by literally thousands of engineers, scientists and other highly skilled and qualified professionals. Further, prior to its adoption this qualification test process set forth in Section IX of the ASME Code received significant and extensive peer review and critique. Finally, the qualification test procedure has withstood the test of time and has proven time and time again that using it will produce welds which are adequate for their intended purpose and every bit as sound as welds produced pursuant to prequalified AWS procedures or procedures qualified by test pursuant to the AWS Code.

Q8. Panel, in CASE's Proposed Findings at page V-1, CASE states that "Applicants on several occasions state categorically that the provisions of the welding Code AWS D1.1 do not apply at CPSES, since they are covered by Section IX of ASME. (See Applicant's Exhibit 142F, page 3, Mr. Finneran's Answer No. 8 to Question in reference to Mr. Doyle's suggestion that AWS D1.1 is required for weld analysis.)" Is the D1.1 AWS Code applicable to welding at CPSES?

A8. (Panel) At the outset, it should be noted that contrary to CASE's statement, Mr. Finneran did not "categorically" state that the Structural Welding Code, AWS D1.1, does not apply at CPSES. Rather, in response to the question of whether the AWS Code is applicable to "safety-related pipe supports at Comanche Peak," Mr. Finneran answered "No." This was in no way meant to imply that the AWS Code is not used for any welding at CPSES. The AWS Code is used for some welding of non-ASME components (such as some cable-tray supports and some building structures) at CPSES. In addition, the AWS Code is frequently used by designers and engineers at CPSES as a reference (along with numerous other industry documents) in performing tasks such as design, design review or verification of weld parameters.

Q9. Panel, are you familiar with CASE's allegations that ten AWS Code provisions were not considered by the ASME Code and applicable CPSES welding procedures?

A9. Yes, these allegations are that the AWS Code includes certain provisions not considered by the ASME Code or used at CPSES; i.e., (1) "Preheat requirements for welds on plates over 3/4-inch thick," (2) "Drag angle and work angles (which limit the space allowed for the welder to function," (3) "Beta factor for tube-to-tube welds," (4) "Multiplication factor and reduction factors for skewed "T" weld joints," (5) "Limitations on angularity for skewed "T"

joints," (6) "Calculations for punching (actually a reduction factor for the weld) shear on step tube joints," (7) "Lap joint requirements," (8) "Design procedure for joint of tube to tube with Beta equal to 1.0," (9) "Limitation on weld sizes relative to plate thickness," and (10) "Calculation for effective throat of flare bevel welds." (This last item was closed out by the Board's Memorandum and Order of December 28, 1983 at page 41).

Q10. Panel, of the nine items noted above which are still open, four items (4, 5, 6 and 8, above) deal primarily with weld joint design and will be discussed in testimony regarding design which will be filed at a later date. Have you conducted any research with regard to the remaining five open items (1, 2, 3, 7 and 9, above)?

A10. (Panel) Yes, we have researched these five items which CASE has characterized as AWS Code provisions and found that not all five are AWS Code provisions.

Q11. Panel, could you please tell us what your research entailed?

A11. (Panel) We first examined the applicable AWS Code to find out if there were any AWS Code provisions related to the item. Next we examined the applicable ASME Code provisions to determine if and how the corresponding AWS Code provision (if any) had been taken into consideration. Finally, we checked to assure that the applicable procedures at CPSES took into consideration the relevant provisions.

Q12. Panel, would you please describe the results of your analysis for "preheat requirements for welds over 3/4-inch thick."

A12. (Panel) The AWS D1.1 Code addresses preheat requirements for prequalified procedures in Subsection 4.2, "Preheat and Interpass Temperature Requirements." (If procedures are to be qualified by test pursuant to the AWS Code, the preheat requirements specified in subsection 4.2 need not be used.) For these prequalified procedures, Table 4.2 establishes preheat requirements based on the type of material and the welding process used. For example, for shielded metal arc welding with low hydrogen electrodes on A36 rolled shapes and A500 Grade B structural tubing, the requirements are as follows:

Thickness (inches)	Minimum Temperature
Up to 3/4	None
Over 3/4 thru 1-1/2	50°F
Over 1-1/2 through 2-1/2	150°F
Over 2-1/2	225°F

Subsection NF-4611 of the ASME Code also addresses preheat requirements based on various properties, as follows:

> The need for and temperature of preheat are dependent on a number of factors, such as the chemical analysis, degree of restraint of the parts being joined, elevated temperature, physical properties and material thickness. Some practices used for preheating are given in Appendix D as a general guide for the materials listed by P-Numbers of Section IX. It is cautioned that preheating suggested in Appendix D does not necessarily ensure satisfactory completion of the welded joint and that the preheat requirements for

> individual materials within the P-Number listing may be more or less restrictive. The Welding Procedure Specification for the material being welded shall specify the minimum preheating requirements under the welding procedure qualification requirements of Section IX [emphasis supplied].

In short, while Appendix D of the ASME Code, Section III, provides guidance for preheat requirements (very similar to that provided in the corresponding sections of AWS), the Code states that during welding procedure qualification, the preheat requirements which have been actually tested and produce acceptable welds are the ones to be specified in the applicable procedures.

(Baker) Qualification of procedures in accordance with the ASME Code has resulted in preheat requirements in the applicable CPSES welding procedures that in all cases either meet or exceed those preheat requirements set forth in the AWS Code.

(Panel) In sum, CASE's allegation that preheat requirements set forth in the AWS Code are not adequately considered at CPSES is without merit.

Q13. Panel, would you please describe the results of your analysis for "Drag Angle and Work Angles" (which limit the space allowed for the welder to function).

A13. (Panel) Contrary to CASE's allegation, neither the AWS nor ASME Codes refer to, or in any way mention "drag angle" or "work angle" requirements or restrictions. In its February

1, 1984, Answer to Applicants' Motion for Reconsideration, CASE provides some clarification to its concern and states in the attached Affidavit of Jack Doyle that the weld designer must take into consideration the welder's drag and work angles. For support, CASE references the Welding Handbook, Seventh Edition, Volume 2. It should be noted that this Handbook in no way states or implies that the drag angle or work angles of a welder should be an explicit design consideration. Regardless of the weld design, the skilled welder assumes the proper drag and work angle for the job. Indeed, that very portion of the Welding Handbook referenced by CASE and attached to the Doyle Affidavit states that proper work orientation of the weld rod (e.g., drag and work angle) are "automatically taken into account" by the trained welder. In short, the welder's very basic training provides this information as well as the precautions a welder has to take to make successful welds. (Baker) Where the area which surrounds the weld of concern is limited so as to potentially adversely impact a welder's ability to maintain proper weld orientation, as a matter of practice at CPSES welders are used who have practiced and been tested in these configurations. For example, on piping where space limitations may require welding using a mirror without directly seeing the weld, welders are trained and tested in this configuration to assure that the weld is

performed correctly. Many times mock-ups of the configuration (including simulating the limited space) are constructed to provide precise conditions the welder will encounter. A qualification listing and matrix of the "specially" qualified welders is maintained.

(Panel) In any event, CASE's stated concern regarding improper work angle and drag angle is that it may cause slag entrapment, porosity and undercut. These defects are no different than potential concerns regarding any other weld. Because of welder training and qualification, coupled with inspections and surveillance of the Welding Engineering Department and QA/QC, there is reasonable assurance that any problems regarding slag entrapment, porosity and undercut will be detected and corrected, as necessary.

In sum, CASE's allegations concerning drag angle and work angle are without merit.

Q14. Panel, would you please describe the results of your analysis for "Beta Factor for Tube-to-Tube Welds"

A14. (Panel) The Beta factor (the ratio of the diameters of two adjoining tubes) is referenced in Section 10 of AWS D1.1 Code, subsection 10.12.5, 10.13.5 and Figure 10.13.5. In essence, these references provide that if the Beta Factor is greater than 1/3 for tube-to-tube (circular) connections and greater than 0.8 for box (rectangular) connections, the weld procedure used must be qualified by test (the greater the

Beta factor, the more likely that stresses at the joint will be higher). In short, where the likelihood of greater stresses is present, the Beta Factor is used in the AWS Code to indicate that qualification of a procedure by test is required. Significantly, the ASME Code requires that all weld procedures be qualified, without consideration of the likelihood of greater stresses.

In any event, in Mr. Doyle's testimony (CASE Exhibit 669, Vol. I, page. 112), he states as his concern that the Beta factor limit of 1/3 applies for shielded metal arc fillet welds used when welding trunions to pressure boundary piping. Since such a trunion would be an "integral attachment" to the piping, the AWS Code does not apply and the weld must be designed to the applicable pressure boundary subsection in ASME, i.e., NB, NC, or ND. AWS D1.1 (as stated in paragraph 1.1.1) clearly does not apply to this case (i.e., pressure boundary piping) and Mr. Doyle's concerns are unfounded.

(Baker) It should be noted that in addition to the qualification of these procedures by testing, CPSES also has performed additional generic testing on equal sized box connections (B=1.0) to assure that penetration depth and minimum throat requirements (the major concerns for these welds) are adequate for rectangular beam welds.

(Panel) From the foregoing, CASE's concerns regarding AWS Code requirements concerning Beta Factor are without merit.

Q15. Panel, would you please describe the results of your analysis for "Lap joint requirements."

A15. (Panel) Subsections 9.10.1, 9.10.2 and 9.10.3 of the AWS D1.1 Code provide lap joint requirements. Appendix XVII of the ASME Code (mandatory to CPSES welding in conformance to ASME requirements) provides corresponding provisions as follows:

1. AWS Code Subsection 9.10.1: ASME Code, Appendix XVII, Paragraph XVII-2431.
2. AWS Code Subsection 9.10.2: ASME Code, Appendix XVII, Paragraphs XVII-2452.3(c) and 2453.1.
3. AWS Code Subsection 9.10.3: ASME Code, Appendix XVII, Paragraphs XVII-2452.9 and 2283.1(c).

In short, these ASME Code provisions (with which applicable welding at CPSES complies) correspond to the AWS Code. Accordingly, CASE is not correct in stating that the ASME Code and applicable welding at CPSES does not adequately consider lap joint requirements as noted in the AWS Code.

Q16. Panel, would you please describe the results of your analyses for "Limitation on weld size relative to plate thickness."

A16. (Panel) Limitations on weld size relative to plate thickness are addressed by AWS D1.1 Code in Subsections 2.7 (fillet welds) and 2.10 (partial penetration groove welds). These subsections basically provide that with regard to fillet and

groove welds, welds to be made without qualifying the applicable procedure by test shall conform to the minimum size requirements of Tables 2.7 and 2.10.3, respectively. These requirements are identical to those required at CPSES by the ASME Code in Appendix XVII, Table XVII-2452.1-1.

In sum, the limitations on weld size relative to plate thickness set forth in the AWS Code are considered in the ASME Code and factored into applicable procedures at CPSES. Accordingly, CASE's allegation that this AWS Code provision was not adequately considered is incorrect.

Q17. Panel, in its January 3, 1984, Memorandum, the Board requested that additional testimony be provided as to the requirements of both Codes concerning weave welding, downhill welding, heat treatment and cap welding. Would you please explain the specific requirements, if any, in each Code regarding these issues and state how CPSES factors these requirements into its procedures?

A17. (Panel)

1. Weave Welding

Neither the AWS nor ASME Codes establish specific requirements limiting weave or oscillating pattern welding. Accordingly, there are no specific Code requirements.

It should be noted, however, that for shielded metal arc welding (the welding of concern) bead width is listed as a supplementary essential variable in Section IX of the ASME Code when impact properties are specified, and a nonessential variable when not specified. In either case, while applicable CPSES welding procedures set an upper limit on bead width, the bead width can vary below that limit without impacting the procedure.

As stated in previous testimony, CPSES welding procedures have limited bead width to four times the core diameter of the weld rod being used. Other industries which comply with the Codes and perform qualification tests of procedures generally use bead widths in excess of four times the rod core diameter, up to and including eight times the rod core diameter.

In sum, although there are no specific Code requirements regarding bead width (other than considering it as a supplementary essential or non-essential variable, as stated above) relevant procedures at CPSES limit the bead width to four times the rod core diameter.

2. Downhill Welding

Neither the ASME nor AWS Codes exclude use of downhill or uphill welding. However, the ASME Code and the AWS Code specify that the direction of travel must be listed. At CPSES, Brown & Root welding procedures state that in all instances the direction of progression will be upward. Other contractors, in a few instances, have performed qualification testing using downward progression, and downhill welding by those contractors is thus permissible.

In short, direction of travel is considered at CPSES and is appropriately factored into welding procedures.

3. Preheat Requirements

Code requirements concerning this area and how they are addressed at CPSES are discussed above in relation to CASE's concern regarding "preheat requirements for welds on plates over 3/4 inch thick."

4. Cap Welding

Cap welding is not terminology common to welding. The usual reference is a cover pass or a reinforcement pass. There are no additional Code requirements regarding cap welding; Code requirements for other

welding apply equally to cap welding. Indeed, the AWS Code (1975 Revision) specifically endorses it as follows:

> Additional weld material to compensate for any deficiency in size shall be deposited using an electrode preferably smaller than that used for making the original weld, and preferably not more than 5/32 in. (4.0 mm) in diameter. The surfaces shall be cleaned thoroughly before welding. [Section D1.1, subsections 3.7.1].

To the extent that CASE is concerned that new weld material cannot be placed on an old weld without some adverse structural impact, CASE's concern is without merit. Neither Code provides any restrictions in this area, or even requires its consideration as an essential or non-essential variable. Such practice occurs daily when a welder takes a lunch break during a weld, or stops in the middle of a weld due to crew change or even to change a weld rod. In all such instances the welder simply follows his procedure to complete the weld. This would require actions such as cleaning the weld surface and assuring that preheat requirements, if any, are met (in most instances 60°F).

(Baker) It should be noted that CASE's concern stems from the fact that some fillet welds in the plant were found to be 1/16 inch below the minimum size specified

in the ASME Code. These welds were subsequently corrected by following appropriate welding procedures that consisted of, among other things, cleaning the weld, assuring preheat requirements were being met, welding the additional pass and obtaining a final QC visual inspection. It should be noted that in no instance did any welder or QC inspector report a crack in any of the welds.

(Panel) Specifically, CASE's concerns appear to be that the minimum size of the weld may have resulted in miscellaneous cracks (caused by external loading on the undersized weld), internal cracking or underbead cracking which would be aggravated when additional material is used to build up the weld.

In the first instance, the welds were designed to resist extensive and substantial seismic loading well in excess of any external loading that did occur from the time that the welds were made until they were built up. In this regard, it should be noted that even with undersized welds, the AWS Code states that the weld is still acceptable even if undersized 1/16 of an inch for 10 percent of the weld length (AWS Code, Sections 8.15.1.6 and 9.25.1.6). The ASME Code added this provision to Subsection NF in the winter 1983 addenda.

Accordingly, CASE's speculation that miscellaneous weld cracks may have formed due to external loading on these welds is without merit.

As to CASE's concerns that internal cracking may have formed because the weld was undersized in the first instance, this is again incorrect. Indeed, it is well known and a very basic principle of welding that the primary reason for internal cracking is not an undersized pass, but rather a weld pass that is too thick. Handbooks on welding have for years stated that to prevent internal cracking you limit the volume of the weld material deposited, not assure that more is deposited. See e.g., Omer W. Blodgett, Design of Welded Structures (1968) at page 7.2-4 which states that "the recommended preventive measures to eliminate internal cracking in fillet welds is to limit the penetration and the volume of weld metal deposited per pass."

As to CASE's concerns that because the welds may have been slightly undersized there is a substantial problem with underbead cracking, this position is again without any supporting basis. Underbead cracking is not a problem with the mild or low carbon structural steels such as used for the bulk of the fabrication of pipe supports at CPSES, including those supports on which the undersized welding referenced by CASE occurred. These

steels contain only carbon and manganese as alloying elements (.29% maximum carbon) and do not form the martensite grain structure in the heat affected zone of the base material that is necessary to promote underbead cracking. The high strength, low alloy steels which contain varying amounts of chromium, vanadium, zirconium, nickel and phosphorous (and thus could result in formation of martensite in the heat affected zone) are only used for special applications at CPSES. Where these materials are used, specific welding procedures are utilized containing special preheats (300° - 400°F) and post weld heat treatment to prevent weld shrinkage and martensite formation, necessary to cause underbead cracking.

In addition to the presence of martensite and stresses caused by weld shrinkage, the presence of entrapped hydrogen is also required to develop underbead cracking. Depending on the steel, with the elimination of either the martensite or hydrogen, underbead cracking will not occur. The hydrogen content of the weld can be reduced or eliminated through the use of low hydrogen electrodes. The martensite grain structure in the heat affected zone can be eliminated through the use of

preheat and post weld heat treatment as specified for the material in ASME III Subsection NF Article 4000 and the applicable welding procedure.

To summarize the above, to prevent underbead cracking, only low hydrogen type electrodes are utilized for the welding of any low or mild carbon steels or high strength low alloy structural steels. Further, the bulk of the pipe support fabrication employs carbon steels not subject to underbead cracking problems. For those special items utilizing steels which may be subject to underbead cracking, welding procedures are utilized which contain the necessary preheat or post weld heat treatment requirements to eliminate the metallurgical conditions which are necessary for underbead cracking to occur. In short, CASE's concerns regarding underbead cracking are totally without merit.

In sum, the concerns regarding cracking raised by CASE are without technical merit. In any event, it must be remembered that no cracks were identified by either the welders or QC inspectors for any of the undersized welds. If cracks had been a problem, at least some of them would have been detected and reported. In that the weld procedure contains preheat requirements, new

cracking would not be a problem. (It should be noted that preheat requirements make the AWS D1.1 Code requirement to complete a weld in one pass unnecessary.)

In short, to the extent that CASE is concerned with welding over previously welded joints, such concerns are completely groundless.

Attachment A

PROFESSIONAL QUALIFICATIONS
OF
MARCUS N. BRESSLER

EDUCATION: M.S.M.E., Case Institute of Technology, 1960; B.M.E., Cornell University, 1952; MIT, Behavior & Properties of Materials at Elevated Temperatures, 1958; Georgia Institute of Technology, Thermal Stress & Low Cycle Fatigue, 1963; Penn State University Extension, ASME Code Section VIII, 1967; University of Delaware, Theory of Plates and Shells, 1970; Union College, Seminar on Fracture Mechanics, 1972.

EXPERIENCE:

1979 to Present: Tennessee Valley Authority -- Staff Specialist -- Codes, Standards and Materials. Acts as consultant on Codes, Standards and Materials to all Divisions of TVA. Provides technical support to the Nuclear Engineering Branch and to the Division of Construction in the design and installation of nuclear power plant equipment and is also involved in failure analysis. Acts as principal contact with ASME for code activities.

1971-1979: Tennessee Valley Authority, Division of Engineering Design, Mechanical Design Branch -- Principal Engineer -- Nuclear Standards and Materials. Supervisor of nine welding and metallurgical engineers. Responsible for the review and approval of all equipment and components supplied by the Nuclear Steam Supply System vendor and the subcontractors under his scope of supply to include the reactor primary coolant pressure boundary to the outer isolation valve.

Prepared and certified ASME Section III, Division 1, Design Specifications -- Coordinator for branch. Contributed material to the TVA Quality Assurance Plan, the Preliminary and Final Safety Analysis Report, and the Design Criteria and Construction Specifications within scope of responsibility. Consultant to other Divisions of TVA on Codes and Materials.

1970-1971: Gulf & Western Industrial Products Co., Taylor Forge Division -- Manager -- Product Design and Development. Responsible for the design,

development, prototype testing and certification of new products. Supervised flange and piping product design.

1966-1970:	Gulf & Western Industrial Products Co., Lenape Forge Division -- Manager of Design Engineering (1968). Responsible for Design of Nozzles, Flanges, Pressure Vessel Connections and Quick-Opening Manways.
1955-1966:	The Babcock & Wilcox Company, Barberton, Ohio, -- Technology Supervisor -- Materials (1962). Boiler Division Materials Engineer -- responsible for the selection of materials for boiler and pressure vessel components.
1953-1955:	Army Environmental Health Laboratory, Industrial Hygiene.
ADDITIONAL INFORMATION:	Registered Professional Engineer -- Ohio and Tennessee; Member -- Cornell Society of Engineers; and Author or co-author of fourteen technical papers.
HONORS:	ASME Certificate of Appreciation, Boiler and Pressure Vessel Committee, 1976 ASME Century Medallion, 1980 Listed in Who's Who in Technology, 1981, 1982, 1983 Listed in Who's Who in International Engineering, 1984 Fellow ASME, 1984

EXPERIENCE OUTSIDE OF EMPLOYMENT:	1963-Present	ASME Boiler & Pressure Vessel Committee
	1963-1966	Secretary, Subgroup on Strength -- Steel & High Temperature Alloys (SCP)
	1965-1971	SG Materials (Sec VIII)
	1966-1980	SC Openings and Attachments; SG Strength, Steel and High Temp Alloys
	1971-1983	SC on Nuclear Powers SG MTLS (SC III)
	1973	SC on Nuclear Certification
	1973-1978	SG Elevated Temp Construction (SC III)
	1973	TG Component Support Materials (SG MTLS/SC III) -- Chairman
	1974	SC Design (SC III); WG Valves (SGD/SC III) -- Chairman until 1972; TG Editorial Revisions (SC III)
	1975	SCNC -- Vice Chairman (now SC on Nuclear Accreditation)
	1976	AD HOC Committee on B16.5/B16.34 Acceptability

1977	Chairman, WG Comp Supports (SGD/SC III); TG on Code Stress Criteria (MC) until 1982
1978	WG Valves (SGD/SC III) Resigned as Member; TG on Operating Owners Cert (MC) until 1981
1979	Main Committee; Reappointed 1983
1981	TG on Metrication (SC III)
1982	TG on Meetings and Operations (MC)
1960-Present	ASTM Committee A-1 on Steel, Stainless Steel and Related Alloys A01.06, A01.11, A01.15, A01.22, A01.93 and Related Subgroups, Member, Committee A-1
1973-1980	Metal Properties Council SC1 -- Steel for Boilers & Pressure Vessels
1980-Present	MPC Subcommittee 6 -- Chairman TG on Materials for Nuclear Power Plants. Member, MPC Technical Advisory Committee

Seminars Instructed: In-House, Buffalo Pump -- QA & Pump Design, February 1976, North Tonawanda, New York

QA In Nuclear Power Plants, ASME, June 1976, Chicago, Illinois

Design, Materials, Fabrication, Brown & Root, Inc., October 1975, Houston, Texas

B31.1, B31.5, Section I, Section VIII, Penelec, September 1977, Johnstown, Pennsylvania

Materials Application, AWS Section, September 1977, Oak Ridge, Tennessee

QA In Nuclear Power Plants, TSI, Inc., February 1978, Los Angeles, California

ASME Section III -- Part II -- Design of Vessels, Piping Pumps, Valves and Component Supports, May 1978, New York, New York

Intro to Sec III, Part I, Brown & Root, Inc., May 1978, Houston, Texas

QA In Nuclear Power Plants, ASME, June 1978, San Francisco, California

Fossil Plant Codes, Penelec, July 1978, August 1978, Johnstown, Pennsylvania

Design of SEC VIII Vessels, TSI, Inc., September 1978, Chicago, Illinois

QA In Nuclear Power Plants, TSI, Inc., April 1979

ASME Section -- ASME Codes and Why They Work, 1977, East Tennessee

ASM/AWS Section -- Fabrication of Heavy Wall Pressure Vessels, 1979, Winston Salem

QA in ASME III, ASME, January 1979, Ft. Lauderdale, Florida

Design of Nuclear Components, TSI, Inc., February 1979

Introduction to Section III and Design and Fabrication of Section VIII Vessels, ASME, November 1977, Buenos Aires, Argentina

Metallurgical Problems in Nuclear Power Plants, December 1978, Buenos Aires, Argentina

New Developments in Design of Pumps and Valves, PSEG, October 1977, Newark, New Jersey

Introduction to Section III, Texas Utilities Services, Inc., September 1979

Introduction to Section III, Baltimore Gas and Electric, March 1979, Calvert Cliffs

Introduction to Section III, TVA, 1975, 1979, 1980, 1981, 1982, 1983

Design of Component Supports, Byron Nuclear Plant, 1982

Introduction to Section III, Kraftwerk Union, 1979, Erlangen, West Germany

Design of Nuclear Power Plant Components, Kraftwerk Union, 1979, Erlangen, West Germany

QA in Nuclear Power Plants, Kraftwerk Union, 1980, Elangen, West Germany

In-House, Design of Components, Mannessmann, 1982, Dusseldorf, West Germany

In-House, Design of Nuclear Power Plant Components, Kraftwerk Union, 1983, Erlangen, West Germany

In-House, Introduction to Section III, Ontario Hydro, 1981-1983, Toronto, Canada

Design of Component Supports, 1982-1983

Design of Nuclear Components, 1982

In-House, Introduction to Section III and other ASME Standards with Don Landers, ICA, Nuclear Laguna Verde Nuclear Plant, 1983, Vera Cruz, Mexico

General Requirement -- Design of Component Supports -- ASME for Defense Services Command, 1982, Bath, England

Instructor, ASME Courses	INTRODUCTION TO SECTION III	
	New York	1974
	New York	1975
	Mexico City, Mexico	1976
	San Francisco	1976
	Atlanta	1977
	Montreal, Canada	1978
	Chicago	1979
	San Francisco	1979

DESIGN OF PUMPS AND VALVES	
New York	1975
Atlanta	1977
San Francisco	1978
San Francisco	1979
Toronto	1981
DESIGN OF COMPONENT SUPPORTS	
San Francisco	1978
San Francisco	1979
New York	1980
Denver	1981
Toronto	1981
San Diego	1981
Atlanta	1981