UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

DOCKETED USNRC

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

'84 SEP -4 A10:41

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

CASE'S PARTIAL ANSWER TO APPLICANTS' STATEMENT OF MATERIAL FACTS AS TO WHICH THERE IS NO GENUINE ISSUE REGARDING ALLEGATIONS CONCERNING CONSIDERATION OF FORCE DISTRIBUTION IN AXIAL RESTRAINTS

in the form of

AFFIDAVIT OF CASE WITNESS MARK WALSH

1. Applicants state:

"Applicants' design approach for modelling trapeze type supports with trunnions is to model the support as a single support acting in the axial direction. (Affidavit at 3.)"

I agree with Applicants' statement, although their philosophy is wrong and this is not what they told the NRC Special Inspection Team (SIT), as will be discussed in answer 2 following.

2. Applicants state:

"Applicants' modelling technique is reasonable. The modelling technique urged by CASE would be very conservative and not necessarily a more realistic modelling technique. (Affidavit at 3-4.)"

I disagree with Applicants' statements. The Applicants' present

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modelling technique does not take into account the rotational restraint provided by these supports that are welded to the pipe, which CASE has argued should be considered and which the Applicants' told the SIT they were going to do. According to the SIT (as discussed on page XVII - 6 of CASE's Proposed Findings /1/):

> "The Special Inspection Team concluded that the rotational stiffness associated with these designs should have been included in the piping stress analysis. Subsequent discussions with the Applicant indicated that this rotational restraint had also been identified during the Applicant's normal design review and that the pipe stress analysis was being modified to consider this rotational restraint. The Special Inspection Team reviewed the proposed method of analysis ('Minutes of discussion at the Meeting between G&H and NPSI on March 17, 1982') and concluded that the method of modeling the rotational restraint and the attendant loads on the snubbers was acceptable. Since the Applicant is including this rotational restraint in the pipe stress analysis, the Special Inspection Team found the concern on moment restraints introduced in the piping system to be resolved." (Emphases added.)

Since the Applicants informed the SIT that they were going to go back and take the rotational restraint into account in the pipe stress analysis, the SIT closed this item -- based on the fact that Applicants already knew about the problem and the Applicants' representation that they were going to do it.

In addition, the Applicants told this Board as part of their Plan (Item 15) /2/ that they would:

/1/ This problem was addressed in detail in Section XVII of CASE's 8/22/83 Proposed Findings of Fact and Conclusions of Law (Walsh/Doyle Allegations).

/2/ See Applicants' Plan to Respond to Memorandum and Order (Quality Assurance for Design), February 3, 1984. See also Footnote 1, page 2, of the Motion being answered here, Applicants' 7/9/84 Motion for Summary Disposition Regarding Allegations Concerning Consideration of Force Distribution in Axial Restraints.

"provide evidence of how the design has accounted for the torsional resistance of axial restraints. This evidence will be generated through the performance of analyses."

However, in their Affidavit (at pages 3 and 4), Applicants are now saying that they don't have to account for the torsional resistance of axial restraints:

" . . . the rotations are very small and accommodated by the play in the two legs of the support. Moreover, when seismic analyses are performed using the response spectrum method, as is the case at CPSES, the resulting support loads are not dependent on the relative phase between the response motions, i.e., the axial and rotational motion. In fact, modelling of the rotational constraint of the support using a response spectrum analysis would always add the peak of the response load resulting from the axial motion to the peak of the response load resulting from the rotation. Therefore, this modelling technique would be very conservative and not necessarily a more realistic modelling technique. Consequently, Applicants believe that modelling the restraints in question as purely axial restraints is adequate." (Emphases added.)

What the Applicants have stated in their Affidavit is contrary to what they had told the NRC SIT and this Licensing Board through their "get well" Plan. The Applicants claim that the rotations are small and are accommodated by the gaps within the support and that they don't have to consider the rotations.

During the 7/3/84 Bethesda meeting between the NRC Staff and Cygna, there was a discussion regarding Applicants' use of welded attachments (see 7/3/84 meeting Tr. 18-43 -- I urge the Board to read this entire transcript portion). Mr. Tereo of the NRC Staff discussed the Staff's concerns in this regard and mentioned NUREG/CR-2175, especially with regard to unequal load distribution (Tr. page 27). He further indicated that as a result of the testing performed (reported in NUREG/CR-2175), the NRC Staff revised its Standard Review Plan, Section 393, to address this issue; he further stated (Tr. page 28) that the July 1981 Standard Review Plan states:

> "The snubber end fitting clearance and lost motion must be minimized and should be considered when calculating snubber reaction loads and stresses which are based on a linear analysis of the system of component."

CASE obtained a copy of NUREG/CR-2175 (it was not received until 8/25/84, so I have only quickly scanned portions of it). As indicated in Attachment A hereto (applicable portions of NUREG/CR-2175), it is stated (page 15 of NUREG) that:

> ". . . a linear analysis may be made provided the total clearance is less than .05 inch, and the load and stresses are multipliled by the appropriate load factors. Snubber reaction loads and stresses shall be increased by 100% for clearances greater than .0 but less than .02 inch. Snubber reaction loads and stresses shall be increased by a factor of 4 for clearances greater or equal to .02 inch but less than .05 inches. Detailed nonlinear analysis is required for systems with .05 inch or greater clearance." (Emphases added.)

For the Board's information, the clearance is defined in Appendix B of the NUREG (Attachment A hereto, page 84), which states, in part:

> "The support clearance is the summation of individual gaps existing between snubber, backup support structure and the center of gravity (or geometry) of the component being supported. The total gap shall not exceed .05 inch." (Emphasis added.)

CASE has already submitted (on 8/13/84) a response to the Applicants' Motion for Summary Disposition Regarding the Effects of Gaps on Structural Behavior Under Seismic Loading Conditions. In response to the Applicants' statement that "Identifying the effects of gaps by comparison of the results of nonlinear time history (with gaps) and response spectrum (without gaps) analyses is difficult," I suggested using a friction type connection (page 24 of Walsh Affidavit). It would appear from this NUREG that the Applicants should be required to perform a detailed nonlinear analysis because of the gaps or go to friction type connections, as I have recommended.

In addition, the small gaps on which the Applicants rely to dismiss the rotational restraint provided by the support in the pipe stress analysis can cause additional problems which the Applicants have not addressed, as discussed above.

3. Applicants state:

"Applicants evaluated the significance of the effects CASE alleges should be considered by reanalyzing several piping stress problems utilizing the modelling assumptions CASE would have Applicants employ. These analyses demonstrated that Applicants' assumption of excluding the rotational restraint of the trapeze support from the analysis has virtually no effect on pipe stresses. (Affidavit at 4-5)."

There are virtually no effects on the pipe stresses, as the Applicants have stated, assuming none of the snubbers or struts exceeds its allowables and assuming that Applicants have done their analyses correctly (assumptions with which I do not agree). When a snubber or strut exceeds its capacity, an additional moment is created within the pipe since the support is not acting through the centerline of the pipe but is offset due to the welded trunnion. This additional moment was not considered by the Applicants in their Affidavit.

4. Applicants state:

"Applicants' analyses demonstrated that changes in loads on the supports on the reanalyzed stress problems occur only with respect to the trapeze supports themselves. This effect is expected in that modelling the rotational constraint of the support will produce an additional load on each side of the trapeze which had not been previously analyzed. These additional loads did not exceed applicable allowables. (Affidavit at 5-6.)"

I agree with Applicants' first sentence, with the same qualifications as discussed in answer 3 preceding.

Regarding Applicants' second sentence, the Applicants state "which had not been previously analyzed." I thought these supports were as they were originally designed, and not containing any additional moments. If there were a problem, the Applicants are committed to resolving that problem in a prompt manner. The Applicants informed the SIT that they were going to take the rotational restraint into account as part of their as-built stress analysis /3/.

By reviewing Table 3 attached to Applicants' Affidavit, one can immediately see that, when the rotational constraint analysis is used, the load can almost double. This analysis had not been considered (to the best of my understanding) prior to Applicants' current Motion for Summary Disposition. Gary Krishnan testified (incorrectly) that I was told in the past that it was not my responsibility to address the issue of welding of stanchions to pipes by NPSI, ITT Grinnell and PSE. Mr. Krishnan told me that they did not intend to include consideration of the welded stanchions /4/.

/3/ See Applicants' Exhibit 142, pages 25-26; NRC Staff SIT Report, NRC Staff Exhibit 207, pages 38 and 39; and discussion at page XVII - 5 of CASE's Proposed Findings.

/4/ See discussion at pages XVII - 2 and XVII - 3 of CASE's Proposed Findings.

The Applicants state that these additional loads did not exceed applicable allowables, but what are they using as an allowable stress? The answer is that they have tripled the allowable stress based on a misconception that the seismic rotation producing the load is a secondary stress (Applicants' Affidavit at page 7). Therefore, when the load doubles, the Applicants have tripled the allowable, and have found no overstressed conditions, which seems very understandable, given their methods. The Applicants are in error. This is not a secondary stress and the allowables cannot be increased by a factor of 3. Cygna agrees with me regarding this, as stated in their August 10, 1984 letter to TUGCO /5/, where they state, in part:

> "Based on a review of that document (Applicants' Motion for Summary Disposition on axial restraints), Cygna does not agree with the interpretation that the rotational constraint provided by the double trunnion trapeze supports constitutes a condition of restraint of free end displacement. And, therefore, an increase in the allowable stress for these supports is not appropriate."

Therefore, Applicants' statement that the additional loads did not exceed the allowables is undocumented and is based upon a false premise of increasing the allowable.

5. Applicants state:

> "Applicants evaluated every Unit 1 and common double trunnion support employed at Comanche Peak for these effects. That analyses (sic) demonstrated that the total loads imposed on each side of the trapeze supports would be acceptable, i.e., in no case were Code allowables exceeded, when the additional loads were factored into the support design. (Affidavit at 6-8.)"

/5/ See CASE Attachment B, 8/10/84 letter from N. H. Williams, Project Manager, Cygna Energy Services, to J. George, Project Manager, TUGCO.

See answer 4 above. In addition, on August 22, the Applicants provided to CASE on discovery (requested 8/(/84 /6/) one pipe support drawing and partial calculations which, according to Applicants, included the maximum difference in loads with and without consideration of the rotational constraint (see Attachment C hereto). On page 1 of 2 of Attachment C, dated 6/14/84, near the middle of the page there is a Table. Above the Table there is a ratio of the old load vs. the new load. The ratio of 1.459 which is shown in the top portion of the calculation is apparently in error. The load due to the moment restraint of the pipe is listed as 142 kips. The original load divided by 2 (for one of the stanchions) is shown to be 97.329 kips. The ratio should be 142 plus 97.329 divided by 97.329 = 2.45, a considerable difference.

In the Table, under Bolt Tension, the new load appears to be obtained by multiplying the existing load by the ratio of 1.459. For example, bolt 6 had an existing tensile load of 26192.38 lbs. The new load is 26192.38 times 1.459 = 38213.87 lbs., as is shown in the table. But using the correct ratio of 2.45, the tensile load in bolt 6 is 26192.38 times 2.45 = 64170. (rounded) lbs.

Under bolt shear for bolt 6, the existing load is 18657.21. The new load using Applicants' figures should be then, 18657.21 times 1.459 = 27221. lbs. (rounded off because I don't think including the 1/100 of a lb. will offset the 27,000 lbs. already calculated). But

/6/ See Applicants' 8/22/84 letter to CASE from William A. Horin, Counsel for Applicants, page 1, item 3.

apparently the Applicants have a new way of figuring their shear loads. They use a new method called "redistribution" (see fifth column of table). Not considering this "redistribution," the correct shear load would be 2.45 times 18657.21 = 45710. lbs. This is over three times greater than what the Applicants arrived at.

The insert allowable (shown at the bottom of the page, left), according to the Applicants' PSE Guidelines, is 25 kips for tension and 25 kips for shear (see CASE Exhibit 724, admitted at Tr. 6471, copy attached). The calculations do not show justification for Applicants' doubling the allowable shear load for the insert (as shown in Attachment C). It is apparent that the correct tensile load by itself will exceed the allowable.

The Applicants have also listed the allowable tensile and shear capacities of the A193 high strength bolt in the attachment as 90 kips in tension and 42.4 kips in shear. The Applicants have shown in their PSE Guidelines (CASE Exhibit 724) the allowable tensile capacity for an A193 bolt as 66 kips (working load), and in shear, the working load is 34.5 kips.

Regulatory Guide 1.124 (CASE Exhibit 743, admitted at Tr. 5901, copy attached) does not permit Applicants to increase the allowables in this manner. It states, in part (page 1.124-2, B.1.b):

> "Allowable service limits for bolted connections are derived from tensile and shear stress limits and their nonlinear interaction; they also change with the size of the bolt. For this reason, the increases permitted by NF-3231.1, XVII-2110(a), and F-1370(a) of Section III are not directly applicable to allowable shear stresses and allowable stresses for bolts and bolted connections."

6. Applicants state:

"With respect to lug-type restraints, it is neither necessary nor reasonable to expect that the lugs can be installed in a perfect circumferential plane with zero tolerance. The lugs have been installed within reasonable limits. (Affidavit at 10-11.)"

This is where the Applicants are wrong -- again. The procedure in question requires zero tolerance in construction, according to their own Affidavit.

In their Affidavit at the bottom of page 9, Applicants represent that CASE asserted that the method employed by ITT Grinnell to determine the loading distribution in axial restraints is inadequate. To be more accurate, as CASE has stated before, ITT Grinnell's method "is a gross error for practical engineering, although the method may be academically correct" /7/.

As the Applicants went out in the field and verified, perfection in construction is not achievable. But the analysis which Applicants had chosen to perform required perfection in the field. This topic was never disputed by the Applicants or the NRC Staff prior to this Motion for Summary Disposition, as stated in CASE's Proposed Findings, page XII - 6, third full paragraph. It appears that the lugs were installed without any QC procedures as to the acceptable tolerance (gap) between the lug and the supporting surface, and therefore any size of gap could exist in the field.

/7/ See CASE's Proposed Findings, bottom of page XII - 5, continued on XII - 6).

7. Applicants state:

"The stresses which may occur in the pipe, lug or frame as a result of differential engagement of the lugs will be localized. These potential local deformations would be self-limiting and readily redistribute the load to other lugs. Only one other lug need be engaged to fully resist the entire load which may be imposed. (Affidavit at 10-11.)"

The Applicants are assuming that, of the four lugs, two lugs are always engaged. This may not be the case. Due to construction, there may be a large gap (greater than 1/16") and due to pipe rotation, the total load may be on just one lug. Since the lug was only designed to carry one-half the load and is now receiving the total load, the pipe stress analysis needs to consider this condition. The self-limiting deformations have already been included in the ASME code, and therefore they don't have any more room to play with the numbers.

In summary, the Applicants did not have a QC program to verify the gaps which now exist in the field, used an improper and impractical design analysis, and are now attempting to justify these cumulative errors.

8. Applicants state:

"It is assumed that loads will be transmitted to the lugs furthest from the support anchors, the frame deflection can be larger than initially assumed. However, both frame deflection and rotation of the pipe will act to close the gap to opposite or adjacent lugs. (Affidavit at 12.)"

The first sentence is not complete. However, in reviewing the Affidavit, it appears that the sentence should read, "If it is assumed . . . ", etc. There is no <u>documentation</u> to support any of Applicants' many assumptions contained in these statements.

Further, as has happened before in Applicants' Statements of Material Facts As To Which There Is No Genuine Issue /8/, whoever prepared the Statements of Material Facts has (whether deliberately or inadvertently) altered the meaning of the sworn Affidavits of Applicants' witnesses. In this instance, words have been added which are not contained in Applicants' Affidavit (which is referenced as the source of the Statements of Material Facts). In this instance, the Statement of Material Facts states:

> "However, both frame deflection and rotation of the pipe will act to close the gap to opposite or adjacent lugs. (Affidavit at 12.)" (Emphases added.)

But nowhere on page 12 of Applicants' Affidavit does it state that rotation of the pipe will help close the gap to opposite or adjacent lugs. Applicants have again misquoted their own Affidavit. This is very misleading, because it means that not only CASE, but the Board cannot depend upon the Statements of Material Facts to be accurate, and must read each and every word of the accompanying Affidavits to be certain what the witnesses are actually saying.

In fact, rotation of the pipe could offset any deflection of the frame which was initially assumed to tend to close the gaps to the other lugs; this is discussed in the Affidavit. Further, rotation of the pipe could even tend to open gaps and transfer the load back to the outboard lug; this is not discussed in the Affidavit.

/8/ See discussion at page 8 of CASE's 8/13/84 Answer to Applicants' Statement of Material Facts As to Which There Is No Genuine Issue Regarding CASE Allegations Regarding Section Property Values.

Also (as CASE has previously demonstrated -- see page XII - 7 of CASE's Proposed Findings), the frame will indeed experience larger stresses than would otherwise be computed on the basis of two lugs sharing the load -- which _is_ discussed in Applicants' Affidavit at page 12.

9. Applicants state:

> "Two conditions may exist with respect to lug-type supports, _viz._, (1) the lugs may be stronger than the frame (and thus greater frame deflection will result) and (2) the frame may be stronger than the lugs (inducing small deformations in the lug until other lugs are engaged). (Affidavit at 12-13.)"

I agree with the concept if one _assumes_ that all the stresses are within the allowables and the application of the loads due to static or dynamic motion can always be accurately anticipated. As will be shown below, the method used by the Applicants is not consistent with the original design assumptions.

10. Applicants state:

> "For the case in which the frames are weaker than the lugs, Applicants performed a study of idealized frames loaded axially using the four lug arrangement. These cases represent the range of deflections which may occur in the field and, thus, provide evidence of the ability of the frame to deflect to permit engagement of additional lugs. Only in the second case was it found that a deflection which could (slightly) exceed Applicants' deflection guideline may be required to bring a second lug in contact with the frame. However, any excess loads would be self-limiting and thus when the load is shared by the second lug the deflection no longer increases for a given load. (Affidavit at 14-15.)"

The study which is referenced by Applicants has two major flaws. The first one, as discussed in answer 8 preceding, is that the Applicants neglected to consider the rotation of the pipe. The rotation of the pipe would increase all loads and stresses which the Applicants have referenced.

The second item is that the Applicants are now relying on a plastic analysis, which is not consistent with their original analysis which was a linear elastic analysis which they are supposed to use. The allowable stresses which the Applicants are committed to use for these types of supports are discussed in ASME Appendix XVII, 2000, which is for a linear elastic analysis.

In addition, the Applicants have not shown that, with their plastic design philosophy, the supports would be capable of sustaining cyclic loads. I believe that the plastic design which they are demonstrating is for a one-time event. and therefore is not applicable to those loading conditions that are repetitive.

11. Applicants state:

"To assess the condition in which the frame is stronger than the lug and, thus, lug localized yielding may occur, Applicants analyzed the effect of the maximum localized yielding in the lug and the pipe surface which could occur to bring the additional lugs in contact with the frame. This analysis was performed using a non-linear finite element technique and the computer program NASTRAN. The result of this analyses (sic) show (sic) that minimal plastic strains, entirely localized at the surface of the pipe and the welds permit a 1/16" deflection from the lugs with no adverse consequence to the lugs. With respect to the stresses on the pipe, Applicants' analysis demonstrates that they would also be acceptable. (Affidavit at 15, Attachment 2)."

As stated before, the use of the nonlinear finite element program is not consistent with the original design and the Applicants did not provide documentation to show cyclic loads would be acceptable. The Applicants' procedure for verifying the lug capacity also did not consider the fact that only one lug may, in fact, be carrying the total load since no tolerance was provided for QC to check.

It should be noted that I have not had time even to scan the transcript of the 8/6/84 Applicants/NRC Staff/CASE telephone conference call (Mr. Doyle was not on that call), the transcripts of the 8/8/84 and 8/9/84 Bethesda meetings between the NRC Staff and the Applicants, (all of which were just received by CASE on 8/22/84), and, of course, the transcript of the meeting held at Comanche Peak 8/23/84 between the NRC Staff and the Applicants. Also, it is my understanding that there will be some changes (at least one substantive) to some of Applicants' Affidavits regarding some of the Motions for Summary Disposition and that by 8/30/84 the Applicants are to provide the Staff with several documents relating to the Motions for Summary Disposition (which obviously we also need to adequately answer Applicants' Motions).

I would have liked to be able to do a more thorough job, and would like to be able to supplement my testimony after I have had a chance to review the referenced transcripts, changed Affidavits, and additional documents.

Attachments:

Attachment A	NUREG/CR-2175, pages 15 and Appendix B, page 84 -- see page 4, answer 2
Attachment B	8/10/84 letter from N. H. Williams, Project Manager, Cygna Energy Services, to J. George, Project Manager, TUGCO -- see page 7, answer 4
Attachment C	Drawings and partial calculations of Support FW-1-18-703-C52R -- see page 8, answer 5
CASE Exhibit 724	PSE Guidelines, Section VI, Richmond Inserts & Anchor Bolts Stress Allowables, Rev. 3, page 1 of 2 -- see page 9, answer 5
CASE Exhibit 743	NRC Regulatory Guide 1.124, Revision 1, January 1978, "Service Limits and Loading Combinations For Class 1 Linear-Type Component Supports" -- see page 9, answer 5

The preceding CASE's Answer to Applicants' Statement of Material Facts As To Which There Is No Genuine Issue was prepared under the personal direction of the undersigned, CASE Witness Mark Walsh. I can be contacted through CASE President, Mrs. Juanita Ellis, 1426 S. Polk, Dallas, Texas 75224, 214/946-9446.

My qualifications and background are already a part of the record in these proceedings. (See CASE Exhibit 841, Revision to Resume of Mark Walsh, accepted into evidence at Tr. 7278; see also Board's 12/28/83 Memorandum and Order (Quality Assurance for Design), pages 14-16.)

I have read the statements therein, and they are true and correct to the best of my knowledge and belief. I do not consider that Applicants have, in their Motion for Summary Disposition, adequately responded to the issues raised by CASE Witness Jack Doyle and me; however, I have attempted to comply with the Licensing Board's directive to answer only the specific statements made by Applicants.

Mark Walsh
(Signed) Mark Walsh

STATE OF TEXAS

On this, the 27 day of August, 1984, personally appeared Mark Walsh, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he executed the same for the purposes therein expressed.

Subscribed and sworn before me on the 27 day of August, 1984.

Samuel W. Nestor
Notary Public in and for the State of Texas

SAMUEL W. NESTOR
My Commission Expires
1-31-85

My Commission Expires: 1-31-85

ATTACHMENT A

NUREG/CR-2175
ETEC-TDR-80-16

Snubber Sensitivity Study

Manuscript Completed: November 1980
Date Published: July 1981

Prepared by
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NRC FIN B3076

TECHNICAL DATA RECORD

AUTHOR

A. T. Onesto

TITLE

Snubber Sensitivity Study Final Report

SUBACCOUNT TITLE

Snubber Sensitivity Study

STATEMENT OF PROBLEM

Develop information which will provide the basis for structural analysis and design rules for systems and components which utilize snubbers as supports. Results will be used to assure that dynamic response characteristics of snubber supported systems and components will be bounded within acceptable limits.

ABSTRACT:

Snubbers are used widely throughout the nuclear industry as seismic restraints. [redacted] The purpose of this work was to: 1) identify those parameters which characterize hydraulic and mechanical snubbers which significantly affect snubber dynamic response; 2) determine the response sensitivity to variations of these parameters. Based upon the results of the foregoing, simplified design and analysis procedures are proposed, to maintain system response within acceptable limits.

Germane results of a test program to evaluate the effects of [redacted] are included in this report.

[redacted]

2.2.3.3 Linear Representation of a Snubber - [redacted] The best simple representation of a snubber is a nonlinear representation consisting of a linear spring with a gap set equal to the total clearance of the component. This representation enables both response and reaction loads to be predicted with sufficient accuracy in most cases, provided all response parameters are bounded within the limits described in 2.2.2. However [redacted] Snubber reaction loads and stresses shall be increased by 100% for clearances greater than .0 but less than .02 inch. Snubber reaction loads and stresses shall be increased by a factor of 4 for clearances greater or equal to .02 inch but less than .05 inches. Detailed nonlinear analysis is required for systems with .05 inch or greater clearance.

2.2.3.4 [redacted] The guidelines for multiple snubber usage are based on a single test program described in Reference 1.

2.2.3.4.1 [redacted] - [redacted] Uniform load sharing of multiple snubber supports (within 10% of the total load) can be expected for hydraulic snubbers when end fitting clearance differentials are less than .01 inches and the activation level and release rate are between 8 and 25 inches/minute and 4 and 14 inches/minute, respectively.

The activation level of a mechanical snubber which is equal to its release rate and defined in terms of its acceleration shall not exceed .02g. Application of the mechanical snubber shall be limited to environments where low frequency loadings (<3 Hz) are not anticipated.

B.2.1.3.2 Release Rate

The release rate is defined as the rate of snubber axial movement under load after the snubber is activated. The release rate of the mechanical snubber is the same value as its activation level and independent of load. The release rate of the hydraulic snubber is independent of its activation level and is proportional to the applied load.

The release rate of a hydraulic snubber is commonly defined in terms of its bleed rate and rated load capacity. The bleed rate is defined as the release rate at the snubber rated load. The bleed rate of the hydraulic snubber used for component and piping systems shall not exceed $\dot{X}_B$, where,

$$\dot{X}_B = .50 \times \left(\frac{\text{RATED LOAD}}{\text{COMPONENT WT}}\right) \text{ inch/minute}$$

If the snubber is used to restrain piping, the component weight represents the equivalent piping weight. The equivalent weight is the weight loading at the snubber assuming all snubbers are locked with the gravity loadings acting in the direction of the snubber.

B.2.1.3.3 Clearance

The response of a piping system or component supported with snubbers is highly dependent on the clearances located at the supports. This is especially true of impact loads. Evaluation of clearance at a specific support location shall be based on snubber free play, end fitting clearances, pipe clamp tolerances, and other clearances not indicated. The support clearance is the summation of individual gaps existing between the snubber backup support structure and the center of gravity (or geometry) of the component being supported. The total gap shall not exceed .05 inch.

Rcd. 8/11/84

CYGNA ENERGY SERVICES

101 California Street Suite 1000 San Francisco, CA 94111-5894

ATTACHMENT B

August 10, 1984
84042.014

Mr. J. George
Project Manager
Texas Utilities Generating Company
Highway FM 201
Glen Rose, Texas 76043

Subject: Force Distribution in Axial Restraints - Phase 3 Open Item
Comanche Peak Steam Electric Station
Independents Assessment Program - Phase 3
Texas Utilities Generating Company
Job No. 84042

Reference: Motion for Summary Disposition Regarding Allegations Concerning Consideration of Force Distribution in Axial Restraints, July 9, 1984

Dear Mr. George:

During the Phase 3 pipe support review Cygna raised a question concerning the appropriate loading to be used in sizing standard components (struts and snubbers) which are used in pairs to form axial restraints. The concern was not with the pipe stress analysis modeling techniques for this type of support, but rather with the appropriateness of sizing the struts or snubbers assuming a 50% - 50% load split. TUGCO responded by referring Cygna to the above referenced Motion for Summary Disposition.

Based on a review of that document, Cygna does not agree with the interpretation that the rotational constraint provided by the double trunnion trapeze supports constitutes a condition of restraint of free end displacement. And, therefore, an increase in the allowable stress for these supports is not appropriate. Justification for the 50% load split must be provided on an appropriate basis. One such basis would be to demonstrate that the support system provided sufficient ductility (deformation) to insure that the proper redistribution of forces occurs prior to achieving ultimate load

Cygna understands that Dr. Iotti has performed some studies on a pipe stress problem to determine whether the pipe axial and rotational displacements are coincident in time. Although we have not reviewed the results, Dr. Iotti believes the correlation will be low. However, it may be difficult to justify the uncoupled nature of these displacements on a generic basis.

While Cygna has noted that TUGCO has chosen a 50% - 50% load split for the design of the supports, the same is not true of the welded attachment local stress evaluation. In all but one of the 16 double trunnion axial restraints reveiwed during all four phases of the Independent Assessment Program, the full load (100%) was assumed for each trunnion design. Although we think a check of all double trunnions should be made to ensure an appropriate load split, it appears this will not be a problem. Given this disagreement on the support design, however, Cygna believes that TUGCO must either evaluate the effects on the basis of support ductility or review the supports on a more specific basis without the increased allowable before Cygna can close this item for the purposes of the Phase 3 reviews.

If you prefer to have further technical discussions on this matter please notify me of this fact.

Very truly yours,

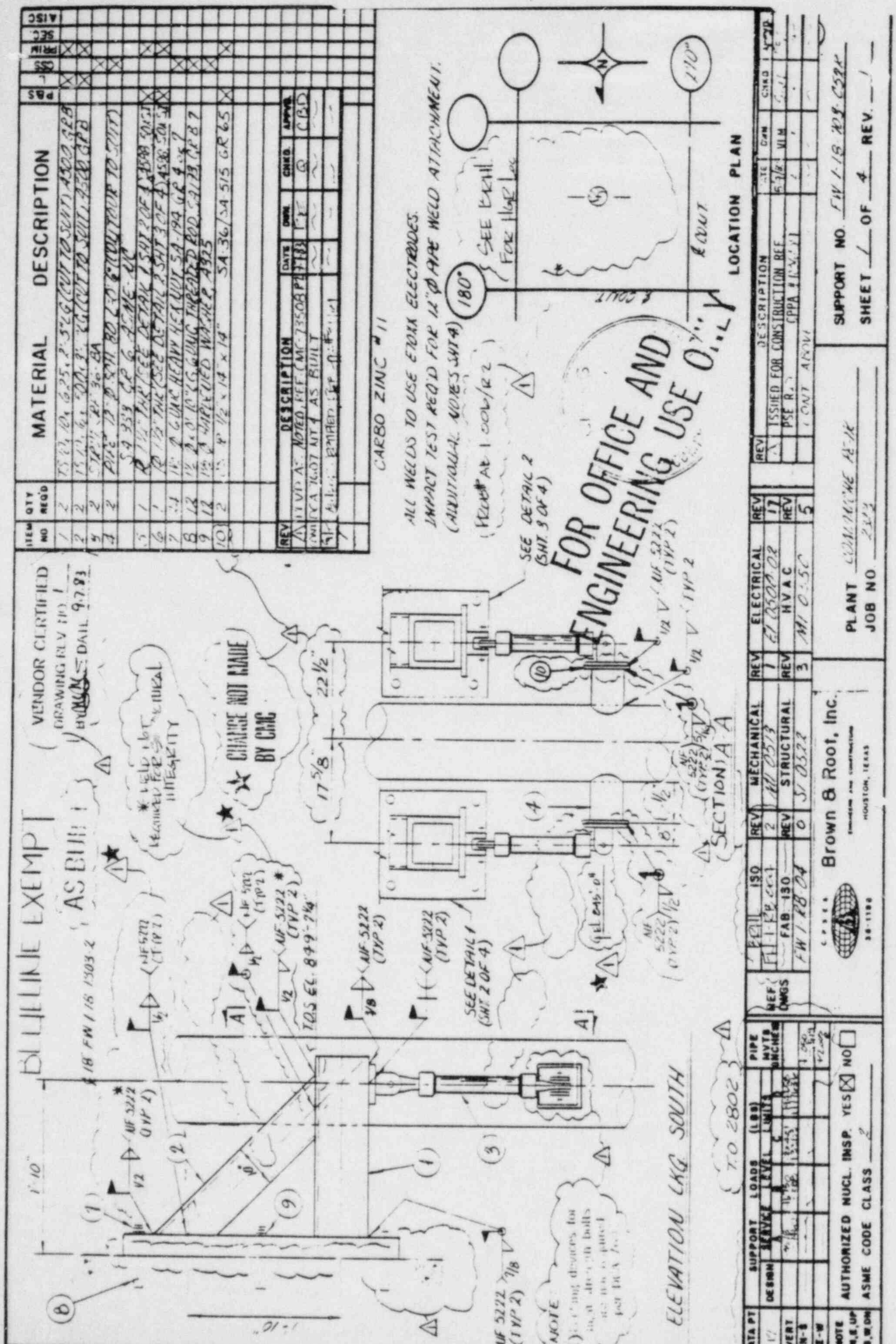
N. H. Williams

N. H. Williams
Project Manager

cc: Mr. S. Burwell (USNRC)
Mr. S. Treby (USNRC)
Mrs. J. Ellis (CASE)
Mr. D. Wade (TUGCO)
Mr. G. Grace (TUGCO/EBASCO)
Mr. D. Pigott (OHS)
Mr. R. Ballard (G&H)

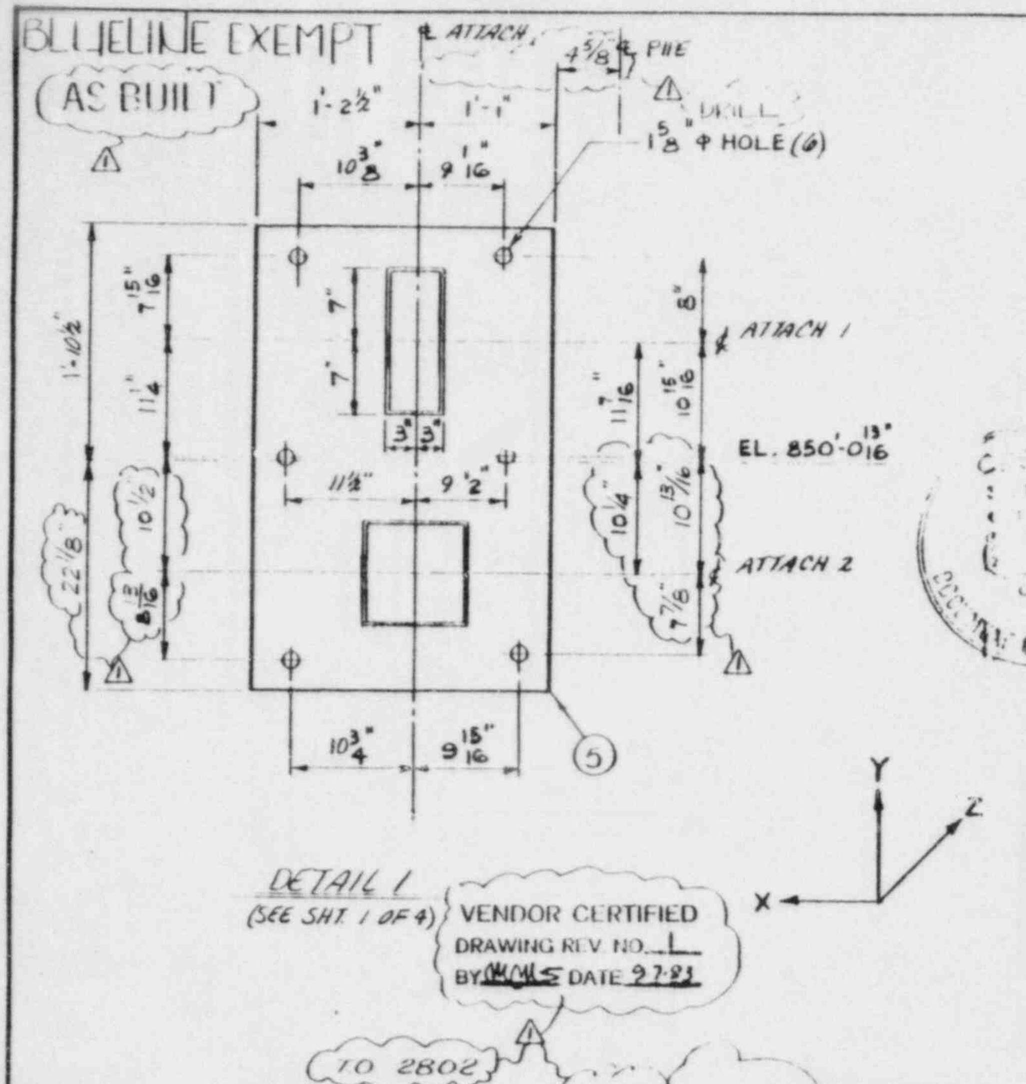
ATTACHMENT C

Item 3



BLUELINE EXEMPT

AS BUILT



ITEM NO.	QTY. REQ'D.	MATERIAL DESCRIPTION	PBS	L	CSB	PRIM	SEC.	AISC

REV	DESCRIPTION	DATE	DWN.	CHKD.	APPVD.
1	REVD AS NTD; REF: CMC-73508 R 2	9-7-83	EE	Q	CBD
DNT	DCA 7607 NTA AS BUILT	~	~	~	~
	VENDOR CERTIFIED REF...				

FOR OFFICE AND ENGINEERING USE O...Y

CPSES 1195 CONTROL COPY DOCUMENT CONTROL CENTER

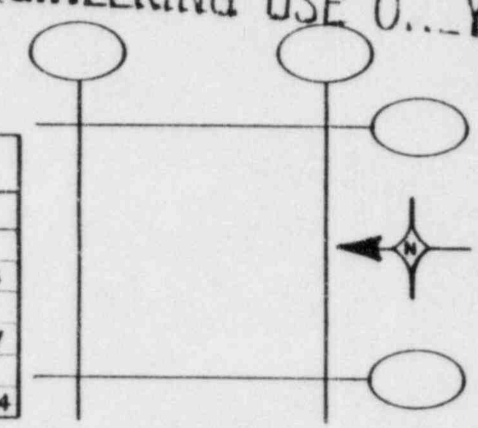
ASME CODE EDITION: —

ADDENDA: —

DESIGN SPEC: —

LOAD TABLE (FROM PSE)			
ATTACHMENT		1	2
LOADS (*)	F_Z (kips)	±56.953	±56.953
	F_Y (Kips)	±54.693	±42.807
	M_X (IN-Kips)	±92.977	±717.954

(*) SERVICE LEVEL 'D' LOADS



LOCATION PLAN

DATA PT.	SUPPORT LOADS (lbs) DESIGN	SERVICE LEVEL LIMITS A	B	C	D	PIPE MVTS (INCHES)
VERT.						
N-S						
E-W						
NOTE +N,E,UP -S,W,DN	AUTHORIZED NUCL. INSP. YES ☒ NO ☐					
	ASME CODE CLASS 2					

REF. DWGS	ISO.	REV.	MECHANICAL	REV.	ELECTRICAL	REV.
	FAB. ISO.	REV.	STRUCTURAL	REV.	H.V.A.C.	REV.

REV	DESCRIPTION	DATE	DWN.	CHKD.	APPVD.
0	ISSUED FOR CONSTRUCTION REF. PSE R.O. CPPA # 19165	5/9/80	VLM	SIUL	RK
	CONT ABOVE	~	~	~	~

CPSES 35-1195

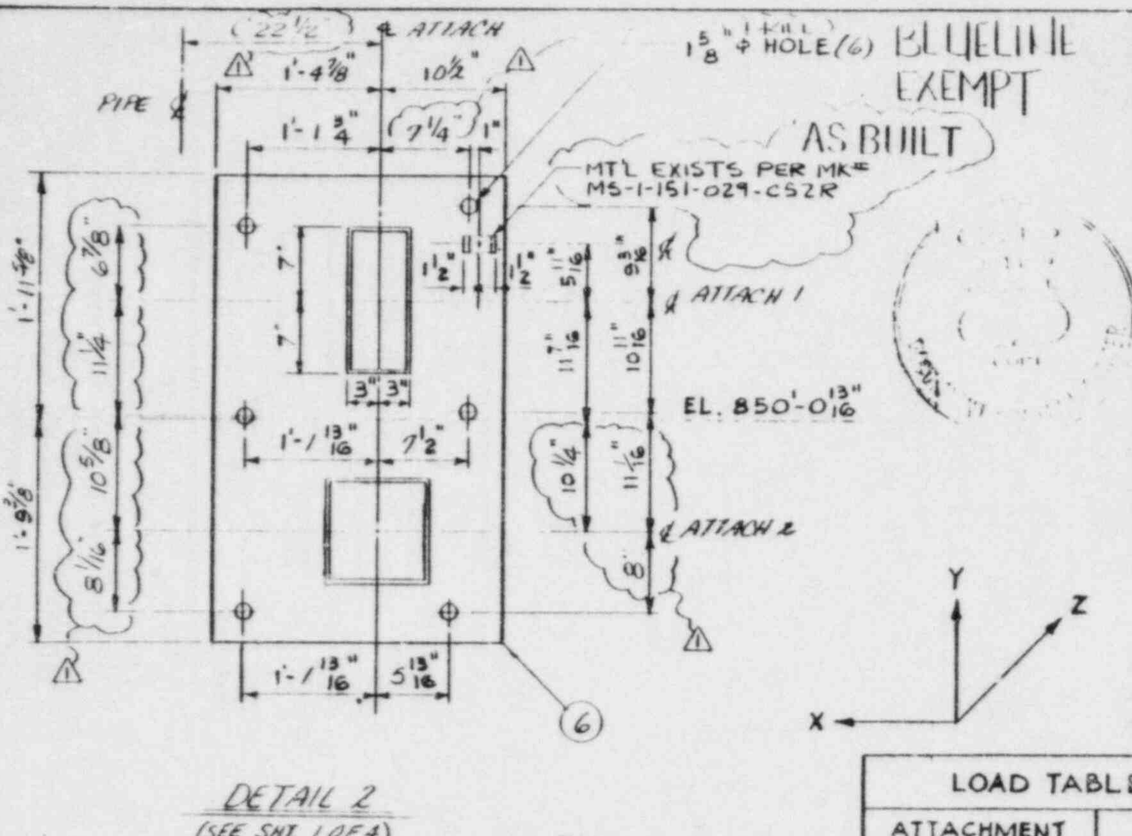
Brown & Root, Inc.
ENGINEERS AND CONSTRUCTORS
HOUSTON, TEXAS

PLANT COMANCHE PEAK
JOB NO. 2323

GGH FAG NO. 02268 - 18

SUPPORT NO. FW-1-18-703-C52R

SHEET 2 OF 4 REV. 1



ITEM NO.	QTY. REQ'D.	MATERIAL DESCRIPTION	PBS	L	CSS	PRIM	SEC	AISC

REV	DESCRIPTION	DATE	DWN.	CHKD.	APPVD.
1	RLVD AS NTD; REF CMC-73508 R2			Q	CBD
CONT	DCA-7607 NT4 AS BUILT	~	~	~	~

VENDOR CERTIFIED
DRAWING REV. NO. 1
BY [illegible] DATE 9-7-83

FOR OFFICE AND ENGINEERING

ASME CODE EDITION: ______
ADDENDA: ______
DESIGN SPEC: ______

LOAD TABLE (FROM PSE)				
ATTACHMENT		1	2	3
LOADS (*)	F_z (kips)	±56.953	±56.953	±2.5
	F_Y (kips)	±54.693	±42.807	–
	M_x (IN-kips)	±92.977	±717.954	–

(*) SERVICE LEVEL 'D' LOADS

LOCATION PLAN

T.O. 2802

DATA PT.	SUPPORT LOADS (lbs) DESIGN	SERVICE LEVEL LIMITS A	B	C	D	PIPE MVTS (INCHES)
VERT.						
N-S						
E-W						

NOTE +N,E,UP −S,W,DN

AUTHORIZED NUCL. INSP. YES ☒ NO ☐
ASME CODE CLASS 2

REF. DWGS. ISO. REV. MECHANICAL REV. ELECTRICAL REV.
FAB. ISO. REV. STRUCTURAL REV. H.V.A.C. REV.

REV	DESCRIPTION	DATE	DWN	CHKD	APPVD.
0	ISSUED FOR CONSTRUCTION REF.		VLM		
CONT	PSE R.0 CPPA #18549				
	CONT. ABOVE	~			

Brown & Root, Inc.
ENGINEERS AND CONSTRUCTORS
HOUSTON, TEXAS

PLANT COMANCHE PEAK
JOB NO. 2323

SUPPORT NO. FW-1-18-703-C52R
SHEET 3 OF 4 REV. 1

BLUELINE EXEMPT

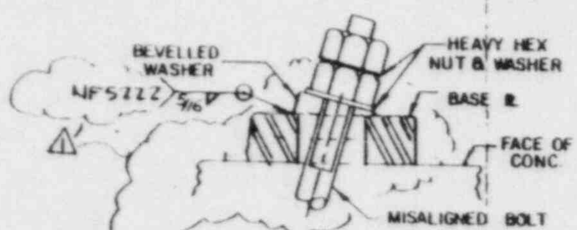
NOTES:

1. FOR MATERIAL, ULTRASONIC EXAMINATION AND POST WELD HEAT TREATMENT, SEE NOTES ON G & H DWG. 2323-SI-0680 ISSUE 2.
2. ALL BOLTS FOR RICHMOND SCREW ANCHORS SHALL BE SA-193, GR. B7 THREADED RODS WITH SA-194, GR. 4 OR 7 NUTS AND A325 HARDENED WASHERS. (8 UNC THREADS FOR 1" Ø, 6 UNC THREADS FOR 1-1/2" Ø)
3. USE BOLT DETAIL FOR BOLTS/RICHMOND SCREW ANCHORS THAT ARE MISALIGNED OR SKEW. ELONGATED HOLE IN BASE ℞ WILL BE REQUIRED FOR SUCH BOLTS. A BEVELLED ℞ WASHER WILL BE USED FOR BOLTS USING ELONGATED HOLES. BEVELLED ℞ WASHER IS FURTHER DESCRIBED AS FOLLOWS.
   - A. THE MATERIAL SHALL BE ASTM A588, GR. A.
   - B. THE HOLE IN THE BEVELLED ℞ WASHER SHALL BE A "STANDARD HOLE."
   - C. THE MINIMUM THICKNESS SHALL BE 3/8".
   - D. THE SURFACE OF THE BEVELLED ℞ WASHER IN CONTACT WITH THE NUT SHALL NOT HAVE SLOPE OF MORE THAN 1:20 WITH RESPECT TO A PLANE NORMAL TO THE BOLT AXIS.
   - E. THE BEVELLED ℞ WASHER SHALL BE SQUARE OR RECTANGULAR AS REQUIRED. THE SIZE OF THE ℞ WASHER SHALL BE A MINIMUM OF 2 BOLT DIAMETERS IN EACH DIRECTION OR SHALL EXTEND 1/2" FARTHER THAN ANY EDGE OF THE ELONGATED HOLE, WHICHEVER IS THE GREATER.

ITEM NO	QTY REQ'D.	MATERIAL DESCRIPTION	MATERIAL DESIG.

REV	DESCRIPTION	DATE	DWN.	CHKD	APPVD.
1	RCVD AS NOTED, REF CMC-7350B R2	[illegible]-83	[illegible]	[illegible]	CBD
[illegible]	LCA-7607 NT4, AS BUILT	~			~
[illegible]	VENDOR CERTIFIED T/O #31 A				

VENDOR CERTIFIED
DRAWING REV. NO. 1
BY [illegible] DATE 9-2-83

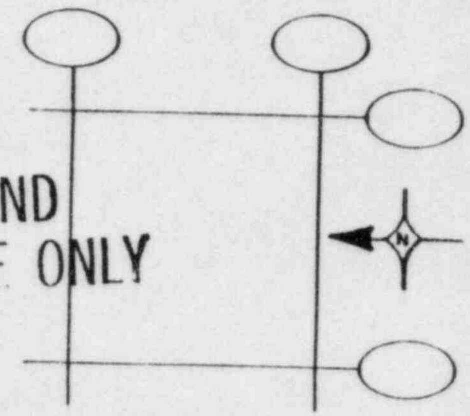


BOLT DETAIL

(T/O # 2802)

ASME CODE EDITION:
ADDENDA:
DESIGN SPEC:

FOR OFFICE AND ENGINEERING USE ONLY



LOCATION PLAN

DATA PT. / SUPPORT LOADS (lbs): DESIGN, SERVICE LEVEL LIMITS A, B, C, D / PIPE MVTS (INCHES)
VERT.
N-S
E-W
NOTE: +N, E, UP; -S, W, DN

REF DWGS: ISO, REV.; FAB ISO, REV.; MECHANICAL, REV.; STRUCTURAL, REV.; ELECTRICAL, REV.; H V A C, REV.

REV	DESCRIPTION	DATE	DWN	CHKD	APPVD.
0	ISSUED FOR CONSTRUCTION REF. PSE R. [illegible] CPPA # [illegible]	[illegible]	VLM	[illegible]	[illegible]
	CONT. ABOVE				

AUTHORIZED NUCL. INSP. YES [x] NO [ ]
ASME CODE CLASS 2

CPSES
Brown & Root, Inc.
ENGINEERS AND CONSTRUCTORS
HOUSTON, TEXAS
SB-1186

PLANT COMANCHE PEAK
JOB NO. 2323

GENFIG NO. [illegible]
SUPPORT NO. FW-1-IS-103-C52R
SHEET 4 OF 4 REV. 1

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 6-13-84
Calc By DYC
Chk'd/Apprd. By T. KUO
Subject FW-1-018-703-C52R R/1

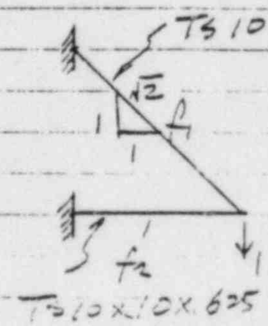
Filing Code
Sheet No. 1 Of 4
G & H Job No.
Ref. Dwg./Spec. No.

TRUNNION 12"φ SCH. 80 $I = 475.2^{IN^4}$

TS 10X6X.5 $A_1 = 13.9^{IN^2}$; $L_1 = 31.11^{IN}$ $L_1/A_1 = 2.24$

TS 10X10X.625 $A_2 = 21.8^{IN^2}$; $L_2 = 22^{IN}$ $L_2/A_2 = 1.01$

BY VIRTUAL WORK FIND FRAME STIFFNESS. (K_{ST})



$$K_{ST} = \frac{E}{f_1^2 L_1/A_1 + f_2^2 L_2/A_2}$$

$$= \frac{27.4E6}{(\sqrt{2})^2 \times 2.24 + 1 \times 1.01} = 4992^{K/IN}$$

STRUT ASSEMBLY = SRF-36 ; C-C = 77.25" — NPSI TD-11

$K_{RB(90°)} = 29297.16^{K/IN}$

$K_{RB(0°)} = 197362.5^{K/IN}$

$K_{STRUT} = 7818.979^{K/IN}$

BASE PL. $\Delta Z = \frac{.0009444 + .000707 + .000701 + .000923}{4}$

$= .0008189$ — SEE P.3

$K_{PL} = \frac{1000}{.0008189} = 1.2212E3^{K/IN}$

RICHMOND INSERTS. (TEST REPORT 4-19-'84) — CPPA 38,367

6 BOLTS $K_{RI} = 6 \times (66-5)/.02 = 1.830E3^{K/IN}$

TOTAL STIFFNESS =

$$K = (K_{ST}^{-1} + K_{RB(90°)}^{-1} + K_{RB(0°)}^{-1} + K_{STRUT}^{-1} + K_{PL}^{-1} + K_{RI}^{-1})^{-1}$$

$$= [(4.992E3)^{-1} + (2.9297E4)^{-1} + (1.9736E5)^{-1} + (7.819E3)^{-1} + (1.2212E3)^{-1} + (1.83E3)^{-1}]^{-1}$$

FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 6-13-84
Calc By DYC
Chk'd/Apprd. By T. Kuo
Subject FW-1-018-703-C52R R/1
Ref. Dwg./Spec. No.
Filing Code
Sheet No. 2 Of 4
G & H Job. No.

$K = 5.77\ E2\ ^{K/''}$

$K_\theta = \left(\frac{2}{K L^2} + \frac{L - D}{12EI} \right)^{-1}$

$= \left(\frac{2}{5.77E2 \times 39^2} + \frac{39 - 18}{12 \times 27.4E3 \times 475.2} \right)^{-1}$

$= 4.145\ E5\ ^{K\text{-}''/RAD.}$

$= 4.145\ E8\ ^{\#\text{-}''/RAD}$

SHEET 3 OF 4
CALC BY DYC 6-13-84
CHK'D BY T. KUO. 6.14.84

****
* RESULTS OF LATEST ANALYSIS *
****

JOB ID - 05-22-19   JOB TITLE - FW-1-18-703-C52R

ACTIVE UNITS -	LENGTH	WEIGHT	ANGLE	TEMPERATURE	TIME	MASS
	INCH	POUN	RAD	DEGF	SEC	LBM

BASEPLATE RESULTS SUMMARY LEVEL 1

SPECIFIED GENERAL DATA

PLATE DIMENSION IN X DIRECTION....... 27.500
PLATE DIMENSION IN Y DIRECTION....... 44.630
PLATE THICKNESS...................... 1.500
PLATE MODULUS........................ 0.277000E 08
FOUNDATION MODULUS................... 0.363000E 07
PLATE ELEMENTS TYPE.................. PBQ1

SPECIFIED BOLT/PIN DATA

NUMBER OF BOLTS/PINS................. 6

NODE	LOCATION X	LOCATION Y	LOCATION Z	BOLT/PIN	KF AXIAL	DIAMETER
20201	3.7500	3.0600	0.0	1	500000.000	1.500
20501	3.0000	22.3800	0.0	2	500000.000	1.500
20801	4.1300	41.5600	0.0	3	500000.000	1.500
80201	24.4400	4.0000	0.0	4	500000.000	1.500
80501	24.0000	22.6900	0.0	5	500000.000	1.500
80801	23.5600	41.6300	0.0	6	500000.000	1.500

LOADING 1   ONE

SHEET 4 OF 4
CALC. BY DYC 6-13-84
CHK'D BY T. Kuo 6.14.84

SPECIFIED LOAD VALUES AND THEIR LOCATIONS

NUMBER OF LOAD POINTS.................. 8

NODE	LOCATION X	LOCATION Y	LOCATION Z	FORCES X	FORCES Y	FORCES Z	MOMENTS X	MOMENTS Y	MOMENTS Z
	9.5000	6.8700	0.0	0.0	0.0	250.000	0.0	0.0	0.0
	9.5000	16.8750	0.0	0.0	0.0	250.000	0.0	0.0	0.0
	19.5000	16.8700	0.0	0.0	0.0	250.000	0.0	0.0	0.0
	19.5000	6.8700	0.0	0.0	0.0	250.000	0.0	0.0	0.0
	11.5000	26.6200	0.0	0.0	250.000	-250.000	0.0	0.0	0.0
	11.5000	40.6200	0.0	0.0	250.000	-250.000	0.0	0.0	0.0
	17.5000	40.6250	0.0	0.0	250.000	-250.000	0.0	0.0	0.0
	17.5000	26.6200	0.0	0.0	250.000	-250.000	0.0	0.0	0.0

COMPUTED BOLT/PIN LOADS

NODE	LOCATION X	LOCATION Y	LOCATION Z	BOLT/PIN	AXIAL FORCE	SHEAR FORCES GLOBAL-X	SHEAR FORCES GLOBAL-Y	SHEAR FORCES SRSS
20201	3.7500	3.0600	0.0	1	242.333	6.457	163.333	163.461
20501	3.0000	22.3800	0.0	2	169.170	0.057	163.085	163.085
20801	4.1300	41.5600	0.0	3	0.3[illegible]	-6.296	163.459	163.580
80201	24.4400	4.0000	0.0	4	273.5[illegible]	6.145	170.187	170.297
80501	24.0000	22.6900	0.0	5	121.0[illegible]	-0.045	170.041	170.041
80801	23.5600	41.6300	0.0	6	0.0	-6.319	169.895	170.012

COMPUTED DISPLACEMENTS/ROTATIONS AT LOAD POINTS

NODE	LOCATION X	LOCATION Y	LOCATION Z	DISPLACEMENTS X	DISPLACEMENTS Y	DISPLACEMENTS Z	ROTATIONS X	ROTATIONS Y	ROTATIONS Z
	9.5000	6.8700	0.0	0.0	0.0	0.000944	0.000009	-0.000043	0.0
	9.5000	16.8750	0.0	0.0	0.0	0.000707	-0.000057	-0.000023	0.0
	19.5000	16.8700	0.0	0.0	0.0	0.000701	-0.000056	0.000024	0.0
	19.5000	6.8700	0.0	0.0	0.0	0.000923	0.000010	0.000046	0.0
	11.5000	26.6200	0.0	0.0	0.0	0.000102	-0.000040	0.000000	0.0
	11.5000	40.6200	0.0	0.0	0.0	-0.000005	-0.000001	-0.000000	0.0
	17.5000	40.6250	0.0	0.0	0.0	-0.000006	-0.000002	0.000001	0.0
	17.5000	26.6200	0.0	0.0	0.0	0.000099	-0.000041	0.000001	0.0

AVG. .0008188

$K_{IE} = \frac{1000}{.0008188} = 1.2213E6$ #111

COMPUTED MAXIMUM PRINCIPAL STRESS VALUES

FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 6.14.84
Calc By TIM KUO
Chk'd/Apprd. By DYC 6-18-84
Subject FW-1-018-703-C52R

Filing Code ______
Sheet No. 1 of 2
G & H Job. No. ______
Ref. Dwg./Spec. No. ______

THE EXTRA FORCE DUE TO DOUBLE TRUNNION (EXTRA MOMENT) WITH THE EXISTING LEVEL D LOADING:

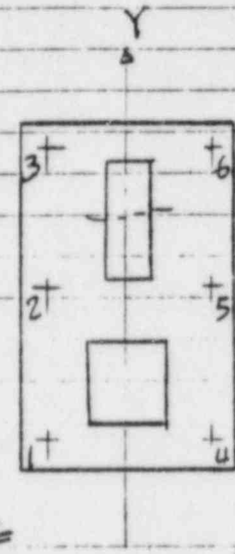
THE OVERALL NEW LOAD FROM G & H.

$F_y' = 142$ KIP. (ONE ARM).

$F_y = \frac{1}{2} F_y = \frac{1}{2} \times 194658$

$= 97.329$ KIP.

$\text{RATIO} = \frac{142}{97.329} = 1.459$



CHECK AGAINST TO THE WORST BASE PLATE (SOUTH PLATE)

BOLTS	BOLT TENSION EXIST. LOAD	BOLT TENSION NEW LOAD	BOLT SHEAR EXIST. LOAD	BOLT SHEAR NEW LOAD ALSO USED RE-DISTRIBUTION	INTERACTION RATIO (I)	INTERACTION RATIO (B)	REMARK
1	0.0	0.0	14651.89	42400	0.834	1	=1 O.K
2	6786.68	9901.56	14650.84	14979.62	0.32	0.137	<1 O.K.
3	14443.98	21073.32	15257.83	14979.62	0.52	0.18	<1 O.K
4	0.0	0.0	17846.42	42400	0.834	1	=1 O.K
5	18805.97	27437.33	18128.09	14979.62	0.658	0.218	<1 O.K
6	26192.38	38213.87	18657.21	14979.62	0.907	0.305	<1 O.K.

TOTAL 99192.28#

NEW LOAD = 144718.47# (SHEAR).

INSERT ALLOWABLE.
TA = 50 KIP. SA = 48.6 KIP

$\left(\frac{T}{T_A}\right)^{4/3} + \left(\frac{S}{S_A}\right)^{4/3} \leq 1$

BOLT ALL. (A-193 1½" φ)
TA = 90 KIP. SA = 92.4 KIP.

$\left(\frac{T}{T_A}\right)^{2} + \left(\frac{S}{S_A}\right)^2 \leq 1$.

FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 6 14 84

Calc By TIM KUO

Chk'd/Apprd. By DYC 6-18-84

Subject FW-1-018-709-CS2R

Ref. Dwg./Spec. No.

Filing Code

G & H Job. No.

THERE ARE ABOUT 35 SUPPORTS ON THIS FEED WATER LINE (STRESS PROBLEM NO. 1-6).

FOR WATER HAMMER ANALYSIS, THERE ARE 9 SPRING SUPPORTS AND 9 SNUBBER SUPPORTS WERE NEGLECTED, THE REST OF THE RIGID SUPPORT WERE CONSIDERED EFFECTIVE TO RESIST THE WATER HAMMER LOAD.

THE SUPPORT DESIGN IS ADEQUATE FOR THE ADDITIONAL LOAD.

CASE EX 724

TEXAS UTILITIES SERVICES INC.	COVER SHEET FOR GUIDELINE REVISIONS	REV.	ISSUE DATE	PAGE
ENGINEERING GUIDELINE TITLE		3	3-9-82	1OF 1
SECTION VI RICHMOND INSERTS & ANCHOR BOLTS STRESS ALLOWABLES		APPROVED: John C. Finneran Jr. PSE PROJ. ENGR.		

I. INSTRUCTIONS FOR FILING GUIDELINE PAGES

Remove Section VI Rev. 2 and replace with Section VI Rev. 3.
Place this cover sheet in front of Section VI Rev. 3.

II. STATUS OF GUIDELINE PAGES

PAGE	REV	PAGE	REV	PAGE	REV	PAGE	REV	PAGE	REV	PAGE	REV
1	3										
2	3										

SECTION VI: RICHMOND INSERTS AND ANCHOR BOLTS STRESS ALLOWABLES

1.0 REFERENCES

A. CP-EP-4.3
B. CP-EI-13.0-3
C. Letter GTN-57677

2.0 GENERAL

This guideline is relative to the stress allowables for Richmond Inserts and the specific type of anchor bolts described.

3.0 RICHMOND INSERTS

ALLOWABLE SINGLE ACTING LOADS

Load Direction	1" Insert	1½" Insert
Tension	10.1 KIPS	25.0 KIPS
Shear	9.5 KIPS	25.0 KIPS

INTERACTION REQUIREMENTS

$$\left(\frac{T}{F_t}\right)^{4/3} + \left(\frac{V}{F_v}\right)^{4/3} \leq 1$$

Where:
T = Applied Tension
V = Applied Shear
F_t = Allowable Tension
F_v = Allowable Shear

3.1 ANCHOR BOLTS

3.1.1 GROUTED-IN ANCHOR BOLTS

The following applies to a single 1½" Ø - A193 bolts installed in accordance with reference "B".

ALLOWABLE TENSILE CAPACITY

Ultimate load condition - 105 KIPS

Working load condition - 66 KIPS

ALLOWABLE SHEAR CAPACITY

Ultimate load condition - 69 KIPS

Working load condition - 34.5 KIPS

CASE EXHIBIT 743

U.S. NUCLEAR REGULATORY COMMISSION

Revision 1
January 1978

REGULATORY GUIDE

OFFICE OF STANDARDS DEVELOPMENT

REGULATORY GUIDE 1.124

SERVICE LIMITS AND LOADING COMBINATIONS FOR CLASS 1 LINEAR-TYPE COMPONENT SUPPORTS

A. INTRODUCTION

General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena," of Appendix A, "General Design Criteria for Nuclear Power Plants," to 10 CFR Part 50, "Licensing of Production and Utilization Facilities," requires that the design bases for structures, systems, and components important to safety reflect appropriate combinations of the effects of normal and accident conditions with the effects of natural phenomena such as earthquakes. The failure of members designed to support safety-related components could jeopardize the ability of the supported component to perform its safety function.

This guide delineates acceptable levels of service limits and appropriate combinations of loadings associated with normal operation, postulated accidents, and specified seismic events for the design of Class 1 linear-type component supports as defined in Subsection NF of Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. This guide applies to light-water-cooled reactors. The Advisory Committee on Reactor Safeguards has been consulted concerning this guide and has concurred in the regulatory position.

B. DISCUSSION

Load-bearing members classified as component supports are essential to the safety of nuclear power plants since they retain components in place during the loadings associated with normal and upset plant conditions under the stress of specified seismic events, thereby permitting system components to function properly. They also prevent excessive component movement during the loadings associated with emergency and faulted plant conditions combined with the specified seismic event, thus helping to mitigate the consequences of system damage. Component supports are deformation sensitive because large deformations in them may significantly change the stress distribution in the support system and its supported components.

In order to provide uniform requirements for construction, the component supports should, as a minimum, have the same ASME Boiler and Pressure Vessel Code classification as that of the supported components. This guide delineates levels of service limits and loading combinations, in addition to supplementary criteria, for ASME Class 1 linear-type component supports as defined by NF-1213 of Section III. Snubbers are not addressed in this guide.

Subsection NF and Appendix XVII of Section III permit the use of four methods for the design of Class 1 linear-type component supports: linear elastic analysis, load rating, experimental stress analysis, and limit analysis. For each method, the ASME Code delineates allowable stress or loading limits for various Code levels of service limits as defined by NF-3113 of Section III so that these limits can be used in conjunction with the resultant loadings or stresses from the appropriate plant conditions. Since the Code does not specify loading combinations, guidance is required to provide a consistent basis for the design of component supports.

Component supports considered in this guide are located within Seismic Category I structures and are therefore protected against loadings from natural phenomena or man-made hazards other than the specified seismic events. Thus only the specified seismic events need to be considered in combination with the loadings associated with plant conditions to develop appropriate loading combinations. Loadings caused

* Lines indicate substantive change from previous issue.

USNRC REGULATORY GUIDES

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142 057

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by natural phenomena other than seismic events, when they exist, should be considered on a case-by-case basis.

1. Design by Linear Elastic Analysis

a. *S_u at Temperature*. When the linear elastic analysis method is used to design Class 1 linear-type component supports, material properties are given by Tables I-2.1, I-2.2, I-13.1, and I-13.3 in Appendix I of Section III and Tables 3 and 4 in the latest accepted version[1] of Code Case 1644. These tables list values for the minimum yield strength S_y at various temperatures but only room temperature values for the ultimate tensile strength S_u. At room temperature, S_y varies from 50% to 87% of S_u for component support materials.

Levels of service limits derived from either material property alone may not be sufficient to provide a consistent safety margin. This is recognized by Section III, since XVII-2211(a) of Section III defines the allowable stress in tension on a net section as the smaller value of $0.6S_y$ and $0.5S_u$. To alleviate the lack of defined values of S_u at temperatures above room temperature and to provide a safe design margin, an interim method is given in this guide to obtain values of S_u at temperature.

While XVII-2211(a) specifies allowable tensile stress in terms of both S_y and S_u, the rest of XVII-2000 specifies other allowable service limits in terms of S_y only. This does not maintain a consistent design margin for those service limits related only to material properties. Modifications similar to XVII-2211(a) should be employed for all those service limits.

b. *Allowable Increase of Service Limits*. While NF-3231.1(a), XVII-2110(a), and F-1370(a) of Section III all permit the increase of allowable stresses under various loading conditions, XVII-2110(b) limits the increase so that two-thirds of the critical buckling stress for compression and compression flange members is not exceeded, and the increase allowed by NF-3231.1(a) is for stress range. Critical buckling stresses with normal design margins are derived in XVII-2200 of Section III. Since buckling prevents "shakedown" in the load-bearing member, XVII-2110(b) must be regarded as controlling. Also, buckling is the result of the interaction of the configuration of the load-bearing member and its material properties (i.e., elastic modulus E and minimum yield strength S_y). Because both of these material properties change with temperature, the critical buckling stresses should be calculated with the values of E and S_y of the component support material at temperature. Allowable service limits for bolted connections are derived from tensile and shear stress limits and their nonlinear interaction; they also change with the size of the bolt. For this reason, the increases permitted by NF-3231.1, XVII-2110(a), and F-1370(a) of Section III are not directly applicable to allowable shear stresses and allowable stresses for bolts and bolted connections. The increase permitted by NF-3231.1 and F-1370(a) of Section III for shear stresses or shear stress range should not be more than 1.5 times the level A service limits because of the potential for non-ductile behavior.

The range of primary plus secondary stresses should be limited to $2S_y$ but not more than S_u to ensure shakedown. For many allowable stresses above the value of $0.6S_y$, the increase permitted by NF-3231.1(a) will be above the value of $2S_y$ and will thus violate the normal shakedown range. A shakedown analysis is necessary to justify the increase of stress above $2S_y$ or S_u.

For the linear elastic analysis method, F-1370(a) of Section III permits increase of tension limits for the Code level D service limits by a variable factor that is the smaller value of $1.2S_y/F_t$ or $0.7S_u/F_t$. Depending on whether the section considered is a net section at pinholes in eyebars, pin-connected plates, or built-up structural members, F_t may assume the smaller value of $0.45S_y$ or $0.375S_u$ (as recommended by this guide for a net section of pinholes, etc.) or the smaller value of $0.6S_y$ or $0.5S_u$ (for a net section without pinholes, etc.). Thus greater values of the factor may be obtained for sections at pinholes, which does not account for local stress and is not consistent with NF-3231.1 and XVII-2110(a) of Section III. A procedure to correct this factor is provided in this guide.

2. Design by Load Rating

When load-rating methods are used, Subsection NF and Appendix F of Section III do not provide a faulted condition load rating. This guide provides an interim method for the determination of faulted condition load rating.

3. Design by Experimental Stress Analysis

While the collapse load for the experimental stress analysis method is defined by II-1430 in Appendix II of Section III, the various levels of service limits for experimental stress analysis are not delineated. This deficiency is remedied by the method described in this guide.

4. Large Deformation

The design of component supports is an integral part of the design of the system and its components.

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[1] Regulatory Guide 1.85, "Code Case Acceptability—ASME Section III Materials," provides guidance for the acceptability of ASME Section III Code Cases and their revisions, including Code Case 1644. Supplementary provisions for the use of specific code cases and their revisions may also be provided and should be considered when applicable.

142 059

A complete and consistent design is possible only when system/component/component-support interaction is properly considered. When all three are evaluated on an elastic basis, the interaction is usually valid because individual deformations are small. However, if plastic analysis methods are employed in the design process, large deformations that would result in substantially different stress distributions may occur.

When component supports are designed for loadings associated with the faulted plant conditions, Appendix F of Section III permits the use of plastic analysis methods in certain acceptable combinations for all three elements. These acceptable combinations are selected on the assumption that component supports are more deformation sensitive (i.e., their deformation in general will have a large effect on the stress distribution in the system and its components.) Since large deformations always affect the stress distribution, care should be exercised even if the plastic analysis method is used in the Appendix F-approved methodology combination. This is especially important for identifying buckling or instability problems where the change of geometry should be taken into account to avoid erroneous results.

5. Function of Supported System

In selecting the level of service limits for different loading combinations, the function of the supported system must be taken into account. To ensure that systems whose normal function is to prevent or mitigate consequences of events associated with an emergency or faulted plant condition (e.g., the function of ECCS during faulted plant conditions) will operate properly regardless of plant condition, the Code level A or B service limits of Subsection NF (which are identical) or other justifiable limits provided by the Code should be used.

Since Appendix XVII derived all equations from AISC rules and many AISC compression equations have built-in constants based on mechanical properties of steel at room temperature, to use these equations indiscriminately for all NF and the latest accepted version of Code Case 1644 materials at all temperatures would not be prudent. For materials other than steel and working temperatures substantially different from room temperature, these equations should be rederived with the appropriate material properties.

6. Deformation Limits

Since component supports are deformation-sensitive load-bearing elements, satisfying the service limits of Section III will not automatically ensure their proper function. Deformation limits, if specified by the Code Design Specification, may be the controlling criterion. On the other hand, if the function of a component support is not required for a particular plant condition, the stresses or loads resulting from the loading combinations under that plant condition do not need to satisfy the design limits for the plant condition.

7. Definitions

Design Condition. The loading condition defined by NF-3112 of Section III of the ASME Boiler and Pressure Vessel Code.

Emergency Plant Condition. Those operating conditions that have a low probability of occurrence.

Faulted Plant Condition. Those operating conditions associated with postulated events of extremely low probability.

Levels of Service Limits. Four levels, A, B, C, and D, of service limits defined by Section III for the design of loadings associated with different plant conditions for components and component supports in nuclear power plants.

Normal Plant Condition. Those operating conditions in the course of system startup, operation, hot standby, refueling, and shutdown other than upset, emergency, or faulted plant conditions.

Operating Basis Earthquake (OBE). As defined in Appendix A to 10 CFR Part 100.

Plant Conditions. Operating conditions of the plant categorized as normal, upset, emergency, and faulted plant conditions.

Safe Shutdown Earthquake (SSE). As defined in Appendix A to 10 CFR Part 100.

Service Limits. Stress limits for the design of component supports as defined by Subsection NF of Section III.

Specified Seismic Events. Operating Basis Earthquake and Safe Shutdown Earthquake.

System Mechanical Loadings. The static and dynamic loadings that are developed by the system operating parameters, including deadweight, pressure, and other external loadings, but excluding effects resulting from constraints of free-end movements and thermal and peak stresses.

Ultimate Tensile Strength. Material property based on engineering stress-strain relationship.

Upset Plant Conditions. Those deviations from the normal plant condition that have a high probability of occurrence.

C. REGULATORY POSITION

ASME Code[2] Class 1 linear-type component sup-

[2] American Society of Mechanical Engineers Boiler and Pressure Vessel Code, Section III, Division 1, 1974 Edition, including the 1976 Winter Addenda thereto.

ports excluding snubbers, which are not addressed herein, should be constructed to the rules of Subsection NF of Section III as supplemented by the following: [3]

1. The classification of component supports should, as a minimum, be the same as that of the supported components.

2. Values of S_u at a temperature t should be estimated by one of the three following methods on an interim basis until Section III includes such values:

a. *Method 1*. This method applies to component support materials whose values of ultimate strength S_u at temperature have been tabulated by their manufacturers in catalogs or other publications.

$$S_u = S_{ur} \frac{S'_u}{S'_{ur}} \text{, but not greater than } S_{ur}$$

where

S_u = ultimate tensile strength at temperature t to be used to determine the service limits

S_{ur} = ultimate tensile strength at room temperature tabulated in Section III, Appendix I, or the latest accepted version [1] of Code Case 1644

S'_u = ultimate tensile strength at temperature t tabulated by manufacturers in their catalogs or other publications

S'_{ur} = ultimate tensile strength at room temperature tabulated by manufacturers in the same publications.

b. *Method 2*. This method applies to component support materials whose values of ultimate tensile strength at temperature have not been tabulated by their manufacturers in any catalog or publication.

$$S_u = S_{ur} \frac{S_y}{S_{yr}}$$

where

S_u = ultimate tensile strength at temperature t to be used to determine the service limits

S_{ur} = ultimate tensile strength at room temperature tabulated in Section III, Appendix I, or the latest accepted version [1] of Code Case 1644

S_y = minimum yield strength at temperature t tabulated in Section III, Appendix I, or the latest accepted version [1] of Code Case 1644

S_{yr} = minimum yield strength at room temperature, tabulated in Section III, Appendix I, or the latest accepted version [1] of Code Case 1644.

c. *Method 3*. When the values of allowable stress or stress intensity at temperature for a material are listed in Section III, the ultimate tensile strength at temperature for that material may be approximated by the following expressions:

$S_u = 4S$ or

$S_u = 3S_m$

where

S_u = ultimate tensile strength at temperature t to be used to determine the service limits

S_u = listed value of allowable stress at temperature t in Section III.

S_m = listed value of allowable stress intensity at temperature t in Section III

3. The Code levels A and B service limits for component supports designed by linear elastic analysis which are related to S_y should meet the appropriate stress limits of Appendix XVII of Section III but should not exceed the limit specified when the value of 5/6 S_u is substituted for S_y. Examples are shown below in a and b.

a. The tensile stress limit F_t for a net section as specified in XVII-2211(a) of Section III should be the smaller value of $0.6S_y$ or $0.5S_u$ at temperature. For net sections at pinholes in eye-bars, pin-connected plates, or built-up structural members, F_t as specified in XVII-2211(b) should be the smaller value of $0.45S_y$ or $0.375S_u$ at temperature.

b. The shear stress limit F_v for a gross section as specified in XVII-2212 of Section III should be the smaller value of $0.4S_y$ or $0.33S_u$ at temperature.

Many limits and equations for compression strength specified in Sections XVII-2214, XVII-2224, XVII-2225, XVII-2240, and XVII-2260 have built-in constants based on Young's Modulus of 29,000 Ksi. For materials with Young's Modulus at working temperatures substantially different from 29,000 Ksi, these constants should be rederived with the appropriate Young's Modulus unless the conservatism of using these constants as specified can be demonstrated.

4. Component supports designed by linear elastic analysis may increase their level A or B service limits according to the provisions of NF-3231.1(a), XVII-2110(a), and F-1370(a) of Section III. The increase of level A or B service limits provided by NF-3231.1(a) is for stress range. The increase of level A

[3] If the function of a component support is not required during a plant condition, the design limits of the support for that plant condition need not be satisfied, provided excessive deflection or failure of the support will not result in the loss of function of any other safety-related system.

142 060

or B service limits provided by F-1370(a) for level D service limits should be the smaller factor of 2 or $1.167S_u/S_y$, if $S_u \geq 1.2S_y$ or 1.4 if $S_u \leq 1.2S_y$, where S_y and S_u are component-support material properties at temperature.

However, all increases [i.e., those allowed by NF-3231.1(a), XVII-2110(a), and F-1370(a)] should always be limited by XVII-2110(b) of Section III. The critical buckling strengths defined by XVII-2110(b) of Section III should be calculated using material properties at temperature. This increase of level A or B service limits does not apply to limits for bolted connections. Any increase of limits for shear stresses above 1.5 times the Code level A service limits should be justified.

If the increased service limit for stress range by NF-3231.1(a) is more than $2S_y$ or S_u, it should be limited to the smaller value of $2S_y$ or S_u unless it can be justified by a shakedown analysis.

5. Component supports subjected to the combined loadings of system mechanical loadings associated with (1) either (a) the Code design condition or (b) the normal or upset plant conditions and (2) the vibratory motion of the OBE should be designed within the following limits: [4,5]

a. The stress limits of XVII-2000 of Section III and Regulatory Position 3 of this guide should not be exceeded for component supports designed by the linear elastic analysis method. These stress limits may be increased according to the provisions of NF-3231.1(a) of Section III and Regulatory Position 4 of this guide when effects resulting from constraints of free-end displacements are added to the loading combination.

b. The normal condition load rating or the upset condition load rating of NF-3262.3 of Section III should not be exceeded for component supports designed by the load-rating method.

c. The lower bound collapse load determined by XVII-4200 adjusted according to the provision of XVII-4110(a) of Section III should not be exceeded for component supports designed by the limit analysis method.

d. The collapse load determined by II-1400 of Section III divided by 1.7 should not be exceeded for component supports designed by the experimental stress analysis method.

6. Component supports subjected to the system mechanical loadings associated with the emergency plant condition should be designed within the following design limits except when the normal function of the supported system is to prevent or mitigate the consequences of events associated with the emergency plant condition (at which time Regulatory Position 8 applies): [4,5]

a. The stress limits of XVII-2000 of Section III and Regulatory Positions 3 and 4, increased according to the provisions of XVII-2110(a) of Section III and Regulatory Position 4 of this guide, should not be exceeded for component supports designed by the linear elastic analysis method.

b. The emergency condition load rating of NF-3262.3 of Section III should not be exceeded for component supports designed by the load-rating method.

c. The lower bound collapse load determined by XVII-4200 adjusted according to the provision of XVII-4110(a) of Section III should not be exceeded for component supports designed by the limit analysis method.

d. The collapse load determined by II-1400 of Section III divided by 1.3 should not be exceeded for component supports designed by the experimental stress analysis method.

7. Component supports subjected to the combined loadings of (1) the system mechanical loadings associated with the normal plant condition, (2) the vibratory motion of the SSE, and (3) the dynamic system loadings associated with the faulted plant condition should be designed within the following limits except when the normal function of the supported system is to prevent or mitigate the consequences of events associated with the faulted plant condition (at which time Regulatory Position 8 applies):

a. The stress limits of XVII-2000 of Section III and Regulatory Position 3 of this guide, increased according to the provisions of F-1370(a) of Section III and Regulatory Position 4 of this guide, should not be exceeded for component supports designed by the linear elastic analysis method.

b. The smaller value of T.L. x $2S/S_u$ or T.L. x $0.7S_u'/S_u$ should not be exceeded, where T.L., S, and S_u are defined according to NF-3262.1 of Section III, and S_u' is the minimum ultimate tensile strength of the material at service temperature for component supports designed by the load-rating method.

c. The lower bound collapse load determined by XVII-4200 adjusted according to the provision of F-1370(b) of Section III should not be exceeded for

[4] Since component supports are deformation sensitive in the performance of their service requirements, satisfying these criteria does not ensure that their functional requirements will be fulfilled. Any deformation limits specified by the design specification may be controlling and should be satisfied.

[5] Since the design of component supports is an integral part of the design of the system and the design of the component, the designer must make sure that methods used for the analysis of the system, component, and component support are compatible (see Table F-1322.2-1 in Appendix F of Section III). Large deformations in the system or components should be considered in the design of component supports.

142 061

component supports designed by the limit analysis method.

d. The collapse load determined by II–1400 adjusted according to the provision of F–1370(b) of Section III should not be exceeded for component supports designed by the experimental stress analysis method.

8. Component supports in systems whose normal function is to prevent or mitigate the consequences of events associated with an emergency or faulted plant condition should be designed within the limits described in Regulatory Position 5 or other justifiable limits provided by the Code. These limits should be defined by the Design Specification and stated in the PSAR, such that the function of the supported system will be maintained when they are subjected to the loading combinations described in Regulatory Positions 6 and 7.

D. IMPLEMENTATION

The purpose of this section is to provide guidance to applicants and licensees regarding the NRC staff's plans for using this regulatory guide.

Except in those cases in which the applicant proposes an acceptable alternative method for complying with the specified portions of the Commission's regulations, the method described herein will be used in the evaluation of submittals for construction permit applications docketed after January 10, 1978. If an applicant wishes to use this regulatory guide in developing submittals for construction permit applications docketed on or before January 10, 1978, the pertinent portions of the application will be evaluated on the basis of this guide.

142 062