April 21, 1983

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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)

APPLICANTS' BRIEF REGARDING CONSIDERATION OF THERMAL STRESSES IN DESIGN OF PIPE SUPPORTS

I. INTRODUCTION

In its conference call of April 7, 1983, the Licensing Board in the captioned proceeding requested that the parties submit briefs regarding the applicable NRC requirements and guidance governing the consideration of LOCA conditions in the design of pipe supports. The Board stated that the brief should provide a "discussion of the relationship between the different regulatory materials, including the design criteria, the standard review plan, staff guidance, staff practice, and applicable industry codes" on this topic. [1] Specifically, the Board inquired as to the legal basis for the conclusion that loads in support

[1] Tr. 43. (Transcript references are to the transcript of the April 7, 1983, Conference Call unless otherwise noted.)

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anchorages and stresses in support steel due to differential thermal expansion in pipe support members under LOCA conditions need not be addressed in the design of individual pipe supports.[2]

A. Background

The issue of whether stresses resulting from differential thermal expansion of pipe supports induced by elevated temperatures within containment following a LOCA need be considered in the design of those supports arose in this proceeding as a result of allegations made by CASE witnesses Walsh and Doyle.[3] Applicants responded to these allegations with detailed testimony[4] at the September, 1982 hearing session by a panel of experts highly qualified in the design of piping and support systems for nuclear power reactors and eminent in the field of American Society of Mechanical Engineers ("ASME") Code requirements. In their testimony, Applicants' witnesses demonstrated that the ASME Code did not require consideration of such LOCA-induced stresses in the design of pipe supports and that this aspect of the Code was based on sound engineering

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2 See Tr. 30-31 whereat Judge Jordan referred to I & E Report 82-26/82-14 (February 15, 1983) at pp. 18-24.

3 See CASE Exhibit 669 at pp. 14-21, 36-63 and Attachment E, and Tr. 3109-3145.

4 Applicants' Exhibits 142, 142F.

principles and judgment. [5] The NRC Staff concurs with Applicants that stresses due to differential thermal expansion in pipe supports under any conditions need not be considered in the design of pipe supports. [6]

B. Issue Presented

It is essential at the outset to establish the precise nature and scope of the conclusions reached by the Applicants and NRC Staff regarding consideration of stresses induced by differential thermal expansion of pipe supports. This will assure that the information necessary to respond to the Board's inquiry is presented concisely. Accordingly, Applicants provide the following discussion.

1. Allegations of Messrs. Walsh and Doyle.

The LOCA-induced stresses of concern to CASE witnesses Walsh and Doyle (and addressed by Applicants and the NRC Staff) are those which result from the differential expansion induced under LOCA (i.e., high temperature) conditions between the support steel in a linear-type pipe support [7] and the structures to which

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5 See e.g., Applicants' Exhibits 142 at 14-25, 142F at 3.

6 I & E Report 82-96/82-14, at 24.

7 ASME Code Paragraph NF-1213 defines a Linear-Type Support as follows: A linear type component support is defined as acting under essentially a single component of direct stress. Such elements may also be subjected to such stresses.

the support is attached. Specifically, Walsh and Doyle argued that the analysis of individual supports should include consideration of stresses induced due to thermal expansion of the support under LOCA (i.e. high temperature) conditions. These stresses arise from the restraint against expansion exerted either by rigid connections (viz., anchorages) to the surrounding structure or by the structure itself (i.e., wall-to-wall or floor-to-ceiling support members).[8] In addition, Walsh and Doyle contended that the loads induced in the support anchorages themselves as a result of this differential thermal expansion should also be calculated in the analysis of individual supports.[9]

2. Applicants' and Staff's Conclusions Regarding the Walsh/Doyle Allegations.

In response to those allegations, Applicants' witnesses demonstrated that such thermal stresses were self-limiting because slight deformations of connections or support members would relieve those stresses without loss of function.[10] Applicants further demonstrated that applicable provisions of the

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8 The Board should examine the discussion at the September 16, 1983 hearing (Tr. 5233-76) for a further explanation of the geometry involved in these supports.

9 CASE Exhibit 669 at 14-21, 36-63 and Attachment E; Tr. 3109-45.

10 See Applicants' Exhibits 142 at 21-25; 142D.

ASME Code allow individual linear-type pipe supports to be designed without consideration of such secondary (i.e., self-limiting) stresses.[11] The NRC Staff has concurred in these conclusions.[12] In sum, both the Applicants and the Staff have concluded that the stresses in pipe supports and anchorages which result from the differential thermal expansion in a LOCA environment between the supports and the structures to which they are attached need not be addressed in the design of individual pipe supports.

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11 Applicants' Exhibit 142 at 14-21. Walsh and Doyle contend that such secondary stresses must be considered as primary stresses in the analysis of linear-type pipe suports. However, as demonstrated by Applicants' witnesses, even where the ASME Code requires evaluation of secondary stresses (e.g., Class 1 vessels) the allowable limit is three times the allowable limit for primary stress. In contrast, in components where only linear (and not multi-directional) stresses are considered, the Code does not require evaluation of secondary stresses because the displacements are limited by virtue of limits on temperature. Id. at 17.

12 I&E Report 82-29/82-14 at 21. The Staff requested that confirmatory shear tests of the deflection/load characteristics of 1 1/2 inch Richmond inserts be conducted. I & E Report 82-29/82-14 at 21. These tests have now been successfully completed and their results will be provided for the record.

3. Scope of Applicants' and Staff's Conclusions.

The Board should note that the allegations of Walsh and Doyle, and the Applicants' and Staff's responses thereto, concern only loads or loading combinations which may be imposed on pipe supports as a result of a LOCA, as discussed above. Those allegations do not implicate the loads on pipe supports resulting from the mechanical and dynamic forces associated with LOCA events. Those loads and associated stresses are the subject of extensive analysis for all pipe supports. [13] Those allegations do not implicate the stresses induced in the pipe supports as a result of the thermal expansion of piping following a LOCA. Those stresses also are considered, [14] as are the variations in allowable stresses which result from changes in the temperature-sensitive pipe support material properties in a LOCA environment.[15] In short, Applicants have considered the effects on pipe supports resulting from LOCA events, and the intervenor's allegations do not involve those considerations. It is only

13 See discussion infra.

14 See FSAR Tables 3.9B-1C and 1D. Applicants note that these effects are considered for Class 1, 2 and 3 supports even though it is not considered necessary with respect to Class 2 and 3 supports. See Regulatory Guide 1.48, p. 1.48-4, ASME Code Class 2 & 3 Piping.

15 See Regulatory Guide 1.124, and the discussion thereof, infra at 19-21.

those stresses induced in the supports and their anchorages as a result of differential thermal expansion under LOCA conditions which are the subject of the allegations.[16]

Accordingly, in view of the allegations made and the carefully-defined conclusions of the Applicants and the NRC Staff, the issue before the Board is clear, viz., LOCA-induced secondary stresses in pipe supports resulting from differential thermal expansion, and this brief addresses that issue. Applicants believe that this inquiry is best addressed with an examination and interpretation of applicable NRC regulations, guidance and practice which govern the consideration of those stresses. As demonstrated below, both NRC regulations and guidance implementing the General Design Criteria provide for the utilization of applicable ASME Code provisions in the construction of pipe supports. The Code provides that these

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16 The record reflects that there had been extensive consideration given to the inclusion of these stresses in the analyses of pipe supports even before Walsh and Doyle presented their allegations in this proceeding. It was concluded on the basis of interpretation of the ASME Code and the engineering judgment of experienced professional engineers that those stresses need not be addressed in the analyses of individual supports. In addition, Applicants subsequently confirmed through case-specific analyses (received into evidence here) that the assumptions premised on the ASME Code and engineering judgment were valid. A more detailed discussion of the record appears infra, at pp. 23-27.

thermal expansion loads need not be calculated in the stress analysis of individual pipe supports because they are self-limiting and therefore of a secondary nature.

II. APPLICABLE REGULATORY REQUIREMENTS GOVERNING CONSIDERATION OF LOCA EFFECTS

A. General Design Criteria

NRC requirements governing the design of structures, systems and components important to safety are the General Design Criteria ("GDC") set forth in Appendix A to 10 C.F.R. Part 50. The General Design Criteria establish minimum requirements for the principal design criteria for nuclear power reactors. 10 C.F.R. §50.34(a)(3)(i). These principal design criteria must be established at the time an application for a construction permit is submitted, 10 C.F.R. §50.34(a)(3)(i), and are to provide the necessary design, fabrication, construction, testing, and performance requirements for structures, systems, and components important to safety. 10 C.F.R. Part 50, Appendix A, Introduction. Applications for operating licenses are to include a sufficient description of the structures, systems and components of the facility to permit an understanding of the system designs and their relationship to safety evaluations. 10 C.F.R. §50.34(b)(2).

Three General Design Criteria govern the consideration of the effects of a LOCA on the structures, systems, and components important to safety, including pipe supports. First, GDC-1 (quality standards and records) provides, in part, as follows:

> Structures, systems, and components important to safety shall be designed, fabricated, erected, and tested to quality standards commensurate with the importance of the safety functions to be performed. [10 C.F.R. Part 50, Appendix A, GDC-1.]

GDC-1 also provides that generally recognized codes and standards may be used to satisfy the criterion where such are identified and evaluated to determine their applicability, adequacy, and sufficiency. Such codes and standards are to be supplemented or modified if necessary to assure a quality product in keeping with the required safety function.

In addition, GDC-2 (design bases for protection against natural phenomena) provides that the design bases for structures, systems, and components important to safety shall reflect, <u>inter alia</u>:

> appropriate combinations of the effects of normal and accident conditions with the effects of . . . natural phenomena. [10 CFR Part 50, Appendix A, GDC-2.]

These design bases are to assure that structures, systems and components important to safety can withstand such combinations of effects without loss of their capability to perform their safety functions. 10 C.F.R. Part 50, Appendix A, GDC-2.

Finally, GDC-4 (environmental and missile design bases) provides, in part, as follows:

> Structures, systems, and components important to safety shall be designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operation, maintenance, testing, and postulated accidents, including loss-of-coolant accidents. [10 CFR Part 50, Appendix A, GDC-4.]

In sum, these General Design Criteria provide general requirements governing the design of structures, systems, and components important to safety at nuclear power reactors. Implementation of these requirements necessarily requires the establishment of specific design criteria for each structure, system, and component important to safety to be utilized at the facility. As discussed below, NRC regulations and guidance address the establishment of such specific criteria, including the utilization of industry codes and standards accepted by the NRC for those purposes.

B. Utilization of the ASME Nuclear Code

NRC regulations impose requirements governing, inter alia, the design, fabrication and installation of certain components of nuclear power reactors. Specifically, Section 50.55a(a)(2) of 10 C.F.R. provides that, at a minimum, the particular systems and components of pressurized water reactors shall meet certain requirements, including pertinent portions of the ASME Boiler and Pressure Vessel Code. The ASME Code is a set of Engineering Safety Standards written and published by The American Society of Mechanical Engineers. Section III of that Code, known as the ASME Nuclear Code ("ASME Code" or "Code"), provides rules for the design and construction of presure vessels, piping system, pumps, valves, storage tanks, component supports and core support structures used in nuclear power plants. The Code presents a set of minimum requirements developed to assure the integrity of the pressure retaining equipment and related systems in a nuclear power plant.

The subsection of 10 C.F.R. §50.55a which governs the design, fabrication and installation of piping which is part of the reactor coolant pressure boundary (10 C.F.R. §50.55a(d)(3)), provides that for facilities for which construction permits were issued on or after July 1, 1974,[17] such piping:

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[17] The construction permits for Comanche Peak, Units 1 and 2 were issued in December, 1974.

> shall meet the requirements for Class 1 components set forth in Section III [footnotes omitted] of the ASME Boiler and Pressure Vessel Code: Provided, that the ASME Code provisions applied to the piping shall be no earlier than those of Winter 1972 Addenda of the 1971 edition.

The design requirements of the ASME Code governing Class 1 piping are set forth in Subsection NB of the Code. That subsection provides that the design of the supports for the Class 1 piping shall be accomplished in accordance with Subsection NF of the Code, as follows:

> NB-3674 Design of Pipe Supporting Elements - Supporting elements, including hangers, anchors, and sliding supports, shall be designed in accordance with the requirements of Subsection NF.

In addition, as will be discussed more fully below, Regulatory Guide 1.124 [18] also provides that Class 1 linear-type component supports shall be constructed in accordance with Subsection NF. Accordingly, both the applicable regulations and NRC guidelines look to the ASME Code for the design of Class 1 linear-type component supports.

With respect to the design of supports for other than Class 1 components, 10 C.F.R. § 50.55a(a)(1) provides that structures, systems and components:

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18 Regulatory Guide 1.124, Revision 1, "Service Limits and Loading Combinations for Class 1 Linear-Type Component Supports" (January 1978).

> shall be designed . . . . to quality standards commensurate with the importance of the safety function to be performed.

Applicable NRC Staff guidance establishes the quality standards that may be used to satisfy GDC-1 for other than the Class 1 safety-related components. As discussed more fully below, both the applicable Regulatory Guide[19] and provisions of the Standard Review Plan[20] provide that with respect to Class 2 and 3 piping, Subsections NC and ND, respectively, of the ASME Code may be utilized as the governing quality standards. As with Subsection NB, those Subsections require design of supports in accordance with Subsection NF.[21]

In sum, for each of Class 1, 2 and 3 supports, both the applicable NRC regulations and guidance look to the ASME Code for construction[22] standards.[23]

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19 Regulatory Guide 1.26, Revision 3 "Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants" (February 1976).

20 SRP 3.2.2, "System Quality Group Classification," Table 3.2.2-1.

21 <u>See</u> Subsections NC-3674 and ND-3674.

22 As defined in Subarticle NCA-1110 of Section III of the ASME Boiler and Pressure Vessel Code, construction is an all-inclusive term comprising materials, design, fabrication, examination, testing, inspection, and certification required in the manufacturing and installation of components.

23 The Commission has proposed to incorporate by reference into (footnote continued)

III. NRC GUIDANCE GOVERNING THE CONSTRUCTION OF PIPE SUPPORTS

To implement NRC regulations governing, inter alia, the construction of component supports, the NRC Staff has issued guidance documents, primarily in the form of Regulatory Guides. In addition, a description of the standards and criteria employed by the NRC in its review of applications for power reactor licenses, including the review of the construction of component supports, is set forth in the Standard Review Plan. These guidance documents provide that the requirements of GDC-1, GDC-2 and GDC-4, as well as 10 CFR §50.55a, concerning the construction of component supports, may be satisfied by adherence to the guidance in the documents. As discussed below, that guidance permits the utilization of applicable ASME Code provisions to determine the types of loads to be considered in the construction of supports.

(footnote continued from previous page)
10 C.F.R. §50.55a other parts of the ASME Code not already expressly incorporated. 47 Fed. Reg. 15801 (April 13, 1982). These other parts of the ASME Code cover, inter alia, component supports. 47 Fed. Reg. 15802. In proposing this amendment to 10 C.F.R. §50.55a, the Commission noted that although not expressly included in the regulation, those parts of the ASME Code that pertain to other systems important to safety are also reviewed by the Commission staff and, if acceptable, are used in the evaluation of specific license applications. Id.

A. Standard Review Plan

The NRC Staff's Standard Review Plan ("SRP") sets forth acceptable bases and criteria for the review of license applications and for the conclusions to be made by the Staff for presention in the Safety Evaluation Report for each facility. The SRP was originally issued in 1975 as NUREG-75/087 and was revised and reissued in September, 1981, as NUREG-0800. The Commission has recently made clear that the SRP is not a regulation and compliance with it is not required. The SRP acceptance criteria are intended by the Staff to provide one (but not the only) method for demonstrating compliance with the Commission's regulations. [24]

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24 On March 18, 1982, the Commission published in the Federal Register a final rule requiring applicants for operating licenses whose applications are docketed after May 17, 1982, to include an evaluation of the differences between the application and the most recent SRP revision. 47 Fed. Reg. 11651. The Commission made clear in that notice that the SRP was simply staff guidance.

1. Types of Loads.

Section 3.9.3 of the SRP (July 1981) [25] provides specific criteria to satisfy the relevant requirements of 10 CFR §50.55a and GDC-1, GDC-2 and GDC-4 regarding the structural integrity of ASME Code Class 1, 2 and 3 pressure-retaining components, component supports, and core support structures. Specifically, Appendix A to SRP 3.9.3 provides that ASME Code Class 1, 2 and 3 component supports shall be designed to satisfy the appropriate subsections of the ASME Code in all respects.[26] With respect to the consideration of specific loads in component supports, the SRP provides that the <u>types</u> of loadings to be taken into account in designing a component and its supports are specified in the Code.[27] As is discussed below, and as demonstrated by Applicants' expert witnesses, the ASME Code does not require that the stresses resulting from differential thermal expansion of pipe supports in a LOCA environment be considered in the design of those supports.

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25 The NRC Staff has utilized the 1975 SRP in reviewing the FSAR for Comanche Peak. However, in that the SRP does not establish any licensing requirements, Applicants discuss the latest edition of the SRP in that it provides the most recent and in some instances more extensive Staff guidance on the subject.

26 SRP 3.9.3, Appendix A, Section C.(4).1.1, p. 3.9.3-14; see also SRP 3.9.3, Sections I, II.

27 SRP Appendix A, Section B, p. 3.9.3-13.

2. Loading Combinations.

With respect to the consideration of loading combinations, SRP Appendix A provides that because the ASME Code merely establishes the types of loads to be considered, it is the responsibility of the designer to include rules specifying how loadings (including those resulting from postulated events and plant and system operating conditions) are to be combined and what stress level is appropriate for use with the loading combinations.[28] Section II.3.a. of SRP 3.9.3 provides that:

> The combination of loadings (including system operating transients) considered for each component support within a system, including the designation of the appropriate service stress limit for each loading combination should meet the criteria in Appendix A [to this SRP section] and Regulatory Guides 1.124 and 1.130.[29]

The specific guidance set forth in Appendix A to SRP 3.9.3 regarding consideration of loading combinations in the design of component supports, including loading combinations incorporating loads due to system operating transients and postulated accidents (e.g., LOCA), utilizes the four categories of limits for service

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28 Id.

29 Regulatory Guide 1.124, "Design Limits and Loading Combinations for Class 1 Linear-type Component Supports" is applicable here and is discussed below. Regulatory Guide 1.130 concerns Class 1 plate and shell-type component supports which are not at issue here.

loading established by the ASME Code,[30] and supplements the guidance established in Regulatory Guide 1.124. [31] As discussed below, Regulatory Guide 1.124 provides that stresses created in pipe supports resulting from loads imposed on piping systems in the event of a LOCA, superimposed on prescribed seismic and normal operating loads, are to be considered in the design of those supports. However, neither the applicable portions of the ASME Code nor NRC requirements and guidance require consideration of the LOCA-induced stresses in linear pipe supports arising from differential thermal expansion between the support members and the structures to which they are attached.

B. Regulatory Guides

Two Regulatory Guides provide guidance regarding the consideration of LOCA-induced loads in the design of pipe supports. Regulatory Guide 1.124 concerns the consideration of loading combinations for Classs 1 linear-type component supports. Regulatory Guide, 1.26 establishes applicable standards and quality group classifications for, *inter alia*, Class 2 and 3 piping and supports. Applicants discuss these provisions below

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30 SRP 3.9.3, Definition of Terms, p. 3.9.3-19. The categorization of loading conditions is provided for in ASME Code Subsection NA-2140. The four categories applicable here are normal, upset, emergency and faulted conditions. *See* ASME Code Subsection NB-3113; *see also* definitions in Regulatory Guide 1.124, Section B.7.

31 SRP 3.9.3, Appendix A, Section 4.2.

to illustrate the consideration given to LOCA-induced loads in the design of linear-type pipe supports. While these Guides do not address the specific question of stresses due to the restraint of thermal expansion (in that they need not be considered), they do provide information regarding the loads and combinations of loads under LOCA conditions which are to be considered.

A third Regulatory Guide, Regulatory Guide 1.48, provides guidance for, inter alia, the design of ASME Code Class 1, 2 and 3 piping. As discussed below, that Guide also provides for the utilization of the ASME Code for the design of pipe supports. Accordingly, Applicants also discuss this Regulatory Guide below.

1. Regulatory Guide 1.124.

Regulatory Guide 1.124 is the principal document establishing the NRC Staff position regarding consideration of loading combinations for Class 1 linear-type component supports.[32] The NRC Staff regulatory position, as stated in Regulatory Guide 1.124, is that ASME Code Class 1 linear-type supports should be constructed to the rules of Subsection NF of the Code, as supplemented by the provisions of the Regulatory

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32 Loading combinations for Class 2 and 3 linear supports are established in accordance with NUREG-0484, "Methodology for Combining Dynamic Loads." SRP 3.9.3, Section IV.3.

Guide.[33] The Guide establishes acceptable levels of service limits and loading combinations associated with normal operation, postulated accidents and specified seismic events to satisfy GDC-2. The loading combinations which are established in Regulatory Guide 1.124 include simultaneous system mechanical loading, the dynamic system loadings associated with a faulted (i.e., LOCA) plant condition and the vibratory motion of a Safe Shutdown Earthquake ("SSE").[34] In addition, the Guide requires that the ultimate allowable stresses in the metal supports be evaluated as a function of temperature to account for changes in material properties which occur in the high-temperature environment following a LOCA event.[35] Applicants' consideration of these loading combinations is described in FSAR Tables 3.9B-1C and 1D.

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33 Regulatory Guide 1.124, Section C. Applicants' position regarding the application of this Regulatory Guide is set forth in FSAR §§ 1A(N), pp. 1A(N)-63 to 67, and 1A(B) at 1A(B)-52. This position has been accepted by the NRC Staff. SER §3.9.3.1. Section 1A(N) of the FSAR concerns the applicability of Regulatory Guides to the NSSS portion of the plant. The supports addressed therein are component (e.g., reactor vessel, steam generator, reactor coolant pump) supports. Piping supports are addressed in FSAR §1A(B) which concerns the applicability of Regulatory Guides to the balance of the plant.

34 Regulatory Guide 1.124, Section C, Regulatory Position 7.

35 Regulatory Guide 1.124, Section C, Regulatory Position 2.

In sum, additional loads imposed on piping and supports by a LOCA are considered in the design of those components in combination with other severe (i.e., SSE) and normal loads. However, as provided in Subsection NF of the ASME Code, and as authorized by Regulatory Guide 1.124, stresses resulting from differential thermal expansion of supports are self-limiting and need not be addressed in the design of individual supports.

2. Regulatory Guide 1.26.

Regulatory Guide 1.26 establishes the quality group classifications "related to specified national standards that may be used to determine quality standards acceptable to the NRC Staff for satisfaction of General Design Criterion 1 for other [than Class 1] safety-related components containing water, steam, or radioactive material" in nuclear power plants.[36] The appropriate quality standards for quality group B and C piping are designated to be the ASME Code provisions for Class 2 and 3 piping, respectively.[37] As noted previously, the portions of the Code applicable to Class 1, 2 and 3 piping (Subsection NB, NC and ND) require that supports for such piping be designed in accordance with Subsection NF of the ASME Code.[38] In addition,

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36 Regulatory Guide 1.26, Section A.

37 Id., Table 1.

38 See discussion, supra at pp. 12-13.

SRP Section 3.2.2 confirms this interpretation where it expressly refers to Subsection NF for the construction of supports in Quality Groups A, B and C. SRP 3.2.2, Table 3.2.2-1, p. 3.2.2-8. Thus, the appropriateness of utilizing the ASME Code for the design of those supports (including the exclusion of secondary thermal loads) is further confirmed by Regulatory Guide 1.26.

3. Regulatory Guide 1.48. [39]

Regulatory Guide 1.48 delineates acceptable design limits and appropriate combinations of loadings associated with normal operation, postulated accidents, and specified seismic events for the design of Seismic Category 1 fluid system components. Though not specifying design limits and loading combinations for piping supports, _per se_, this Guide establishes such guidance for ASME Code Class 1, 2 and 3 piping. Specifically, the Guide delineates applicable design limits established in the ASME Code for specified loading combinations. [40] As noted previously, [41] the Code itself provides that pipe supports for piping designed in accordance with the Code shall be designed in accordance with

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39 Regulatory Guide 1.48, "Design Limits and Loading Combinations for Seismic Category I Fluid System Components" (May 1973). Applicants' position regarding the applicability of this Guide is set forth at FSAR §§1A(N), p. 1A(N)-28 and 1A(B), p. 1A(B)-20.

40 Regulatory Guide 1.48, Sections C.1 (Class 1 piping) and C.8 (Class 2 and 3 piping).

41 _See_ discussion _supra_ at 12-13.

Code Subsection NF. Accordingly, this Regulatory Guide also provides for the utilization of the ASME Code in the design of supports for Class 1, 2 and 3 piping.

IV. ASME CODE REQUIREMENTS GOVERNING CONSIDERATION OF THERMAL STRESSES

A. ASME Code Requirements

While the Board has requested only that the parties discuss NRC regulations and guidance governing the design of pipe supports to clarify the regulatory basis for not considering thermal stresses in those supports under LOCA conditions, Applicants believe a brief discussion of the record in this proceeding regarding the basis for the provision in the ASME Code regarding the consideration of thermal expansion stresses would be helpful. Accordingly, we present below a brief summary thereof.

1. Walsh/Doyle Allegations.

Both CASE witnesses contend that the ASME Code requires consideration in pipe support designs of thermal stesses induced by expansion of pipe supports under LOCA conditions.[42] The thermal stresses of concern were those induced by expansion of the pipe support when heated under LOCA conditions where the support is restrained or is attached to a wall or other fixed structure on both ends. Tr. 5233-42.

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42 CASE Exhibit 659 at 2; 659B; Tr. 3677.

2. Applicable Code Provisions.

Article NF-3000 of the ASME Code contains both general requirements (NF-3100), and specific rules that vary depending upon the type of support. The general requirements, NF-3100, merely identify loads that should be included in the design specifications for the diferent types of supports. In order to determine which loads are to be used for any specific situation, the designer must consider the specific rules depending on the Class (1, 2, or 3), type (plate and shell or linear) and loading condition (normal, upset, emergency and faulted). For Class 1, 2 or 3 linear supports, the Code (NF-3231.1) does not require thermal stresses to be considered for any loading condition.[43]

Further, thermal stresses are defined as secondary stresses by the ASME Code. Section NF-3213.8 of the Code provides that secondary stress is a normal stress or a shear stress developed by the constraint of adjacent material or by self-constraint of the component. The basic characteristic of a secondary stress is that it is self-limiting. The self-limiting characteristic arises because of ductile displacement in the beam upon expansion which relieves the thermal stress.[44]

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43 Applicants' Exhibit 142 at 14-15; Tr. 5230-32.

44 Applicants' Exhibit 142 at 15; Tr 5236-37.

In sum, the ASME Code clearly excludes consideration of thermal stress in the design of linear-type pipe supports. While this alone should be sufficient to find that the design of the supports for Comanche Peak is adequate, Applicants' witnesses also provided a detailed analysis of the self-relieving characteristics of thermal stresses. This analysis is also discussed below.

B. Analysis of LOCA Temperature Effects

To demonstrate the technical validity of the position in the ASME Code regarding consideration of thermal stresses in linear-type pipe supports, Applicants performed an analysis of the self-limiting characeristics of thermal stresses with respect to the slippage of support attachments or deformation of welds at anchorages. This analysis demonstrated that the movement of the support anchors under thermally induced stress relieves that stress. The analysis of LOCA temperature effects on the anchors is based on the use of test data results of load versus displacement characeristics of various types of anchors (Hilti Bolts, Richmond Anchors,[45] and Nelson Studs). The analyses

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45 As noted previously (see note 12, supra) the NRC Staff concurred in this assessment but requested that additional testing be performed to confirm the allowable for one size of Richmond Anchors. This additional testing was completed successfully.

performed in Applicants' Exhibit 142D are conservative because they were performed on the most extreme conditions which exist at Comanche Peak.[46]

The analysis performed by Applicants comports with sound engineering principles and affords more realistic results of thermal stresses than if the anchors are assumed to be "rigid." In the case of thermal stresses, it was demonstated that anchors which would ordinarily be considered rigid have, in fact, enough "flexibility" to relieve virtually all thermal stress.[47]

In response to the Board's questions, Applicants' witnesses also provided further explanation of these specific stress-relieving mechanisms. Specifically, Applicants' witnesses testified that in the case of a support beam which spans between two structures, such as floor-to-ceiling and wall-to-wall, the displacement which relieves the thermal stress could arise either from slight displacement of the structures upon expansion of the beam or by local yielding of the structual member. The latter yielding results in minute plastic deformation of the support

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46 Applicants' Exhibits 142 at 22 and 142D; Tr. 5239-40, 5250.

47 Applicants' Exhibit 142 at 23-24.

which relieves the thermal stress. The relief of thermal stresses induced in a support with a beam mounted on a wall by a series of bolts occurs by a displacement of the bolts.[48]

In sum, the record in this proceeding reflects that the ASME Code permits the exclusion of thermal stresses from the analysis of Class 1, 2 and 3 linear-type pipe supports. Further, the record also reflects that such provisions of the Code have been demonstrated by analysis and sound engineering principles and judgment to be technically correct. Thus, the exclusion of those stresses from the design of pipe supports at Comanche Peak does not raise any valid design question or present any adverse implications for the safe operation of the facility or its ability to withstand the effects of postulated accidents.

V. CONCLUSION

As demonstrated above, NRC regulations and Staff guidance implementing those regulations clearly provide for the utilization of the standards established by the ASME Code for determining the types of stresses to be considered in the design of pipe supports. In turn, and as demonstrated in the record of this proceeding, the Code provides that the thermal stresses induced in linear-type supports are self-limiting, and therefore need not be considered in the design of individual supports.

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48 Applicants' Exhibit 142D; Tr. 5239-56.

Accordingly, Applicants submit that upon conclusion of the testimony of the NRC Staff on these matters, the record should be closed.

Respectfully submitted,

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April 21, 1983

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)

CERTIFICATE OF SERVICE

I hereby certify that copies of the foregoing "Applicants' Brief Regarding Consideration Of Thermal Stresses In Design Of Pipe Supports" and "Applicants' Brief On The Effect On This Proceeding Of The Recommended Decision Of The Department Of Labor's ALJ In 'Atchison v. Brown & Root'," in the above-captioned matter were served upon the following persons by express delivery (*), deposit in the United States mail, first class postage prepaid, or by hand delivery (**) this 21st day of April, 1983:

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