NUREG-0797
Supplement No. 14

Safety Evaluation Report
related to the operation of Comanche Peak Steam Electric Station, Units 1 and 2

Docket Nos. 50-445 and 50-446

Texas Utilities Electric Company, et al.

U.S. Nuclear Regulatory Commission

Office of Special Projects

March 1988

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ABSTRACT

Supplement 14 to the Safety Evaluation Report related to the operation of the Comanche Peak Steam Electric Station (CPSES), Units 1 and 2 (NUREG-0797), has been prepared by the Office of Special Projects of the U.S. Nuclear Regulatory Commission (NRC). The facility is located in Somerville County, Texas, approximately 40 miles southwest of Fort Worth, Texas. This supplement presents the staff's evaluation of the applicants' Corrective Action Program (CAP) related to large and small bore piping and pipe supports. The scope and methodologies for CAP workscopes as summarized in Revision 0 to the large and small bore piping project status reports and as detailed in related documents referenced in this evaluation were developed to resolve various design issues raised by the Atomic Safety and Licensing Board (ASLB); the intervenor, Citizens Association for Sound Energy (CASE); the Comanche Peak Response Team (CPRT); CYGNA Energy Services (CYGNA); and the NRC staff.

The NRC staff concludes that the CAP workscopes for large and small bore piping provide a comprehensive program for resolving the associated technical concerns identified by the ASLB, CASE, CPRT, CYGNA, and the NRC staff and their implementation ensures that the design of large and small bore piping and pipe supports at CPSES satisfies the applicable requirements of 10 CFR 50.

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ABBREVIATIONS

ACI	American Concrete Institute
AE	architect-engineer
AFW	auxiliary feedwater
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ARMS	automatic records management system
ASLB	Atomic Safety and Licensing Board
ASME	American Society of Mechanical Engineers
ASTM	Amercian Society for Testing and Materials
AWS	American Welding Society
CAP	Corrective Action Program
CASE	Citizens Association for Sound Energy
CFR	Code of Federal Regulations
CPPP	Comanche Peak Project Procedure
CPRT	Comanche Peak Response Team
CPSES	Comanche Peak Steam Electric Station
CYGNA	CYGNA Energy Services
DAP	Design Adequacy Program
DBCP	Design Basis Consolidation Program
DBD	design basis document
DIR	discrepancy/issue resolution report
DR	deviation report
DSAP	discipline specific action plan

DVP	design validation package
EFE	Engineering Functional Evaluation
ERC	Evaluation Research Corporation
ESIS	external source issue summary
FSAR	final safety analysis report
FVM	field verification methods
GENX	Stone & Webster Generic Calculation Number
G&H	Gibbs and Hill, Incorporated
GIR	Generic Issues Report
HVP	Hardware Validation Program
IE	NRC Office of Inspection and Enforcement
IAP	Independent Assessment Program
ISAP	issue-specific action plan
IWA	integrally welded attachment
LBP	large bore piping
LCDS	load capacity data sheet
LOCA	loss-of-coolant-accident
MSS	Manufacturers Standardization Society
NCR	nonconformance report
NRC	U.S. Nuclear Regulatory Commission
OBE	operating basis earthquake
PCHVP	Post-Construction Hardware Validation Program
PCI	Prestressed Concrete Institute
PSR	project status report
QA	quality assurance
QC	quality control
QOC	quality of construction

RCCL	record classification code list
RCS	reactor coolant system
RIL	review issues list
RLCA	Robert L. Cloud Associates
SDAR	significant deficiency analysis report
SER	safety evaluation report
SIF	stress intensification factor
SIT	special inspection team
SRSS	square-root-of-the-sum-of-the-squares
SRT	senior review team
S/RV	safety/relief valve
SSE	safe shutdown earthquake
SSER	Supplemental Safety Evaluation Report
SWEC	Stone & Webster Engineering Corporation
TAP	Technical Audit Program
TENERA	TENERA, L.P. (formerly TERA Corporation)
TRT	technical review team
TU Electric	Texas Utilities Electric Company (formerly TUGCO)
TUGCO	Texas Utilities Generating Company
WRC	Welding Research Council
WSTI	Welded Steel Tube Institute

1 INTRODUCTION

In September 1984, Texas Utilities Electric Company (TU Electric), lead applicant for the Comanche Peak Steam Electric Station (CPSES) Units 1 and 2 established the Comanche Peak Response Team (CPRT) and formulated the CPRT Program Plan and issue-specific action plans to address issues identified by the U.S. Nuclear Regulatory Commission (NRC) staff in its reviews of technical concerns and allegations pertaining to the CPSES plant. As the CPRT Program Plan evolved, its scope was expanded to include (1) the resolution of all design, construction, testing, and quality assurance/quality control issues raised in the Atomic Safety and Licensing Board (ASLB) proceedings, in the Independent Assessment Program conducted by CYGNA Energy Services, and in other NRC staff reviews, and (2) the development of self-initiated reviews to broadly examine the adequacy of the design and construction of the CPSES plant.

In early 1987, TU Electric evaluated the preliminary results of the CPRT self-initiated reviews as the investigative phase of these reviews was completed. As a result of the numerous, broad-scope findings, TU Electric initiated a comprehensive Corrective Action Program (CAP) that consisted of a complete design and hardware validation and provided for an integrated resolution of identified problem areas rather than a resolution of each issue. In the design area, ongoing design validation activities from the CPRT Program Plan were incorporated into the CAP, which was divided into the following design workscopes:

(1) mechanical systems
(2) electrical systems
(3) instrumentation and control
(4) civil/structural
(5) large bore piping
(6) small bore piping
(7) cable tray hangers
(8) conduit supports (Trains A and B, and Train C greater than 2 inches)
(9) conduit supports (Train C less than or equal to 2 inches)
(10) heating, ventilation, and air-conditioning
(11) equipment qualification

The applicant contracted with three major design organizations - Ebasco Services Incorporated, Impell Corporation, and Stone & Webster Engineering Corporation (SWEC) - to perform the activities related to the above design workscopes.

This supplement presents the NRC staff's safety evaluation of two of the CAP design workscopes: large and small bore piping. The CAP contractor for large and small bore piping is SWEC. The staff review of the remaining nine CAP design workscopes will be addressed in subsequent safety evaluations.

The staff's evaluation of the CPSES piping and pipe support activities provided in this supplement covers a wide range of subjects that cannot be presented appropriately in the usual Safety Evaluation Report (SER) format used for licensing activities. Therefore, the format in this supplement will be used for the staff evaluations of the TU Electric CAP.

Section 2 of this supplement discusses the background and source of the issues of concern. Section 3 provides an overview summary of the corrective actions taken by the applicant. Section 4 discusses the staff's evaluation of the corrective actions including the design criteria and methodologies used in the CAP. Section 5 provides the staff's evaluation of the applicant's preventive actions including the programmatic and quality assurance aspects. Section 6 presents the staff's overall conclusions. Section 7 lists the references cited in this report. Availability of all reference material cited is described on the inside front cover of this report.

Appendix A provides the staff's review and evaluation of the generic technical issues associated with piping and pipe supports. Appendix B describes the resolution of open items related to piping and pipe support design from previous NRC inspection reports. Appendix C describes the resolution of open items related to piping and pipe supports from Supplement 13. Appendix D provides a chronology of NRC staff meetings, audits, and inspections associated with these workscopes. Appendix E is a listing of Comanche Peak Project procedures and project memoranda used in the CAP piping and pipe support design validation. Appendix F discusses the staff evaluation of piping and pipe support issues raised in the ASLB hearings on CYGNA's Independent Assessment Program.

Management and coordination of all the outstanding regulatory actions for Comanche Peak are under the overall direction of Mr. Christopher I. Grimes, the NRC Comanche Peak Project Division Director. Mr. Grimes may be contacted by calling (301) 492-3299 or by writing to the following address:

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Copies of this supplement are available for public inspection at (1) the NRC's Public Document Room located at 1717 H Street, NW, Washington, DC 20555, (2) the Local Public Document Room located at the Somervell County Public Library on The Square, P. O. Box 1417, Glen Rose, TX 76043, and (3) the mini Local Public Document Room at the University of Texas at Arlington Library, 701 South Cooper, PO Box 19447, Arlington, TX 76019.

2 SOURCE OF ISSUES

Since 1982, the applicant for CPSES has been involved in a heavily contested hearing before the Atomic Safety and Licensing Board (ASLB). The only remaining contention is Contention 5.* Contention 5 was broadly interpreted by the ASLB to apply to quality assurance in regard to the design and construction of CPSES. The ASLB also permitted the intervenor, Citizens Association for Sound Energy (CASE), to raise questions related to potential design deficiencies that allegedly were not caught by the design control program.

The pipe support design issues (Walsh/Doyle issues) were initially raised during the July and September 1982 ASLB hearing sessions by CASE witnesses, Mark A. Walsh and Jack Doyle, who both worked for the same pipe support group at CPSES from August 1981 to June 1982. The staff formed a Special Inspection Team (SIT) to review and evaluate the Walsh/Doyle issues during an inspection performed from October 1982 to February 1983. The SIT categorized the Walsh/Doyle issues into the following 19 broad areas of concern and the SIT's conclusions regarding each of the areas of concern were documented in NRC Inspection Report 50-445/82-26, 50-446/82-14 dated February 15, 1983 (SIT Report) (Reference 1).

(1) the interface between pipe support design groups

(2) interface between pipe support design groups and pipe stress analysis organizations

(3) design analysis for Richmond inserts and Hilti-bolts

(4) differential thermal expansion effects in pipe supports

(5) differential thermal expansion and other effects in wall-to-wall, floor-to-ceiling, and floor-to-wall pipe supports

(6) stability of pipe support designs

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* Contention 5 in the ASLB hearings on Comanche Peak states:

The applicants' failure to adhere to the quality assurance/quality control (QA/QC) provisions required by the construction permits for Comanche Peak, Units 1 and 2, and the requirements of Appendix B of 10 CFR Part 50, and the construction practices employed, specifically in regard to concrete work, mortar blocks, steel, fracture toughness testing, expansion joints, placement of the reactor vessel for Unit 2, welding, inspection and testing, materials used, craft labor qualifications and working conditions (as they may affect QA/QC) and training and organization of QA/QC personnel, have raised substantial questions as to the adequacy of the construction of the facility. As a result, the Commission cannot make the findings required by 10 CFR 50.57(a) necessary for issuance of an operating license for Comanche Peak.

(7) use of U-bolts in pipe support designs

(8) loading due to seismic acceleration of the pipe support structure

(9) moment restraint and local pipe stress due to welded stanchions

(10) deflections and local stresses in pipe support structure

(11) consideration of friction loads

(12) consideration of kick loads

(13) modeling of wide-flange members as infinitely rigid in torsion

(14) effect of cold forming on the ductility of tube steel

(15) operating loads that appeared to be in error

(16) welded stepped connections, fillet welds, and skew welds

(17) section property values used by Pipe Support Engineering

(18) support pads welded over pipe girth welds

(19) damage to pipe support during hydrostatic testing

Concurrent with the ASLB hearings, the staff requested the applicant to conduct an independent verification program in regard to the quality of design and construction activities at CPSES. In requesting this independent verification program, the staff was seeking additional assurance that the design process used at CPSES complied with NRC regulations and licensing commitments. The applicant submitted a plan for an Independent Assessment Program (IAP) for CPSES to be performed by CYGNA Energy Services (CYGNA). In November 1983, CYGNA submitted the results of the draft IAP Phases 1 and 2 (Reference 2) to the staff and the applicant. The CYGNA IAP report (Phases 1 and 2) was a limited-scope assessment of a portion of the design control process and its implementation. In its IAP, CYGNA concluded that the overall design activities at CPSES were adequate and were properly implemented.

Subsequently, the ASLB issued its preliminary findings on the design issues (i.e., Walsh/Doyle issues) in its Memorandum and Order (Quality Assurance for Design) dated December 28, 1983 (Reference 3). The ASLB found that the applicant had not demonstrated the existence of a system to promptly correct design deficiencies and concluded that the applicant was in non-compliance with 10 CFR 50, Appendix B. The ASLB also noted that the hearing record was devoid of a satisfactory explanation for several piping and pipe support design questions raised by the intervenor, CASE. The ASLB urged that a third party conduct an independent review of the technical issues addressed in the hearings. The applicant again contracted with CYGNA to perform this review and referred to this review as Phases 3 and 4 of the CYGNA IAP. Phase 3 was directed primarily toward a review of the piping and pipe support designs for selected systems. Phase 4 was primarily a multidisciplined review of the design of a portion of the component cooling water system for Unit 1.

In addition, the applicant proposed to conduct tests and analyses, prepare testimony and documentary evidence, and perform an independent review of the principles and analyses contained therein. This effort resulted in several submittals to the ASLB by the applicant containing affidavits, documentary evidence, and the results of tests and analyses to address the specific unresolved concerns related to piping and pipe support design discussed in the hearings. The intervenor responded with many counterarguments. The staff review of the applicant's submittals resulted in many questions and unresolved concerns which the staff determined should be addressed in order to ensure that technically justified resolutions for the Walsh/Doyle issues existed. The staff presented its views on the piping and pipe support design and design process used by TU Electric in a public meeting held at the CPSES site on February 26-27, 1985 (Board Notification BN-85-026A) (Reference 4). Subsequently, the applicant developed Revision 2 of its CPRT Program Plan, which included a plan for the resolution of the Walsh/Doyle issues, and withdrew its previous submittals to the ASLB.*

Because of the conclusions in the draft IAP report for Phases 1 and 2, CYGNA personnel appeared as witnesses before the ASLB in hearings held during February, April, and May 1984 to testify on the quality of design at CPSES. In the course of their testimony, CYGNA witnesses responded to numerous questions posed by CASE on specific piping, pipe support, and cable tray design issues pertaining to the scope of work in the draft IAP report for Phases 1 and 2. The hearings resulted in several items that required further explanations by CYGNA. When errata finalizing the CYGNA IAP Phases 1 and 2 report were issued on October 12, 1984 (Reference 5), these hearing items had not been fully resolved. The staff evaluation of the unresolved items pertaining to piping and pipe supports from the CYGNA hearings with respect to their applicability to the current designs under the CAP design validation is provided in Appendix F to this supplement.

In July 1984, CYGNA submitted a report documenting the initial results of its Phase 3 IAP (Reference 6) which was initiated to address the concerns of the ASLB in its December 28, 1983 Memorandum and Order (Reference 3). Errata finalizing the report were submitted on November 1984 (Reference 7). CYGNA concluded that the two piping systems reviewed (main steam and component cooling water) were designed to perform their intended function. The staff raised the question of whether the CYGNA Phase 3 IAP (Reference 7) had been fully responsive to the ASLB's concerns regarding the pipe support issues

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* The applicant's withdrawal of its submittals to the ASLB are documented in the following pleadings and ASLB decision in the CPSES record:

(1) Applicants' Memorandum in support of Motion for Modification With Respect to the Board's Memorandum of August 29, 1985 (Proposal for Governance of This Case), dated September 25, 1985 at 10.

(2) Memorandum and Order (Withdrawal of Written Filings Motion), dated November 8, 1985, at 4-5.

(3) Applicants' Statement of Continuing Intent to Withdraw Motions for Summary Disposition, dated December 5, 1985.

raised by Walsh and Doyle. CYGNA subsequently identified many open issues associated with the Walsh/Doyle concerns that were not adequately addressed in the Phase 3 report in a letter from N. H. Williams (CYGNA) to V. Noonan (NRC) dated January 18, 1985 (Reference 8). In a letter from N. Williams (CYGNA) to V. Noonan (NRC) dated January 25, 1985 (Reference 9), CYGNA retracted its conclusions previously established in Phases 1, 2, and 3 of its IAP because of information obtained through later reviews and conclusions affected by a cumulative effects assessment across all phases of the IAP and identified many open and unresolved issues remaining from its IAP (Phase 4) that were related to cable tray and conduit support design. In a letter from N. Williams (CYGNA) to J. Beck (Texas Utilities Generating Company) dated April 4, 1985 (Reference 10), CYGNA summarized in its review issues list (RIL) all its findings and open items from Phases 1, 2, 3, and 4 of the IAP. The staff finds that the CYGNA IAP (Phases 1, 2, 3, and 4) had not only substantiated some of the concerns related to pipe supports but also revealed additional design concerns related to pipe stress, cable tray and conduit support design.

3 OVERVIEW SUMMARY

3.1 CPRT Program Plan

Because of many technical concerns identified in regard to the design of large bore piping and pipe supports at CPSES, the CPRT developed an action plan to identify and correct design deficiencies relating to these components. This piping discipline-specific action plan (DSAP) was part of the overall CPRT Program Plan to address and resolve all technical concerns relating to the adequacy of design, quality of construction, quality assurance/quality control, and testing at CPSES.

The "Comanche Peak Response Team Program Plan and Issue-Specific Action Plans," Revision 2, was issued on June 28, 1985. Revision 3 was issued on January 27, 1986, and Revision 4 was issued on June 18, 1987.* The NRC staff provided its evaluation of Revision 3 to the CPRT Program Plan in SER Supplement 13 dated May 1986 13) (Reference 11).

In regard to piping and pipe supports, DSAP IX was developed as part of the Design Adequacy Program (DAP) under the charter of the CPRT Program Plan. DSAP IX (Appendix C of the CPRT Program Plan) described project** and third-party activities pertaining to the resolution of concerns related to piping and pipe supports. The action plan included project activities involving a complete piping and pipe support requalification program and a third-party review of this program. The project activities were to be performed by Stone & Webster Engineering Corporation (SWEC), and the third-party activities were to be performed by TENERA, L.P. (formerly known as TERA Corporation).

Because the scope of the CPRT Program Plan was dynamic in nature, its implementation was continually changing. In addition to providing for the resolution of all identified technical concerns, the plan included a self-initiated evaluation of the CPSES quality of construction and adequacy of design to investigate additional areas so that its conclusions could be extended to the balance of the CPSES plant. In the piping and supports action plan, the scope of the requalification program was essentially all-encompassing and a self-initiated review in regard to the piping discipline was not required.

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* Revisions 0 and 1 of the CPRT Program Plan, which were issued on October 8 and November 21, 1984, respectively, provided a plan for the resolution of only those issues identified by the NRC Technical Review Team's inspection at CPSES conducted from July to September 1984. The piping issues identified in the ASLB hearings and by CYGNA were not included.

** "Project" includes the TU Electric organization and its contractors (e.g., Stone & Webster Engineering Corporation) responsible for design activities.

In Section 3.5.3 of Supplement 13 (Reference 11), the staff in its evaluation of the piping and supports action plan found that the piping and pipe support requalification program provided an adequate framework to address the design issues raised in regard to the piping and pipe support discipline.

Additionally, the staff stated that it would assess the effectiveness and completeness of the program through technical audits performed during the implementation of the program.

3.2 TU Electric Corrective Action Program

In April 1987, as the investigative phase of the DAP (Appendix A to the CPRT Program Plan) neared completion, TU Electric became aware of the numerous and broad-scope findings of the CPRT self-initiated design reviews. Subsequently, TU Electric decided to initiate a comprehensive Corrective Action Program (CAP) involving a complete design validation of 11 design workscopes to be performed by three major design organizations. The design workscopes and the responsible CAP contractors are:

(1) mechanical systems (SWEC)*
(2) civil/structural (SWEC)
(3) electrical systems (SWEC)
(4) instrumentation and control (SWEC)
(5) large bore piping (SWEC)
(6) small bore piping (SWEC)
(7) heating, ventilation, and air-conditioning (Ebasco)
(8) cable tray hangers (Ebasco/Impell)
(9) conduit supports (Trains A and B and Train C greater than 2") (Ebasco)
(10) conduit supports Train C less than or equal to 2" (Impell)
(11) equipment qualification (Impell)

The establishment of the CAP made the continuation of some CPRT overview and corrective action activities unnecessary and resulted in a redirection of the CPRT's assessment of design adequacy. The applicant provided a description of the CAP to the NRC staff in letters from W. Counsil dated January 29, June 25, August 20, August 28, September 8, and September 23, 1987 (References 12, 13, 14, 15, 16, and 17). As a result of the establishment of the CAP and the completion of the CPRT investigative activities, Revision 4 to the CPRT Program Plan was issued on June 18, 1987 (Reference 18) to reflect the CPRT Program Plan's revised scope of work. The staff provided its evaluation of Revision 4 to the CPRT Program Plan and of the overall CAP in a letter from S. D. Ebneter to W. G. Counsil (TU Electric) dated January 22, 1988 (Reference 19).

The scope of the piping and pipe support requalification program being implemented by SWEC under Revision 3 to the CPRT Program Plan (DSAP IX) was not significantly affected by the establishment of the CAP. The SWEC requalification program was incorporated into the CAP and reformatted so that

* The design validation of Fire Protection is being performed by Impell and that of systems interaction is being performed by Ebasco.

it was consistent with the Design Basis Consolidation Program (DBCP)* (Reference 20), and its overall scope was expanded. The SWEC requalification program as described in Attachment 2 of DSAP IX of the CPRT Program Plan (Reference 18) evolved into the design validation component of the CAP for large and small bore piping and supports.

The CAP process in regards to piping and pipe supports consists of design validation, modifications, hardware validation, final reconciliation, and final documentation. This supplement addresses the overall CAP process, each of its components (except for those modifications for which the applicable site procedures for hardware rework are being evaluated under the NRC site inspection program for CPSES), and the effectiveness of the third-party reviews.

The staff evaluated the activities completed by TENERA under the CPRT Program Plan's DAP for piping and supports (DSAP IX) through several design audits and inspections. The staff's evaluation of TENERA's activities and associated reports is provided in Section 4.2.1 of this supplement. Resolution of open items identified during previous NRC staff inspections of TENERA activities as documented in NRC Inspection Report 50-445/86-19, 50-446/86-16 dated November 4, 1986 (Reference 21) is provided in Appendix B to this supplement.

The third-party review activities that were transferred from TENERA to the TU Electric Technical Audit Program (TAP) as a result of the CPRT redirection are described in the foreword to Appendix A to the CPRT Program Plan (Revision 4) (Reference 18). The staff's review and evaluation of the effectiveness of the TAP activities related to piping and pipe supports are provided in Section 4.2.2 of this supplement.

The open items identified in the Independent Assessment Program (IAP) conducted by CYGNA from 1983 to 1985 have been addressed under both the CPRT Program Plan and the Corrective Action Program. In addition, since November 1986, TU Electric has been actively pursuing the resolution of the open IAP issues with CYGNA in meetings between CYGNA and the CAP contractors. The status of the CYGNA open items related to piping and supports have been documented in review issues lists (References 22 and 23) by CYGNA. The staff evaluation of the CYGNA activities is provided in Section 4.2.3 of this supplement.

The staff has completed its audits and inspections of the piping and pipe support design validation and third-party activities and concludes that the effectiveness and completeness of the program's implementation are sufficient to ensure that licensing commitments are satisfied and that the piping and pipe support issues raised by the intervenor (CASE), CYGNA the NRC staff, and other external sources currently known to the staff are being properly resolved. The staff reviews and evaluations are provided in Section 4 of this supplement. Open items from Supplement 13 (Reference 11) related to the design of piping and pipe supports under the CPRT Program Plan are discussed in Appendix C to this supplement.

* The applicant uses the DBCP to manage the CAP and ensure consistency of each contractor's activities and products.

4 CORRECTIVE ACTIONS

To evaluate the design of large and small bore piping and pipe supports at CPSES, the staff reviewed the CPRT Program Plan up to and including Revision 4 the applicant's letters describing its Corrective Action Program (CAP) (References 12, 13, 14, 15, 16, and 17), CYGNA's Independent Assessment Program and review issues lists (References 2, 5, 6, 7, 9, and 10), and the piping project status reports (References 24 and 25). In addition, the NRC staff conducted audits and inspections of the CPRT Program Plan and CAP activities related to large and small bore piping and pipe supports at CPSES from August 1985 through January 1988 (see Appendix D of this supplement for a chronology of staff audits and inspections of piping and pipe support activities).

The following sections provide the staff's review and evaluation of the corrective actions taken by the applicant to ensure the structural integrity of the piping and pipe supports at CPSES including third-party overviews of the CAP activities.

4.1 Applicant Actions

4.1.1 Corrective Action Program Process

The CAP process for large and small bore piping and pipe supports is described in a letter from W. Counsil to the NRC dated August 28, 1987 (Reference 15) and in the piping project status reports (PSRs) (References 24 and 25). The major elements of the CAP process are design validation, hardware modifications, hardware validation, final reconciliation, and final documentation.

(1) Design Validation

The design validation for piping and pipe supports provides a comprehensive program for the reanalysis of American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code) Class 2 and 3 piping* and ASME Code Class 1, 2 and 3 pipe supports. The scope of the CAP implemented to date for CPSES Unit 1 and Common** also includes (a) non-seismic Category I piping as defined in NRC Regulatory Guide 1.29 (Reference 26) Position C.2, (b) high and moderate energy piping that is computer analyzed to determine

* ASME Code Class 1 piping is under the design scope of the Nuclear Steam Supply System (NSSS) vendor and is, thus, excluded from the balance-of-plant piping scope of the CAP.

** "Common" refers to the areas of the CPSES plant containing systems, components, and equipment for both Units 1 and 2.

locations for pipe breaks and leakage cracks, and (c) portions of non-seismic piping that are included in seismic Category I pipe stress analysis packages. Design validation includes (a) establishing design basis documents (DBDs) including the validation of piping system design input, (b) conducting pipe stress analyses and pipe support calculations, and (c) performing a final reconciliation. The results of design validation at the conclusion of final reconciliation are provided in piping design validation packages (DVPs) consisting of piping and pipe support calculations, drawings, and related interface data. The DVPs provide the necessary documentation to ensure compliance with the design requirements of Section III of the ASME Code (References 27 and 28).

(2) Modifications

As a result of the resolution of generic technical issues (see Appendix A to this supplement), several types of pipe supports were identified for modification before stress analyses were performed as described in Section 5.2.2.1 of the piping PSRs (References 24 and 25). In addition, pipe supports were modified in conjunction with design validation on the basis of the following reasons: prudency, adjustments, cumulative effects, and recent industry practice. Table 5-4 of the piping PSRs (References 24 and 25) lists the CPSES Unit 1 and Common pipe support modifications and the reasons for the modifications. Appendix A of this supplement provides the evaluation of the adequacy of the modifications of pipe support designs for each generic technical issue (as applicable).

(3) Hardware Validation

The Post Construction Hardware Validation Program (PCHVP) (References 16 and 17) was established by the applicant as a complete validation of final inspection attributes and included safety-related and selected non-safety related piping and pipe supports. Reinspection by either physical verification or engineering evaluation is performed for those inspection attributes associated with (1) CPRT recommendations to reinspect, (2) system design changes, or (3) modifications to existing piping and pipe supports. The PCHVP provides assurance that as-installed piping and pipe supports meet the validated design.

(4) Final Reconciliation

The final reconciliation resolves differences between the piping stress analyses and support calculations and the validated design input and as-built configuration. The piping design input data are confirmed by interfacing design organizations and as-built piping and pipe support configurations are validated under the PCHVP. The final reconciliation of the pipe stress analyses is performed using validated as-built data from the PCHVP and satisfies the requirements of Office of Inspection and Enforcement (IE) Bulletin 79-14, "Seismic Analysis for As-Built Safety-Related Piping Systems" (Reference 29). The final reconciliation ensures that the piping DVPs adequately validate the as-built piping and pipe support hardware.

(5) Final Documentation

This element requires that all piping DVPs are transmitted to the permanent records facilities (Vault). This ensures that the results of the CAP are adequately maintained and retrievable.

On the basis of its review, the staff finds that the overall CAP process for piping and pipe supports, provides a complete program for ensuring compliance with licensing commitments, the identification and resolution of design deficiencies, conformity of design with construction, and proper documentation and maintenance of results, and is thus acceptable.

4.1.2 Design Validation

The design validation phase of the CAP process includes validation of design input, development of design criteria and analytical methodologies to resolve generic technical issues, piping and pipe support analyses, and final reconciliation. The areas reviewed and the staff evaluation are provided below.

4.1.2.1 Validation of As-Built Design Input

The accuracy of the piping and support as-built drawings used as input to the initial pipe stress analyses of design validation were verified by SWEC using Comanche Peak Project Procedures CPPP-5 and CPPP-8 (see Appendix E to this supplement) before the stress analyses were initiated.

Initial As-Built Walkdown

The initial SWEC walkdown was performed in accordance with procedure CPPP-5 (see Appendix E to this supplement). The purpose of the CPPP-5 walkdown was to establish confidence in the adequacy of dimensions and the functionality of supports shown on the existing as-built drawing before the piping analysis effort was initiated. The results have been published in SWEC walkdown reports "Large Bore Field Walkdown Report," dated October 10, 1985, and "Small Bore Field Walkdown Report," dated June 19, 1986.

The staff audited the CPPP-5 walkdown process (Appendix D to this supplement - Event 2) and reviewed the CPPP-5 procedure and the two SWEC walkdown reports. The results of the staff audit were discussed in a public meeting in Granbury, TX held on October 2, 1985. The staff found that the SWEC CPPP-5 walkdown verified the adequacy of four attributes obtained from a random selection of 680 large bore pipe supports and valves. The four attributes were (1) valve location (sample size of 80), (2) pipe support location (sample size of 200), (3) pipe support function (sample size of 200), and (4) valve and support orientation (sample size of 200). The four attributes were selected on the basis of their potential impact on the pipe stress analyses. Other attributes (e.g., pipe run geometry) that could also affect pipe stress analyses were verified indirectly by the methods used in verifying the above four attributes (e.g., pipe run distances from elbows, tees, valves, and supports). The staff audit of the CPPP-5 walkdown found that the attribute sample size was adequate for the purpose of establishing trends in the data accuracy and that the four attributes were the significant attributes with respect to potential impact on piping stress analyses.

The staff concludes that the CPPP-5 walkdown was well-documented and easily verifiable. The dimensions measured by the staff verified the accuracy of the SWEC dimensions as marked in the SWEC CPPP-5 as-built walkdown packages. As a result, the staff concurs with the conclusions reached by SWEC as reported in the two SWEC walkdown reports that the as-built documentation was adequate to initiate the SWEC design validation activities.

The SWEC walkdown reports identified a need to review the results from the CPRT Quality of Construction (QOC) Program (Appendix B to the CPRT Program Plan) and a need to verify the accuracy of valve and support orientations shown on the drawings. A study was initiated to review the deviation reports generated by the CPRT QOC Program and to evaluate their impact on the design validation of piping and pipe supports. This study is discussed in more detail later in this supplement. In addition, the walkdowns identified a need for a complete walkdown of valve and support orientation that was subsequently performed in accordance with Comanche Peak Site Procedure CPSP-12, "As-Built Verification."

The staff finds that the CPPP-5 walkdowns verified the adequacy of dimensions and functions shown on existing as-built drawings to support initiation of the piping analysis activities and provides confidence that the use of existing as-built piping data in the initial stress analyses of design validation will not result in significant changes to the stress analysis results during final reconciliation when verified as-built data from the PCHVP are available.

Engineering Walkdown

In a public meeting held on February 26-27, 1985 (Board Notification BN-85-026A) (Reference 4), the NRC staff identified a need for an as-built walkdown to verify engineering assumptions used in piping stress analyses. In response to the staff concern, a second type of walkdown was performed by SWEC in accordance with CPPP-8 (see Appendix E to this supplement) which consisted of a piping and support system walkdown by experienced SWEC engineers in the piping and support design discipline. The objectives of the CPPP-8 walkdown were

(1) to determine whether there were issues in regard to hardware configurations - other than external source issues - that should be evaluated relative to the functional behavior of the piping system

(2) for experienced SWEC personnel to become familiar with the physical aspects of piping and pipe support design and to determine whether additional, or refinements of, design inputs, guidelines, or procedures were necessary for the pipe stress and pipe support requalification effort

The results of the CPPP-8 walkdown are documented in a SWEC report entitled "Piping and Support System Engineering Walkdown Final Report," dated June 4, 1986 (CPPP-8 walkdown report).

The staff audited the CPPP-8 walkdown process (Appendix D to this supplement - Events 3 and 6) and reviewed the CPPP-8 procedure and the CPPP-8 walkdown report. The staff found that the SWEC CPPP-8 walkdown resulted in a field walkdown of 70 CPSES Unit 1 piping stress packages involving approximately 2,400 pipe supports. The scope included portions of small bore piping and supports. The staff review of the scope finds it encompasses various piping systems, sizes, and classes and is thus representative of the types of piping systems included in the SWEC design validation.

The staff audit of the CPPP-8 walkdown included accompanying the SWEC walkdown teams, independently verifying two piping systems, and reviewing the completed SWEC data packages. The staff audit confirmed the accuracy and completeness of the SWEC CPPP-8 walkdowns. The CPPP-8 walkdown observations resulted in modifications and additions to the Comanche Peak Project procedures (Appendix E to this supplement) and to design input provided by TU Electric. The modifications to the procedures were mainly administrative and address the interdisciplinary interface requirements in the design validation process.

The staff finds that the CPPP-8 walkdown provided an opportunity for both the pipe stress engineers and the pipe support engineers to thoroughly understand the actual piping and pipe support installations in the plant thus enabling them to verify the appropriateness of the design criteria used in the design validation. It also identified the need for consistent interaction between the pipe stress engineers and the pipe support engineers.

Impact of As-Built Piping Construction Deviations

As a result of the CPPP-5 and CPPP-8 walkdowns, several areas of as-built piping construction deviations were identified that could affect the SWEC design validation activities. The quality of construction of CPSES, however, was being evaluated under the CPRT QOC Program under Issue-Specific Action Plan VII.c.

A review of the piping-related deviation reports generated from the CPRT QOC Program was performed by SWEC. The results of the review were documented in a SWEC report entitled "Impact of Construction Deviations on Stress Requalification Program," Report No. 15454-N(c)-010, dated December 15, 1986. The report concluded that the concerns related to clearances and other hardware construction deviations did not directly affect the SWEC piping stress analyses activities and, thus, there was no need to change these activities to address the CPRT QOC Program deviation reports. However, the report confirmed the need to address clearances between the piping and adjacent components and structures on a plantwide basis as committed to in Section 7.2 of CPPP-6 (Revision 2) (Appendix E of this supplement). It also verified the need to conduct a Hardware Validation Program (HVP), as recommended in a SWEC report entitled "Assessment of TUGCO's As-Built Documentation for Piping and Pipe Supports," dated July 1986. The HVP concept was subsequently adopted by TU Electric for all 11 CAP scopes of work and evolved into the Post-Construction Hardware Validation Program as discussed in Section 4.1.3 of this SSER.

Based on its review of the applicant's actions discussed above that were taken to address the impact of construction deviations identified by the CPRT QOC Program on the piping and pipe support requalification effort, the staff finds that the PCHVP and its implementation reasonably ensure that construction deviations are identified and corrected and, thus, will not adversely affect the ability of piping and pipe supports to perform their intended functions.

4.1.2.2 Design Criteria and Methodology

The CPSES pipe stress and pipe support design criteria in CPPP-7 (Reference 30) have been developed by SWEC for the design validation of ASME Code Class 1, 2, and 3 pipe supports and ASME Code Class 2 and 3 piping systems. The controlling documents for the SWEC design validation effort are contained in Comanche Peak Project Procedures CPPP-1 through CPPP-35 (Appendix E of this supplement). The piping stress analyses and pipe support calculations will become the CPSES analyses of record and provide assurance that the structural qualification of the piping an[illegible] ipe supports within the CAP scope are in accordance with CPSES licensi[illegible] mitments and the applicable requirements of the ASME Boiler and Pressure [illegible] l Code (References 27 and 28). The following sections discuss the staff review and evaluation of the CPSES design criteria and analytical methodologies used in the piping and pipe support design validation.

<u>Review of Final Safety Analysis Report Amendment 61</u>

In Amendment 61 (Reference 31) to the CPSES Final Safety Analysis Report (FSAR) (Reference 32), the applicant provided the changes made to the FSAR piping design criteria as a result of the CAP design validation effort. As a result of its review of the FSAR Amendment 61 changes, the staff concludes that the changes do not significantly alter the staff findings in the previous CPSES SER and supplements (Reference 11) except in the areas related to (1) the combination of loss-of-coolant accident (LOCA) and safe-shutdown earthquake (SSE) loads (Section 3.9.2.3 of the SER) and (2) the piping system damping values (Section 3.7.1 of the SER).

The staff evaluated the combination of LOCA and SSE loads for reactor coolant system heavy component supports in its safety evaluation provided in a letter from C. I. Grimes (NRC) to W. Counsil (TU Electric) dated June 8, 1987 (Reference 33), in conjunction with the implementation of the final rule on the modification of 10 CFR 50, Appendix A, General Design Criterion 4 requirements for protection against the dynamic effects of postulated pipe ruptures (51 <u>Federal Register</u> 12505, dated April 11, 1986). Similarly, the staff found that the use of revised damping values per ASME Code Case N-411 (Reference 34) was acceptable for CPSES as discussed in a letter from V. Noonan (NRC) to W. Counsil (TU Electric) dated March 13, 1986 (Reference 35).

The staff also reviewed the technical acceptability of the FSAR Amendment 61 changes and the use of later ASME Code provisions as permitted in paragraph NA-1140(f) of the ASME Code, Section III (Reference 27). The staff's review of the use of later ASME Code provisions focused primarily on the technical justifications provided in the applicant's report entitled, "Documentation of ASME III NA-1140 Review for Piping and Supports," Revision 2, dated September 30, 1987 (NA-1140 report). This report documented the applicant's review performed to ensure that the use of design criteria in CPPP-7 is in conformance with paragraph NA-1140(f) of the ASME Code and, in particular, that all related ASME Code requirements are met. The code of record for CPSES piping is ASME Code, Section III, 1974 Edition, including Summer 1974 Addenda Subsections NC/ND (Reference 27). The code of record for CPSES pipe supports is the 1974 Edition including Winter 1974 Addenda Subsection NF (Reference 28). On the basis of its review of the NA-1140 report, the staff finds that all related requirements associated with the use of specific provisions of a Code edition or addenda were met and thus, the use of later Code provisions as specified in the NA-1140 report is acceptable. The specific provisions from later Code editions and addenda reviewed and approved by the staff for CPSES are listed below:

(1) 1977 EDITION - WINTER 1978 ADDENDA

Appendix O - Rules for Design of Safety Valve Installations

(2) 1983 EDITION

NC-3658.2 - Standard Flange Joints at Moderate Pressures and Temperatures

NC-3658.3 - ANSI B16.5, Flanged Joints with High-Strength Bolting

ND-3658.2 - Standard Flange Joints at Moderate Pressures and Temperatures

ND-3658.3 - ANSI B16.5, Flanged Joints with High-Strength Bolting

(3) 1983 EDITION - WINTER 1984 ADDENDA

Figure NC-3673.2(b)-1 - Flexibility and Stress Intensification Factors (Do/tm less than or equal to 100) (Branch Connections, Buttwelds, and Fillet Welds)

Figure NC-3673.2(b)-2 - Branch Dimensions

Figure ND-3673.2(b)-1 - Flexibility and Stress Intensification Factors (Do/tm less than or equal to 100) (Branch Connections, Buttwelds, and Fillet Welds)

Figure ND-3673.2(b)-2 - Branch Dimensions

(4) 1977 EDITION - WINTER 1978 ADDENDA

XVII-2211 - Stress in Tension

Figure XVII-2111(c)-1 - Illustrations of Maximum Design Stress in Through Thickness Direction of Plates and Elements of Rolled Shapes (Figure Deleted)

NF-3226 - Through Plate Thickness Tensile Limit

Figure NF-3226.5-1 - Illustrations of Maximum Design Stress in Through Thickness Direction of Plates and Elements of Rolled Shapes (Figure Deleted)

NF-3321.1 - Design Conditions

(5) 1977 EDITION - WINTER 1979 ADDENDA

NF-3391.1 - Allowable Stress Limits (Class 2 and MC Plate/Shell)

NF-3392.1 - Allowable Stress Limits (Class 2 and MC Linear)

(6) 1980 EDITION

NF-1133 - Intervening Elements in Relation to Jurisdictional Boundaries

NF-1131.6 - Portion F

(7) 1980 EDITION

XVII-2462 - Minimum Edge Distance

(8) 1983 EDITION - SUMMER 1983 ADDENDA

NF-3225 - Design of Bolting

NF-3324.6 - Design Requirements for Bolted Joints

(9) 1983 EDITION - SUMMER 1985 ADDENDA

NF-4721 - Bolt Holes

(10) 1974 EDITION - WINTER 1975 ADDENDA

NC-6221 - Minimum Required Hydrostatic Test Pressure

(11) 1974 EDITION - WINTER 1975 ADDENDA

XVII-2410 - General Requirements (for the Design of Connections and Joints

(12) 1980 EDITION - WINTER 1982 ADDENDA

NF-3324.5 - Design Requirements for Welds

(13) 1974 EDITION - SUMMER 1975 ADDENDA

NB-3630(d) - Exemptions for Class 1 Piping

It should be noted that 10 CFR 50.55a "Codes and Standards," currently references the ASME Code, Section III, Division 1 up to the 1983 Edition including the Summer 1984 Addenda. Although the portion of 10 CFR 50.55a pertaining to ASME Code Class 2 and 3 piping is not directly applicable to CPSES, it does provide the staff position regarding the latest Code edition and addenda found suitable for use. Several provisions listed above from later Code addenda (i.e., Winter 1984 Addenda and Summer 1985 Addenda) are not referenced currently in 10 CFR 50.55a. A final rule has been developed to update 10 CFR 50.55a to incorporate by reference the Winter 1984 Addenda, Summer 1985 Addenda, Winter 1985 Addenda, and 1986 Edition of Section III, Division 1 and its issuance is awaiting final staff approval. Thus, contingent upon final acceptance of those Code editions and addenda for which final staff approval is pending, the staff finds the use of the above listed Code provision to be acceptable for CPSES.

The staff's findings as a result of its review of the FSAR changes in Amendment 61 related to the design of piping and pipe supports are given below.

In FSAR Section 3.7B.3.1, an analytical technique, developed in accordance with NUREG/CR-1161, "Recommended Revisions to Nuclear Regulatory Commission Seismic Design Criteria," May 1980 (Reference 36), is used by SWEC for piping systems to account for the modal contribution above the cutoff frequency. The NUREG/CR-1161 methodology ensures participation of high frequency seismic responses in the zero period acceleration region of the seismic response spectra and is thus acceptable.

In FSAR Section 3.7B.3.2, the maximum amplitude loading cycles for an operating basis earthquake have been revised from 600 cycles to 50 cycles and for a safe shutdown earthquake from 120 cycles to 10 cycles. The number of cycles specified by this change is applicable to ASME Code Class 2 and 3 piping systems. The revised number of earthquake cycles is in conformance with the acceptance criteria in Section 3.9.2 of the NRC Standard Review Plan (Reference 37) and is thus acceptable.

In FSAR Section 3.9B.1.1.1, the SSE has been removed from the emergency conditions (but remains in the faulted condition). This change is applicable to ASME Code Class 2 and 3 piping systems and Class 1, 2, and 3 pipe supports. The FSAR change as such is in conformance with the service conditions specified in Appendix A to Section 3.9.3 of the NRC Standard Review Plan (Reference 37) and is thus acceptable.

In FSAR Section 3.9B.3.1.1, Amendment 61 changed the combination of peak dynamic responses from the absolute-sum method to the square-root-of-the-sum-of-the-squares (SRSS) method. The SRSS method for combining dynamic responses is consistent with the guidelines of NUREG-0484, "Methodology for Combining Dynamic Responses," Revision 1 dated May 1980, (Reference 38) and is thus acceptable.

In FSAR Section 3.9B.3.1.2, the applicant has established stress limits in addition to those established by the ASME Boiler and Pressure Vessel Code (Reference 27) to ensure that during and after a design basis accident condition, essential piping systems will maintain their capability to deliver the rated flow and retain their dimensional stability. These stress limits used to ensure the piping functional capability are in accordance with the General Electric Company topical report, "Functional Capability Criteria for Essential Mark II Piping," NEDO-21985 dated September 1978 (Reference 39), which has been approved by the NRC staff for all nuclear facilities. As an alternative criteria for stainless steel elbows and bends, the applicant will continue to use the stress limits for functional capability that had been approved for CPSES in Sections 3.9.3.1 of Supplements 1 and 3 (Reference 11). The criteria used to ensure piping functional capability are thus acceptable.

In FSAR Section 3.9B.3.3, the applicant has described more detail the fluid transient analysis methods used by SWEC. Specifically, the fluid transient hydraulic forces - previously calculated using a factor approach - are now computed directly by SWEC analysis methods. Secondly, rather than providing a pipe support for each straight run of piping, to which the applicant had previously committed, SWEC determines the need for a pipe support for fluid transient loadings by dynamic analysis methods and eliminates unnecessary supports. In addition, for open discharge piping systems, the SWEC methodology used is in conformance with Appendix O of ASME Code Section III (Reference 40). The staff's review of fluid transient analysis methods is provided in Appendix A to this supplement (Section 18). On the basis of its review and audits of the SWEC fluid transient analysis methods, the staff finds that the approach is technically adequate and consistent with the analysis methods used by SWEC for other nuclear facilities and is thus acceptable.

In Table 3.9B-1B, the loading combinations and stress limits are provided for ASME Code Class 2 and 3 piping. In Amendment 61, the loading combinations have been revised to describe the loading combinations used by SWEC in the piping design validation. The normal condition has been expanded to include testing conditions and thermal anchor movements. The upset condition has been revised to include thermal anchor movements. The emergency condition has been revised to delete the SSE as previously discussed. The faulted condition has been expanded to include temperature, thermal anchor movements, containment displacements, and SSE anchor movements. These changes to Table 3.9B-1B (with the exception of deleting the SSE from the emergency condition) result in more conservative loading combinations than those that were previously considered and are thus acceptable.

In Appendix 3B, the applicant has provided a description of the computer codes and the verification methods used by SWEC in the piping design validation. All codes have been used by SWEC for other nuclear facilities. The staff's review and evaluation of the computer code methods of verification are provided in Appendix A to this supplement (Section 29).

On the basis of its review of FSAR Amendment 61 (Reference 31), the staff finds the revised criteria related to piping and pipe support design provided in FSAR Amendment 61, including the use of later ASME Code provisions as discussed in the NA-1140 report, are in accordance with the ASME Code (Reference 27), satisfy the applicable provisions of 10 CFR 50.55a as qualified above, and are thus acceptable.

Review of Piping Design Criteria

The piping design criteria for CPSES Units 1 and 2 are documented in CPPP-7 (Reference 30) and project memoranda (Appendix E of this supplement). The staff reviewed the design criteria to ensure that the design validation of the piping and supports at CPSES Units 1 and 2 is in accordance with licensing commitments and the applicable ASME Boiler and Pressure Vessel Code requirements (Reference 27 and 28). The staff's evaluation of the design criteria consisted of reviews and audits in the following areas:

(1) FSAR changes to reflect revised design criteria

(2) design criteria pertaining to the resolution of generic technical issues as incorporated in CPPP-7

(3) third-party actions relative to the detailed review and evaluation of the design criteria

(4) overall adequacy of pipe stress design criteria

The staff's review and evaluation of the piping design criteria in the CPSES FSAR (up to and including Amendment 60) are discussed in the CPSES SER and supplements (up to and including Supplement 12). The staff's review and evaluation of Amendment 61 to the FSAR - which included changes to reflect the revised piping design criteria applicable to the CAP design validation effort - are discussed in the previous section of this supplement. Subsequent changes to piping design criteria that may affect FSAR licensing commitments or the bases of staff evaluations contained in its SER and supplements shall appear in future FSAR amendments, and staff evaluations of those changes will be provided in future supplements to the SER.

The staff in its review of the piping design criteria for resolving generic technical issues conducted several design audits. (See Appendix D to this supplement - Events 11, 17, 18, and 31.) The piping design criteria audited by the staff were developed by SWEC in part to address the generic technical issues applicable to piping and pipe supports at CPSES. The staff review and evaluation of the piping design criteria pertaining to the resolution of generic technical issues as incorporated in CPPP-7 are discussed later in this section and specifically in Appendix A to this supplement.

The staff's review and evaluation of the third-party (TENERA) activities associated with the review of the piping design criteria are discussed in Section 4.2.1.

The staff reviewed the overall technical adequacy of the pipe stress design criteria in CPPP-7 (Reference 30). As part of its design audit, the staff reviewed the bases for selected design criteria and their applicability to CPSES (see Appendix D to this supplement - Events 35 and 37). As a result of its audits, the staff finds that the CPPP-7 design criteria for pipe stress analysis provide adequate guidelines to ensure that the design of ASME Code Class 2 and 3 piping systems satisfies the design requirements of ASME Code, Section III, Subsections NC and ND (Reference 27) and are thus acceptable.

On the basis of its review of the CPPP-7 design criteria (Reference 30), the staff finds that the criteria provide adequate technical guidelines for the resolution of generic technical issues and for ensuring that the applicable piping and pipe support design requirements of ASME Code, Section III (References 27 and 28) and licensing commitments are satisfied and are thus acceptable.

Generic Technical Issues

The generic technical issues are those design concerns identified by sources external to the TU Electric organization that potentially affects more than one specific pipe support calculation or pipe stress package. The staff has reviewed the resolution of the generic technical issues provided in the SWEC "Piping Generic Technical Issues Report" (Reference 41) and piping project status reports (PSRs) (References 24 and 25) as incorporated in the CPPP-7 design criteria. Several audits were conducted to evaluate the adequacy of the piping design criteria developed for the resolution of the generic technical issues (see Appendix D to this supplement - Events 10, 11, 17, 18, and 31).

The staff finds that the design criteria in CPPP-7 (Reference 30) provide explicit guidelines for the resolution of the generic technical issues and that the overall approach for issue resolution as described in Appendix A to the piping PSRs (References 24 and 25) is acceptable. The staff has also completed its evaluation of the resolution of each generic technical issue and finds that the approach used by SWEC is acceptable. The staff's review and evaluation of each generic technical issue are discussed in Appendix A to this supplement.

The staff also conducted an audit (see Appendix D to this supplement - Event 29) of the CPRT third-party (TENERA) activities and reviewed the CPRT evaluations of the piping issue resolutions as documented in the CPRT "Discipline Specific Results Report: Piping and Supports," (piping results report) (Reference 42). The staff's audit of the CPRT third-party activities and evaluations is provided in Section 4.2.1. The staff finds that the CPRT third-party (TENERA) evaluations of piping issue resolutions were comprehensive in scope and was based on extensive and indepth engineering evaluations for each issue. Thus, the third-party conclusions in regard to the resolution of the generic technical issues as documented in the piping results report (Reference 42) and supporting engineering evaluations provide assurance to the staff of the technical acceptability of the resolution and of the specific design criteria in CPPP-7 (Reference 30) applicable to the resolution of each issue.

On the basis of its review of the CPRT piping results report and engineering evaluations and its audits of the SWEC resolutions of generic technical issues, the staff finds that a technically sound and viable approach for each generic technical issue has been developed and is being implemented as a part of the CAP design validation and is thus acceptable.

Small Bore Piping

A staff review of the CAP for both large bore and small bore piping design determined that the scopes of both programs are identical except for the following three design areas - applicable only to small bore piping. (1) the design of an ASME Code, Section III Class 1 system, (2) the design of cantilever vent or drain lines having no supports, and (3) the use of a clamp anchor type of support.

The staff's evaluation of an ASME Code, Section III Class 1 piping system in the small bore scope finds that the Class 1 system, for which design validation is being performed by SWEC, is an in-core instrumentation line with a nominal pipe diameter of 1 inch or less and as such can be designed using ASME Code Class 2 piping rules in accordance with ASME Code, Section III (Summer 1975 Addenda) subsubparagraph NB-3630(d)(1). The use of ASME Code Class 2 rules for this particular Class 1 piping system is thus acceptable.

The staff's evaluation of the cantilever vent or drain lines having no supports finds that Procedure CPPP-15 (see Appendix E to this supplement) permits the use of equivalent static analysis calculations for small bore, cantilever vent and drain lines having no supports. The use of this equivalent static analysis for short cantilever vent and drain lines whose fundamental frequency is greater than 33 hz is acceptable based on rigid body mechanics. In addition, the equivalent static analyses for small bore piping use the damping values in accordance with ASME Code Case N-411 (Reference 34) that are consistent with those for large bore piping. The use of N-411 damping values for small bore piping equivalent static analyses is acceptable based on the use of a 1.5 factor which results in a more conservative method than the amplified response method used for large bore piping and is thus acceptable.

The staff's evaluation of the use of a clamp anchor type of support finds that the clamp anchor provides an alternative and acceptable means of restraining pipe translational and rotational movements when additional weldment to the piping is undesirable. CPPP-7 Paragraph 4.2.7 and Attachment 4-22 provide the methods for evaluating the frictional capacity of the clamp anchors.

On the basis of the above evaluations, the staff finds that CPPP-7 as supplemented by subsubparagraph NB-3630(d)(1) of the ASME Code, Section III (Summer 1976 Addenda) and SWEC procedure CPPP-15 (Appendix E to this supplement) provides adequate design guidance and control for the three design areas that are applicable to small bore piping and thus are acceptable.

4.1.2.3 Implementation of Design Validation

The staff conducted several audits of the implementation of design validation by reviewing the SWEC application of large bore piping and pipe support design criteria related to CPSES Units 1 and 2. (See Appendix D to this supplement - Events 32, 33, 34, 35, and 36.) The purpose of the audits was to determine the adequacy of the application of CPPP-7 design criteria (Reference 30) developed by SWEC for the resolution of generic technical issues associated with the design of large bore piping and pipe supports at CPSES. Before these audits, the staff had reviewed the conceptual approach to resolving large bore piping generic technical issues as initially documented in the SWEC "Generic Technical Issues Report" (Reference 41) and subsequently finalized in Appendix A to the Piping PSRs (References 24 and 25). Since the SWEC approach to issue resolution is implemented through the use of specific CPPP-7 design criteria developed to address each issue, the staff tracked selected issue resolutions from the "Piping Generic Technical Issues Report" through their implementation in the piping and pipe support design verification activities and finally in the plant. For these audits the staff selected when possible, examples of specific piping analyses or supports that had previous concerns associated with them as identified by external sources (i.e., ASLB, CASE, CYGNA, and NRC staff). The staff's review and evaluation of the SWEC application of the design criteria for each generic technical issue as applicable are discussed in Appendix A to this supplement.

On the basis of the audits discussed above, the staff finds that the piping and pipe support design criteria developed for the resolution of the generic technical issues are being adequately applied in the CAP design validation and plant hardware modifications in accordance with CPPP-7 guidelines and are thus acceptable.

4.1.3 Hardware Validation

The applicant described to the NRC staff a program for hardware validation in letters dated August 20, August 28, September 8, and September 23, 1987 (References 14, 15, 16, and 17). The program referred to as the Post-Construction Hardware Validation Program (PCHVP) is one of the major elements of the CAP.

The staff's evaluation of the overall concept of the CAP including hardware validation was provided in a letter from C. I. Grimes (NRC) to W. G. Counsil (TU Electric) dated January 22, 1988 (Reference 19). Specifically for piping and pipe supports, the need for and development of a hardware validation program are described in Section 4.1.2.1 of this supplement. The PCHVP procedures (field verification methods or FVMs) were developed by SWEC to validate that the as-built piping and pipe supports are in compliance with the CPSES installation and inspection procedures. The PCHVP procedures for piping and pipe supports include the following:

(1) FVM-81, "Piping and Pipe Supports Inspection and Hardware Validation"

(2) FVM-80, "Clearance Walkdowns"

(3) FVM-82, "Validation of Seismic Category II Large Bore Piping and Pipe Supports Over Seismic Category I Equipment"

These procedures are described in Section 5.1.3.1 of the piping project status reports (References 24 and 25). The staff finds that the PCHVP procedures for piping and pipe supports ensure that construction deviations, system design changes, and hardware modifications associated with piping and pipe supports will be adequately evaluated for reinspection as part of the overall CAP process and are, thus acceptable. However, the acceptability of the specific attributes to be inspected or excluded from the PCHVP will be reviewed in detail by the staff at a later date.

4.1.4 Final Reconciliation

Final reconciliation of piping and pipe support design is performed in accordance with CPPP-23 (Appendix E to this supplement) for all small and large bore piping and pipe supports within the scope of the CAP. The purpose is to ensure compliance of the piping and pipe support design and analyses with the as-built configuration, final design criteria, and validated design input.

The as-built configuration used in the final reconciliation is obtained from results of as-built and engineering walkdowns performed as a part of the CAP and implemented in accordance with TU Electric quality control inspections and the PCHVP. Final reconciliation of the piping stress analyses is performed using validated as-built data from the PCHVP and complies with IE Bulletin 79-14 (Reference 29).

As a result of its review of CPPP-23 (Appendix E to this supplement), the staff finds the final reconciliation of piping and pipe supports to be sufficient and complete because it

(1) complies with IE Bulletin 79-14 (Reference 29) and incorporates validated design input and as-built piping and pipe support configurations

(2) incorporates the resolution of NRC staff open items identified in Supplements 8, 10, and 11 (Reference 11) related to piping and pipe supports

(3) incorporates the resolution of CPRT issue-specific action plans and external source issues

(4) includes confirmation of results by interfacing design organizations

(5) resolves open items from NRC notices of violations and TU Electric significant deficiency analysis reports

Because of the inclusion of the above items in the final reconciliation, the staff concludes that the CPPP-23 procedure developed for the final reconciliation is sufficient to ensure compliance of the piping systems with final and validated design requirements and is thus acceptable.

4.1.5 Final Documentation

The fifth and final step in the overall CAP process for piping and pipe supports is the transmittal of CAP results (e.g., design validation packages) to the permanent records facilities (Vault) in accordance with procedures CPPP-4, CPPP-11, and CPSP-11 (Appendix E to this supplement). Because the design basis and analyses of record for the CPSES plant are established under the CAP, the staff finds that the final documentation ensures that the technical bases and criteria used for the CPSES design and the analysis results documenting the compliance of the as-built piping and pipe supports with the design basis are controlled during plant operation, and are thus acceptable.

4.2 Third-Party Actions

4.2.1 CPRT (TENERA, L.P.)

The CPRT third-party review of the project (SWEC) activities was conducted by TENERA, L.P. (previously known as TERA Corporation) to ensure verification of the resolution of issues, confirm the adequacy of design criteria, and provides overview of piping design validation activities. The review as described in CPRT Program Plan DSAP IX (Revision 3) consisted of three major activities:

(1) identification, review, and tracking of all external source issues

(2) verification that all design criteria and applicable standards are addressed in project procedures

(3) overview of the SWEC piping and pipe support requalification program

The CPRT Program Plan describes the third-party area of review related to the identification, review, and tracking of external source issues. The external source issue review included not only issues related to piping and pipe supports but also issues related to cable tray hangers, conduit supports, mechanical systems and components, electrical systems, instrumentation and control, and civil/structural disciplines. However, this supplement addresses only those external source issues related to piping and pipe supports. The external source issues also included the NRC technical review team issue, evaluated by the CPRT under Issue-Specific Action Plan ISAP V.c, concerning design considerations for piping between seismic Category I and nonseismic Category I buildings. This ISAP has been resolved as part of the project (SWEC) piping and pipe support design validation and is discussed in Appendix A to this supplement (Section 31).

As stated in the foreword to Revision 4 of the CPRT Program Plan (Reference 18), the TU Electric's commitment to the CAP, with its comprehensive design validation component, resulted in a decision by the CPRT senior review team (SRT) to redirect the Design Adequacy Program as of April 10, 1987. As a result of this redirection, further identification, review, and tracking of external source issues was terminated.

The third-party has verified that the methodologies and acceptance criteria used to establish the SWEC piping and support design criteria are in accordance with licensing commitments. The commitments include satisfying FSAR commitments, design specifications, and ASME Code requirements and were used in the development of checklists for the review of specific areas of the SWEC design validation.

The third-party overview of the CAP design validation for piping and pipe supports consisted of two major activities: (1) a review of Comanche Peak Project Procedures CPPP-6 and CPPP-7 (Appendix E to this supplement) to be used for the CAP design validation and (2) a review of the SWEC resolution methodologies for the external source issues.

The staff conducted inspections and an audit of the third-party activities at the offices of TENERA, L.P. to evaluate the activities associated with the CPRT third-party review. The inspections in the area of piping and pipe support design were conducted during the period from October 28 to November 1, 1985 at Bethesda, MD (Appendix D to this supplement - Event 4) as documented in Inspection Report 50-445/85-17, 50-446/85-14 (Reference 43) and from July 7 to July 10, 1986 at Berkeley, CA (Appendix D to this supplement - Event 20) as documented in Inspection Report 50-445/86-19, 50-446/86-16 (Reference 21). Open items identified in Inspection Report 50-445/86-19, 50-446/86-16 related to piping and pipe supports have been addressed by TENERA, and their resolution is provided in Appendix B to this supplement.

In addition, the staff conducted an audit of the TENERA activities at Berkeley, CA from August 17 to August 20, 1987 (Appendix D to this supplement - Event 29) to determine (1) the final scope of the TENERA third-party review of large bore piping, (2) the completeness of the piping issues addressed in the TENERA engineering evaluations, and (3) to determine the overall comprehensiveness of the TENERA evaluations of the SWEC resolution of the piping and pipe support issues raised by external sources. The scope of the audit included a review of the CPRT "Discipline Specific Results Report: Piping and Supports" (DAP-RR-P-001) Revision 0, dated July 2, 1987 (piping results report) including selected supporting engineering evaluations and third-party calculations. The following sections summarize the portions of the inspections and subsequent audit that were relevant to piping and pipe support design.

The staff reviewed the process used by TENERA to verify design criteria and standards used by SWEC. The TENERA process involved a review of all FSAR commitments, design specifications, ASME Code requirements, and other relevant industry standards (e.g., those of the American National Standards Institute, American Institute of Steel Construction, and Manufacturers Standardization Society) in accordance with CPRT Design Adequacy Procedure DAP-1, "Preparation and Review of Criteria Lists," to develop a design criteria list. DAP-1 describes the preparation of design criteria lists and requires all criteria and commitments used in the CPSES design to be sequentially numbered, summarized, and its source document identified. The design criteria list was used to develop a checklist for reviewing SWEC design criteria and procedures. The staff finds that the process provides a systematic method for ensuring that all relevant design criteria, standards, and licensing commitments were identified, documented, and addressed in SWEC design procedures and is thus acceptable.

In its review of the third-party overview of the project (SWEC) actions, the staff found that the third-party had completed its review of the SWEC piping analysis and pipe support design procedures contained in CPPP-6 and CPPP-7 (Appendix E to this supplement). The third-party design criteria list as discussed above was used to develop a checklist for the review of the piping analysis and pipe support design validation. TENERA conducted several audits of the SWEC design validation. However, the overview of the SWEC piping and pipe support design validation has been transferred to TU Electric Technical Audit Program (TAP) in accordance with Revision 4 of the CPRT Program Plan as discussed above. During the staff's August 17-20, 1987 audit (Appendix D to this supplement - Event 29), specific activities that TENERA recommended be transferred to TAP were identified. At the time of the staff audit, this list of activities was under preparation and upon completion will be transmitted to TU Electric TAP for followup.

The staff has reviewed and evaluated the CPRT third-party involvement in the identification, review, and tracking of issues. In its review of the process used by the CPRT third-party to identify, review, and track external source issues, the staff found that the issues, as they were identified, were logged into a computer and their status was tracked on the basis of a periodic updating of the issue evaluation. This process provided a reasonable method for ensuring that all identified external source issues were properly tracked until they were resolved. The external source issues were identified by a TENERA review of 364 source documents containing issues of concern. The documents included Atomic Safety and Licensing Board (ASLB) hearing transcripts, submittals to the ASLB by the various parties, NRC staff meeting transcripts, safety evaluation reports, inspection reports, and CYGNA letters and reports. The TENERA review of the source documents resulted in the identification of 781 specific issues that were related to piping and pipe supports. A Discrepancy/Issue Resolution Report (DIR) used to track each issue to closure was assigned to each issue. The 781 DIRs were consolidated by TENERA into 32 external source issue summaries and 51 miscellaneous DIRs. The 781 DIRs correspond approximately to the first 35 SWEC external source issues described in Appendix A to the piping project status reports (References 24 and 25) and to the 33 generic technical issues described in Appendix A to this supplement.

On the basis of its review of the scope of the external source issues, including all issues identified by CYGNA, the intervenor, and the NRC staff, the staff concludes that the scope was complete and thus acceptable.

The piping results report (Reference 42) documents the conclusions of TENERA's evaluation of the SWEC resolution methodologies for the piping external source issues. The basis for TENERA's conclusions are primarily documented in 32 engineering evaluations. Additional engineering evaluations were generated in TENERA's review of supporting calculations and studies. The staff's review of the 32 TENERA engineering evaluations finds that each engineering evaluation contains (1) a detailed description of the issue, (2) the TENERA review process, (3) relevant reference documents, (4) acceptance criteria, (5) the SWEC resolution methodology and the TENERA evaluation including the details of its basis for acceptability, and (6) conclusions. The staff found the engineering evaluations to be thorough in their technical justifications and bases of acceptance. It was apparent that many of the TENERA engineering evaluations were the result of technically extensive and in-depth efforts involving many engineers who were knowledgeable of the CPSES piping issues.

On the basis of its review of the technical bases discussed in the TENERA engineering evaluations, the staff finds that the piping results report and supporting engineering evaluations provide a comprehensive technical review of the resolution of the piping external source issues developed by SWEC and thus ensures the adequacy of the resolution.

The staff concludes that the CPRT third-party activities related to piping and pipe support design provided an adequate program to ensure that all external source issues are identified, that the SWEC resolution methodologies for the generic technical issues are technically adequate, and that the SWEC procedures and design criteria satisfy FSAR commitments, ASME Code requirements, design specifications, and other relevant industry standards.

4.2.2 TU Electric Technical Audit Program

The TU Electric Technical Audit Program (TAP) is described in a letter from W. Counsil to the NRC dated September 8, 1987 (Reference 44). The TAP, which is part of the TU Electric Quality Assurance Program, was established to (1) ensure the technical and programmatic effectiveness of the Corrective Action Program, and (2) provide oversight of project responses to CPRT recommendations.

For piping and pipe supports, the TAP audits of the CAP activities are designed to evaluate the effectiveness of the design validation process and the technical adequacy of the validated design product and supporting documentation. These audits are coordinated with other TU Electric audit activities and with the Engineering Functional Evaluation (EFE) (Reference 44). (The EFE activities are being addressed by NRC staff inspections of those design areas under the EFE scope of review.) TAP audits are also conducted on project actions taken in response to CPRT recommendations as a part of the ISAP audit program. The TAP audit methodology used for the CAP and ISAP audits are described in NEO Quality Assurance Department Procedure NQA 3.07-1.01, "Technical Audit Program" (Attachment 3 to Reference 38). The audit methodologies include both a vertical and a horizontal review of the design validation process. A vertical review would involve a review of the piping and pipe support designs contained within a selected package. A horizontal review would involve a review of a SWEC resolution of a generic technical issue common to a number of piping packages.

On the basis of its review of TAP audit reports on CAP activities (Appendix D to this supplement - Event 35), the staff finds that under the TU Electric TAP, the implementation of technical and design control requirements for the design validation of CPSES Unit 1 piping and pipe supports is being effectively audited. In addition, the staff finds that under the TAP, appropriate actions have been taken to resolve discrepancies previously identified during the CPRT audits of the piping and pipe support design validation activities. On the basis of its review of the TAP activities, the staff finds the TAP provides an effective level of technical oversight of the CPSES piping and pipe support design validation that is comparable to the level provided previously by the CPRT third-party oversight and is thus, acceptable.

4.2.3 CYGNA Energy Services

The piping and pipe support design issues identified by CYGNA as a result of its Independent Assessment Program (IAP) (Phases 1-4) for CPSES were included in CPRT Program Plan DSAP IX and designated as external source issues. With the establishment of the CPRT Program Plan and the TU Electric CAP design validation, the activities of CYGNA related to the IAP have been effectively overtaken. The CYGNA piping and pipe support issues were addressed by SWEC as part of the resolution of generic technical issues in Appendix A to the piping project status reports (References 24 and 25) and have been evaluated by the staff in Appendix A to this supplement. The CYGNA findings related to other design areas - cable tray hangers, conduit supports, civil/structural, mechanical and electrical systems, instrumentation and control, and design control - will be addressed by the staff in safety evaluations for those areas. As such, Supplement 5 to the CPSES SER, which was intended to evaluate the CYGNA IAP, is no longer necessary.

CYGNA is continuing its design reviews under the formal protocol established during the IAP for closure of the piping and pipe support issues raised by CYGNA. The status of the CYGNA reviews are documented in review issue lists (RILs) for each design discipline in their scope. For piping and pipe supports, all the issues in the respective RILs (References 22 and 23) have been closed.

The staff finds that the CYGNA review provides an additional level of confidence that the corrective actions taken by TU Electric to resolve the piping and pipe support design deficiencies are appropriate and acceptable.

5 PREVENTIVE ACTIONS

In assessing the adequacy of the preventive actions taken by TU Electric with respect to the programmatic and quality assurance aspects of the CPSES piping and pipe support design, it is important to understand the underlying causes of the piping and pipe support design problems that resulted in the type of design deficiencies identified in the external source issues. The staff's evaluation identifies the underlying causes and addresses the appropriateness of the preventive actions taken to preclude their recurrence.

Construction and Design Interface

In its safety evaluation of the Corrective Action Program (CAP) (Reference 19), the staff noted that programmatic deficiencies have occurred historically in the quality assurance/quality control activities during the design and construction of CPSES. Evidence of these programmatic deficiencies occurred in the control of field design changes (Reference 45). Although procedures existed to control field design changes, many design problems evolved from an insufficient review by the original architect-engineer of the field-originated designs and design changes on a concurrent basis.

On the basis of its observations of the number of non-standard large bore pipe supports installed in the plant, it has become evident to the staff that in the piping and pipe support area, significant design changes were implemented during construction to expedite hardware installation. Although the field designs and design changes did not necessarily result in an unacceptable design, the type of changes, in many cases, invalidated the analytical assumptions made in the supporting calculations and thus caused a deficiency in the supporting calculations. Specific analysis methods to reconcile these designs did not exist to guide the designers consistently in their work. As a result, analytical justification was difficult and would have required extensive reanalysis, advanced analytical techniques, or experimental tests to adequately qualify the designs. The applicant's use of engineering judgement at the time to qualify the designs was found unacceptable because the designs transgressed the limits of standard industry practice into an area where that judgment had little or no basis. Because the design process was not effective in promptly correcting these design deficiencies caused by construction, the staff found that many of the field design changes - and subsequent designs that may have been based on those field design changes - resulted in a large number of unacceptable pipe support designs at CPSES. The responsible design organization could have readily eliminated the non-standard pipe support designs had it been properly informed of their existence before their installation. However, once installed, the design process appeared to cause undue pressure to justify what was done and the design was accepted rather than causing extensive and costly construction rework. As a result, major design changes to pipe supports which should have required detailed reconciliation with the pipe stress analyses were not receiving an adequate degree of design review after their installation.

Piping and Pipe Support Design Interface

Piping design and pipe support design are so closely intertwined and technically interdependent that it is difficult to separate the two from a design standpoint. In designing a piping system, the designer makes certain assumptions concerning individual pipe support configurations. Also, a piping designer usually cannot make appropriate judgments about the adequacy of a piping system without reviewing the piping layout with all of its supports. This review is particularly important when addressing an issue such as pipe support stability because the interaction between the support and the pipe is usually critical in making this determination. To accomplish the kind of design review discussed above, it is necessary to have an established and functioning link between the group responsible for piping design and analysis and the group responsible for pipe support design and analysis.

Typically, in the design of nuclear facilities, a utility constructing a nuclear power plant contracts with a design firm (usually one of the major architect-engineering firms) to provide design services in the areas of both piping and pipe supports. The architect-engineer (AE) is responsible for the design process interface controls and procedures required to develop construction drawings for piping and pipe supports. The AE may elect to delegate a portion or all of this design work to a subcontractor. However, responsibility for, and control of, the design of both piping and supports rests with the AE. This responsibility and control exists even when the subcontractor uses its own design QA process and procedures. The AE will review and approve the process and perform audits to determine the acceptability of implementation. The above does not eliminate the requirement that the utility is ultimately responsible for the overall safety of the design.

For CPSES, TU Electric originally contracted with Gibbs and Hill, Inc. (G&H) to perform piping design and separately contracted with ITT Grinnell and NPSI to perform pipe support design. In addition, the applicant established its own pipe support design group (Pipe Support Engineering) to perform a portion of the pipe support design work and directly managed the ITT Grinnell and NPSI pipe support work at the site. The interfacing (control) document between the piping and support groups was Specification MS-46A.* From a contractual standpoint, it was TU Electric's responsibility to perform the activities necessary to ensure that an overall process was in place and functioning, including necessary interfaces, and that the process was one that would provide control on the drawings for compliance with licensing commitments. Although this contractual approach is not unique to CPSES and is not necessarily an unworkable approach, the responsibility placed on the utility coordinating the independent piping and pipe support design groups requires extremely close communication and coordination. The staff concludes that a lack of close communication and coordination existed at the time between the piping and pipe support design groups. Additionally, from a technical standpoint, it was G&H's responsibility to ensure the adequacy of the overall piping system design

* Specification 2323-MS-46A, "Nuclear Safety Class Pipe Hangers and Supports."

including the piping and pipe supports. This assurance was to have been provided through the as-built piping program. However, the staff found that an onsite TU Electric as-built group - functioning as part of the QA/QC organization - performed the as-built walkdown and provided the as-built information to G&H for final as-built reconciliation. Because G&H was not required to (and therefore did not) review support designs before their fabrication and installation, it was always involved with pipe supports as installed or "ready for installation." This situation could bias the judgment of a reviewing individual. The staff finds that the CPSES as-built walkdown program as performed by the applicant's as-built group is not unique to CPSES and also is not an unworkable approach. However, the overall situation involving the lack of interface between the piping and pipe support groups, the as-built walkdown performed by TU Electric, in conjunction with the types of field design changes made to the pipe supports, tended to place G&H in a position where a detailed review of the pipe supports to assess their impact on the overall piping system would have been an extremely difficult task and one for which [illegible] had ultimate responsibility. As a result, many of the pipe support design details that influenced the overall acceptability of the piping systems were apparently overlooked in the design review process.

<u>Staff Evaluation</u>

In the discussion above on the underlying causes for the piping and pipe support design problems, it follows that a detailed review of all pipe support designs, as a minimum, would be required to identify potential design deficiencies. It is also apparent that an objective review of the pipe support designs by an organization not initially involved with the CPSES pipe support designs would be necessary to provide an unbiased assessment of the conventionality and acceptability of those designs.

When TU Electric contracted with Stone & Webster Engineering Corporation (SWEC) to perform a complete design validation of ASME Code Class 1, 2, and 3 large bore pipe supports as part of its corrective action, objectiveness and fresh perspective was established. The pipe support calculations for all ASME Code Class 1, 2, and 3 piping systems are being design validated by SWEC at their home offices and at the CPSES site. The previous Texas Utilities Generating Company pipe support engineering organization has been dissolved and a new TU Electric engineering organization has been formed. A significant change is that TU Electric no longer directly supervises the technical work of the pipe support engineers but rather monitors and oversees the daily administrative activities. The direct supervision of the pipe support engineers is performed under the SWEC engineering organization.

Additionally, the engineering walkdown conducted under CPPP-8 (Appendix E to this supplement) provided SWEC engineers the opportunity to obtain a firsthand understanding of the pipe support issues and to identify any other yet undetected technical issues arising from a lack of control of construction practices that may have a potential impact on the piping and pipe support design adequacy. The results of the engineering walkdown and the resolution of the generic technical issues by SWEC led to the development of explicit design guidelines for the piping and pipe support designers to use to determine the acceptability of the designs thus ensuring a uniformly applied validation of the installed hardware.

Based on the many modifications SWEC has developed for the pipe support designs, the staff has gained confidence that the design validation process does not cause the same degree of pressure to accept the installed designs which the original architect-engineer may have experienced. Furthermore, on the basis of its audits, where designs were deemed questionable but not necessarily a proven design deficiency, the staff has found that it was likely that those designs had been subsequently eliminated or acceptably modified by SWEC.

Thus, on the basis of its review of the corrective actions associated with the CAP, the staff finds that the extent of the design validation performed by SWEC and the degree to which design changes are being made to the installed piping and pipe supports provide sufficient confidence that all design deficiencies in the large and small bore pipe supports resulting from the failure of the original design process to promptly correct design deficiencies have been identified and corrected in the implementation of the CAP design validation activities. Consequently, the staff finds that the pipe support designs have been adequately reviewed under the CAP thus satisfying the applicable portion of Criterion III of 10 CFR 50, Appendix B. Furthermore, design deficiencies have been corrected, thus satisfying the applicable portions of 10 CFR 50, Appendix B, Criterion XVI.

On the basis of its review of the CAP activities related to the design-construction interface and the piping-pipe support design interface, the staff concludes that the TU Electric CAP for piping and pipe supports adequately corrects the underlying causes of the past design problems to prevent their recurrence and, thus, satisfies the applicable portion of Criterion XVI of 10 CFR 50, Appendix B.

6 CONCLUSIONS

On the basis of its review of the CPRT Program Plan (Revision 4) and the TU Electric Corrective Action Program as discussed in Section 4 of this supplement, the staff concludes for the design validation of ASME Code piping and pipe supports at CPSES Units 1 and 2 that the specified design is acceptable and meets the applicable requirements of 10 CFR 50.55a and General Design Criteria 1, 2, and 4 of 10 CFR 50, Appendix A. This conclusion is based on the following.

The applicant has met the requirements of 10 CFR §50.55a and General Design Criteria 1, 2, and 4 with respect to the design and service load combinations and associated stress and deformation limits specified for ASME Code Class 2 and 3 piping and ASME Code Class 1, 2, and 3 pipe supports by ensuring that the piping and pipe supports important to safety are designed to quality standards commensurate with their importance to safety and that these piping systems can accommodate the effects of normal operation as well as postulated events such as loss-of-coolant accidents and the dynamic effects resulting from earthquakes. The specified design and service combinations of loadings as applied to the piping and pipe supports at CPSES Units 1 and 2 in piping systems designed to meet seismic Category I standards are such as to provide assurance that in the event of an earthquake affecting the site or other service loadings due to postulated events or system operating transients, the resulting combined stresses imposed on system components will not exceed allowable stress and strain limits for the materials of construction. Limiting the stresses under such loading combinations provides a conservative basis for the design of system components to withstand the most adverse combination of loading events without loss of structural integrity. (See Section 4.1.2.2 and Appendix A of this supplement.)

The staff further concludes that for the resolution of identified and potential design deficiencies in the piping and pipe supports at CPSES Units 1 and 2, the TU Electric Corrective Action Program for large and small bore piping and pipe supports and the CPRT Program Plan (Revision 4) collectively establishes effective means to identify all design deficiencies, provide comprehensive corrective actions for their resolution, and ensure proper implementation of the corrective actions. These conclusions are based on the following.

The applicants' piping and pipe support design validation activities performed by SWEC and the CPRT third-party review by TENERA, L.P. provide a comprehensive program for identifying and resolving the technical concerns raised by the intervenor, CYGNA Energy Services, the NRC staff, and other external sources related to the design adequacy of large and small bore piping and pipe supports at CPSES. The staff concludes that the overall program reasonably ensures that all deficiencies in the design of large bore and small bore piping and supports are identified and corrected. The staff further concludes that the effectiveness of the program implementation ensures that those issues will be acceptably resolved upon completion of the program. (See Sections 4.1.2 and 4.2.2 and Appendix A of this supplement.)

The applicant's piping and pipe support hardware validation activities provide assurance that construction deviations in the piping and pipe support areas are corrected and, thus, will not adversely affect the ability of piping and pipe supports to perform their functions. (See Sections 4.1.2.1 and 4.1.3 of this supplement.)

The scope and depth of the independent review by CYGNA Energy Services provide additional assurance of the satisfactory resolution of deficiencies in the design of piping and pipe supports at CPSES. Additionally, satisfactory findings by the third-party (TENERA) in its review of the large bore piping and pipe support design criteria provide assurance that the design of the large bore piping and pipe supports satisfies licensing commitments and applicable ASME Code requirements. (See Sections 4.2.1 and 4.2.2 of this supplement.)

The TU Electric Technical Audit Program provides assurance that the execution of the design validation by SWEC is technically adequate and that the implementation of the resolution of the piping and pipe support generic technical issues is appropriate and complete. (See Section 4.2.2 of this supplement.)

On the basis of its review of the design and interface controls associated with the TU Electric Corrective Action Program as discussed in Section 5 of this supplement), the staff concludes that the corrective actions are acceptable and satisfy the applicable requirements of 10 CFR 50, Appendix B, Criteria III and XVI. This conclusion is based on the following.

The applicant has satisfied the requirements of 10 CFR 50 Appendix B, Criterion III with respect to establishing measures to ensure that the applicable regulatory requirements and the design basis are correctly translated into specifications, design drawings, and procedures by establishing design basis documents and implementing a complete design validation for piping and pipe supports importa to safety. The design validation provides proper control of the design interface between the piping and pipe support groups and provides an adequate review of installed field designs and design changes. (See Sections 4.1.1, 4.1.2, and 5.0 of this supplement.)

The applicant has satisfied the requirements of 10 CFR 50 Appendix B, Criterion XVI by establishing a program to correct design deficiencies and to preclude repetition of the underlying causes of the problems associated with the design of piping and pipe supports at the CPSES. (See Section 5 of this supplement.)

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15. Letter from W. G. Counsil (TU Electric) to USNRC, Subject: Corrective Action Program Description and Flow Diagrams, Docket Nos. 50-445/446, August 28, 1987.

16. Letter from W. G. Counsil (TU Electric) to USNRC, Subject: Post Construction Hardware Validation Program Engineering Evaluation Methodology, Docket Nos. 50-445/446, September 8, 1987.

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19. Letter from S. D. Ebneter (USNRC) to W. G. Counsil (TU Electric), Subject: CPSES Licensing and Corrective Action Programs, Docket Nos. 50-445/446, January 22, 1988.

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21. U.S. Nuclear Regulatory Commission, Inspection Report No. 50-445/86-19; 50-446/86-16, November 4, 1986.

22. Letter from N. H. Williams (CYGNA) to W. G. Counsil (TU Electric), Subject: Pipe Stress Review Issues List - Revision 4, Docket Nos. 50-445/446, September 16, 1987.

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32. "Comanche Peak Steam Electric Station - Final Safety Analysis Report," Docket Nos. 50-445/446, up to and including Amendment 65.

33. Letter from C. I. Grimes (USNRC) to W. G. Counsil (TU Electric), Subject: Implementation of Revised GDC-4, Docket Nos. 50-445/446, June 8, 1987.

34. "ASME Boiler and Pressure Vessel Code - Code Cases," N-411, Alternative Damping Values for Response Spectra Analysis of Class 1, 2, and 3 Piping, American Society of Mechanical Engineers (1983).*

35. Letter from V. Noonan (USNRC) to W. G. Counsil (TU Electric), Subject: Use of ASME Code Case N-397 and N-411, Docket Nos. 50-445/446, March 13, 1986.

36. D. W. Coats, Lawrence Livermore Laboratory, "Recommended Revisions to Nuclear Regulatory Commission Seismic Design Criteria," USNRC Report NUREG/CR-1161, May 1980.

37. U.S. Nuclear Regulatory Commission, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants - LWR Edition," USNRC Report NUREG-0800, Revision 1, July 1981.

38. U.S. Nuclear Regulatory Commission, "Methodology for Combining Dynamic Responses," Revision 1, USNRC Report NUREG-0484, May 1980.

39. E. C. Rodabaugh, Batelle Columbus Laboratories, "Functional Capability Criteria for Essential Mark II Piping," General Electric Company, NEDO-21985, September 1978.

40. "ASME Boiler and Pressure Vessel Code," Section III, Division 1, Appendices, (1977 Edition including Winter 1978 Addenda), Appendix O, Rules for Design of Safety Valve Installations, American Society of Mechanical Engineers.

41. Stone & Webster Engineering Corporation, "Generic Technical Issues Report," Revision 0, Docket Nos. 50-445/446, June 27, 1986, transmitted in a letter from W. G. Counsil (TU Electric) to V. Noonan (USNRC) dated July 9, 1986.

42. Comanche Peak Response Team, "Discipline Specific Results Report: Piping and Supports," DAP-RR-001, Revision 1, Docket Nos. 50-445/446, August 27, 1987, transmitted in a letter from W. G. Counsil (TU Electric) to USNRC dated September 29, 1987.

43. U.S. Nuclear Regulatory Commission, Inspection Report No. 50-445/85-17; 50-446/85-14, January 21, 1986.

44. Letter from W. G. Counsil (TU Electric) to USNRC, Subject: Technical Audit Program and Engineering Functional Evaluation, Docket Nos. 50-445/446, September 8, 1987.

45. Management Analysis Company, Management Quality Assurance Audit Report, Appendix B (pps. 4-5), May 17, 1978, transmitted in a letter from R. A. Wooldridge (Worsham, Forsythe, Sampels, and Wooldridge) to P. B. Bloch (USNRC), Subject: Supplementation of Applicants' Response to CASE's Request for Production, Docket Nos. 50-445/446, May 29, 1985.

* Available through public technical libraries and at the NRC Library, 7920 Norfolk Avenue, Bethesda, Maryland.

APPENDIX A

RESOLUTION OF GENERIC TECHNICAL MATTERS

The generic technical issues* consist of those external source issues raised primarily by the intervenor Citizens Association for Sound Energy (CASE) (e.g., Walsh/Doyle concerns), CYGNA Energy Services, and the NRC staff that could potentially affect more than one specific pipe support calculation or pipe stress analysis package. The third-party organization (TENERA, L.P.) was responsible for identifying, reviewing, and tracking of the resolutions of the external source issues. The development of the technical resolutions of the external source issues was the responsibility of Stone & Webster Engineering Corporation (SWEC) as part of the piping and supports design validation. The resolution methodologies for the generic technical issues were initially discussed in a SWEC report entitled "Generic Technical Issues Report," dated June 26, 1986 (generic issues report) (Reference A1) and subsequently have been documented in Appendix A to the project status reports for large bore piping and small bore piping (References A2 and A3) (hereinafter referred to as the "piping project status reports"). The method for implementing the technical resolutions was incorporated into the Comanche Peak Project Procedure CPPP-7, "Design Criteria for Pipe Stress and Pipe Supports" (Revision 3) dated February 23, 1987 (Reference A4). SWEC implemented that method in conjunction with the large and small bore piping and pipe support design validation under the TU Electric Corrective Action Program (CAP).

The Comanche Peak Response Team's (CPRT's) third-party (TENERA, L.P.) evaluations of the SWEC resolution methodologies were summarized in the CPRT "Discipline Specific Results Report: Piping and Supports," DAP-RR-P-001 Revision 1, dated September 29, 1987 (hereinafter referred to as the "piping results report") (Reference A5). The CPRT detailed evaluations were documented in supporting engineering evaluations developed by the CPRT third-party for each generic technical issue. Each engineering evaluation contains (1) a detailed description of the issue, (2) the CPRT third-party review process, (3) relevant reference documents, (4) acceptance criteria, (5) the SWEC resolution methodology and accompanying CPRT evaluation, and (6) conclusions. This appendix contains the relevant portions of the engineering evaluations that give the staff assurance about the technical acceptability of the SWEC resolution methodologies for those areas of the generic technical issues not specifically reviewed by the staff. As such, the reader does not need the engineering evaluations to understand the CPRT's basis for acceptability,

* In the staff's terminology a generic technical issue (e.g., Richmond inserts) may consist of several external source issues (e.g., factor of safety, concrete strength, etc.)

however, the amount of technical detail provided therein might contain useful background information for the reader should further details be required.*

The staff's review of the generic technical issues and their resolution consisted of a review of the SWEC generic issues report, a review of Appendix A to the piping project status reports, a review of the applicable paragraphs of CPPP-7, a review of the CPRT piping results report and engineering evaluations, and audits and inspections at the SWEC and TENERA, L.P. offices (Appendix D to this supplement - Events 4, 10, 11, 17, 18, 20, 29, 31, 32, 33, 34, 35, and 36). The staff has evaluated each external source issues in this appendix. The staff evaluation addresses all 781 discrepancy/issue resolution reports (DIRs) generated by the CPRT in its review of 364 various source documents which are related to piping and pipe support issues raised by external sources. The 33 generic technical issues evaluated by the staff in this appendix and all external source issues addressed under each generic technical issue are:

1 Richmond Inserts

- 1.1 Factor of Safety
- 1.2 Concrete Strength
- 1.3 Shear Stress Allowables for 1-1/2-inch Richmond Inserts (Type EC-6W)
- 1.4 Computation of Bolt and Insert Loads
- 1.5 Frame Modeling of Tube-to-Insert Connections
- 1.6 Testing of Richmond Inserts
- 1.7 TUGCO** Finite Element Study
- 1.8 Local Stress at Bolt Holes in Tubing
- 1.9 Fatigue
- 1.10 Improper Use of Richmond Allowables
- 1.11 Spacing at Richmond Inserts
- 1.12 Shear Distribution at Richmond Inserts
- 1.13 LOCA Thermal Expansion of Tube Steel

2 Local Stresses in Piping

- 2.1 Integral Welded Attachments and Pads
- 2.2 Radial Loads on Piping
- 2.3 Line Loads on Piping
- 2.4 Welded Attachments on Girth Butt Welds

3 Large Framed Wall-to-Wall and Floor-to-Ceiling Supports

- 3.1 Thermal Expansion and Relative Differential Displacement Effects

* The Engineering Evaluations are a part of the CPRT working files and are available for inspection with 48 hours notice at the offices of Texas Utilities Electric Company, Skyway Tower, 400 N. Olive Street, Dallas, TX 75201 or at the Comanche Peak Steam Electric Station site in Glen Rose, TX.

** Texas Utilities Generating Company

4 Stability of Pipe Supports

4.1 Box Frames Connected to Struts or Snubbers
4.2 U-Bolts With Single Struts or Snubbers
4.3 Trapeze Supports
4.4 Column/Strut Assemblies
4.5 Trunnion/Strut Assemblies

5 Generic Stiffness of Pipe Supports

5.1 Actual Versus Generic Stiffness Values
5.2 Local Flexibility Effects

6 Uncinched U-Bolts Acting As Two-Way Restraints

6.1 Modeling of U-Bolts in Piping Analysis
6.2 Qualification of U-Bolts

7 Friction Forces

7.1 Friction Considerations in Piping Analysis

8 AWS Versus ASME Weld Design

8.1 Pre-heat Requirements for Welds on Plates Over 3/4 Inch Thick
8.2 Drag Angles and Work Angles
8.3 Beta Factors for Tube-to-Tube Welds
8.4 Multiplication Factor and Reduction Factor for Skewed T-Joint Welds
8.5 Limitations and Angularity for Skewed "T" Joints
8.6 Calculations for Punching Shear on Step Tube Joints
8.7 Lap Joint Requirements
8.8 Design of Tube-to-Tube Joints With Beta Equal to 1.0
8.9 Calculation for Effective Throat of Flare Bevel Welds
8.10 Limitations on Weld Sizes Relative to Plate Thickness

9 A500 Grade B Tube Steel

9.1 Material Properties for A500 Grade B Tube Steel

10 Tube Steel Section Properties

10.1 Variations in Tube Steel Section Properties
10.2 Effect of Bolt Holes on Section Properties

11 U-Bolt Cinching

11.1 Cinching of Standard U-Bolts
11.2 Stiff Pipe Clamps

12 Axial/Rotational Restraints

12.1 Rotation Restraint Effects in Piping Systems
12.2 Rotation Restraint Effects on Component Standard Support Design Loads

12.3 Differential Snubber Lock-up and End Clearance Effects on Snubber Design Loads in Dual Snubber Supports
12.4 Design Allowables for Dual Component Standard Supports
12.5 Cinched U-Bolts in Trapeze Supports
12.6 Lug Load Distribution
12.7 Load Point Application on Frames with Lugs

13 Gaps

13.1 Use of Linear Elastic Analysis Techniques
13.2 Concrete Anchorage Gaps
13.3 U-Bolt Gaps
13.4 Pipe/Support Clearances

14 Seismic Design Load Specification

14.1 Piping Computer Analysis Seismic Load Input
14.2 Seismic Response Spectra Definition
14.3 Equivalent Static Analysis Dynamic Amplication Factor

15 Support Mass Effects on Piping Analysis

15.1 Support Mass Criteria, Modeling, and Dynamic Effects

16 Mass Point Spacing

16.1 Mass Point Spacing Criteria and Computer Application

17 High Frequency Mass Participation

17.1 Insufficient Modes and Computer Program Concerns

18 Fluid Transients

18.1 Main Steam SRV Load Modelling
18.2 Fluid Transient Analysis Methodology

19 Self-Weight Excitation

19.1 Dead Weight Loads
19.2 Seismic Self-Weight Excitation

20 Local Stress in Pipe Support Members

20.1 Zero-Gap and Cinched U-Bolt Design
20.2 Highly Constrained Pipe Anchors
20.3 Structural Connections and Localized Loadings
20.4 Short/Deep Beams
20.5 Support Deflection and Flexibility

21 Safety Factors

21.1 Cumulative Effect of Issues

22 SA-36 and A-307 Bolting Material

22.1 SA-36 Used in Dynamic Applications
22.2 SA-307 Material in U-Bolts and Richmond Inserts
22.3 Use of Low Strength Nuts with High Strength Bolting

23 Valve and Flange Qualification/Valve Modeling

23.1 Main Steam Relief Valve Qualification
23.2 Modeling of Supported Valves
23.3 Valve and Flange Qualification

24 Piping Modeling

24.1 Pipe Support Locations
24.2 Stress Intensification Factors (SIFs)
24.3 Valve and Flange Insulation and Fluid Mass
24.4 Snubbers Adjacent to Restrained Piping Locations
24.5 Minimum Pipe Wall Thickness Violations

25 Design of Welds

25.1 Unsymmetrical Welds (Eccentricity of Three-Sided Welds)
25.2 Cover Plate Welds
25.3 Combination Bolt and Welded Connections

26 Anchor Bolts

26.1 Friction Versus Bearing Connections
26.2 Baseplate Edge Distance
26.3 Embedment Lengths

27 Strut Angularity

27.1 Design Considerations for Strut Angularity (Kick Loads)
27.2 Justification for 5-Degree Angular Tolerance

28 Structural Modeling for Frame Analysis

28.1 Torsional Stiffness of Wide Flange Members
28.2 Member End Restraint and Boundary Conditions

29 Computer Verification and Use

29.1 Computer Program Qualification

30 Hydrotest

30.1 Design Considerations for Hydrotest Conditions
30.2 Main Steam Line Flushing

31 Seismic/Non-Seismic Interface

31.1 Seismic Design Considerations for Piping Routed Between Seismic Category I and Non-Seismic Category I Buildings

32 Programmatic Aspects and QA

33 Miscellaneous External Source Issues

The references identified in this appendix are listed in Section 34.

1 RICHMOND INSERTS

A number of concerns were raised associated with the design of pipe supports using Richmond inserts at Comanche Peak Steam Electric Station (CPSES). In its December 28, 1983 Memorandum and Order (Reference A6) (p. 1445), the Atomic Safety and Licensing Board (ASLB) discussed concerns related to pipe support designs using Richmond inserts. Subsequently, the CPRT third-party (TENERA) identified 79 related issues from various source documents associated with the design of Richmond inserts. In its Engineering Evaluation DAP-E-P-001, "Richmond Inserts," TENERA categorized these issues into 13 areas of concern as follows:

(1) factor of safety
(2) concrete strength
(3) shear stress allowables for 1-1/2 inch Richmond inserts
(4) computation of bolt and insert loads
(5) frame modelling of tube-to-insert connections
(6) testing of Richmond inserts
(7) TUGCO finite element study
(8) local stress at bolt holes in tubing
(9) fatigue
(10) improper use of Richmond allowables
(11) spacing at Richmond inserts
(12) shear distribution at Richmond
(13) LOCA thermal expansion of tube steel

1.1 Factor of Safety

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping project status reports (Section 2.1 of Subappendix A1). The Design Adequacy Program (DAP) evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.1).

Of primary concern was whether the design allowable values used at CPSES for Richmond inserts were adequate using a safety factor of 2.0 for normal, upset, and emergency loading conditions. SWEC uses a safety factor of 3.0 for normal, upset, and emergency conditions which complies with the recommendation of the manufacturer, Richmond Screw Company. SWEC uses a safety factor of 2.0 for the faulted conditions. Although ACI-318-71 (Reference A7) is the CPSES code of record, this code does not contain explicit provisions for the consideration of the faulted load condition. However, ACI-349-85 (Reference A8), which is based on the general building code ACI-318, was developed specifically for concrete structures in nuclear facilities and contains appropriate guidance for considering seismic loadings for steel embedments. On the basis of ACI-349-85, a safety factor of 2 for faulted load conditions is acceptable.

SWEC uses the Prestressed Concrete Institute (PCI) Manual (Reference A9) interaction equation to evaluate Richmond inserts for combined tension and shear. The justification for using the PCI interaction equation is provided in SWEC Calculation GENX-037, "Generic Calculation: Qualification of Richmond Inserts," which has been reviewed and found acceptable by TENERA in DAP-E-P-001 based on the equation providing a lower bound curve on the insert test results. The curve represents the minimum test failure loads to be used for design and is a conservative assumption.

On the basis of (1) the Richmond insert methodology providing design factors of safety based on manufacturer recommendations and code guidelines and (2) the DAP evaluation of the PCI Manual interaction equation concluding its use appropriate for inserts, the staff finds the safety factors used by SWEC for Richmond inserts in the design validation of pipe supports acceptable.

1.2 Concrete Strength

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping project status reports (Section 2.0 of Subappendix A36). The DAP Evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.4.2) and is summarized in the piping results report (Section 3.2.3.1).

The concern of whether a minimum required design strength of 4000 psi was met has been reviewed by SWEC under the civil/structural Corrective Action Program (CAP). Plant concrete strength was addressed by the CPRT in the Issue-Specific Action Plan (ISAP) II.b results report, "Concrete Compressive Strength." Accordingly, the staff's evaluation of this issue will be addressed in conjunction with the staff's review of the civil/structural CAP and the ISAP II.b results report.

1.3 Shear Stress Allowable for 1-1/2-inch Richmond Inserts (Type EC-6W)

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A1 Section 2.7). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.4.2) and is summarized in the piping results report (Section 3.2.3.1).

Of initial concern was that the CPSES design of 1-1/2-inch Richmond inserts used shear allowables 50 percent greater than the values recommended by the manufacturer, Richmond Screw Company. SWEC developed shear allowables for Richmond inserts based on average TUGCO test failure loads. The DAP evaluation found the SWEC allowables in compliance with ACI-349-85 and the manufacturer's recommendations.

On the basis of DAP conclusions, the staff finds the shear allowables for Richmond inserts used by SWEC in the CAP design validation for piping and pipe supports acceptable.

1.4 Computation of Bolt and Insert Loads

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.5). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.5.2) and is summarized in the piping results report (Section 3.2.3.1).

At CPSES, Richmond inserts are used to attach tube steel to the concrete structure. Although Richmond inserts are commonly used in other nuclear facilities, their use with tube steel rather than baseplates is not standard industry practice. The analysis methods used previously by TUGCO did not account for the Richmond threaded rod/bolt bending when there was torsional moment about the tube steel axis and may have underpredicted prying tension in the threaded rods/bolts.

SWEC uses a non-linear interaction equation to evaluate the adequacy of the threaded rod in Richmond insert connections. The justification for this equation is provided in R. L. Cloud Associates (RLCA) reports RLCA/P142/01-85/003 "Richmond Insert/Structural Tube Steel Connections," and RLCA/P142/01-86/008, "Richmond Insert/Structural Tube Steel Connections, Design Interaction Equation for Bolt/Threaded Rods." The SWEC non-linear rod interaction equation was evaluated by TENERA in DAP calculation DAP-C-P-006, "Rods in Tension and Shear - SWEC Interaction Equation," February 9, 1987. The DAP calculation shows that the SWEC interaction equation satisfies the applicable portions of the American Institute of Steel Construction (AISC) specification for A36 and A193 Grade B7 rod material.

TENERA has reviewed the SWEC modeling requirements to compute the rod end reactions at the insert. The SWEC method was compared to a more detailed finite element analysis in RLCA reports RLCA/P142/01-85/003, "Richmond Insert/Structural Tube Steel Connections" and RLCA/P142/01-86/006, "Richmond Insert/Structural Tube Steel Connections, Evaluation of CPPP-7 Modelling Procedures." TENERA concluded that the SWEC method always results in a larger rod interaction equation value than the finite element analysis and is, thus, conservative.

TENERA reviewed the SWEC procedure for computing insert tension from the bolt/rod loads. A comparison to RLCA finite element analysis results found that the SWEC procedures resulted in insert tension loads equal to or greater than the finite element analysis loads and are, thus, acceptable.

In audits conducted by the staff (Appendix D to this supplement - Events 32 and 34), the staff selected two supports to assess the adequacy of SWEC's design criteria application. For support AF-1-001-035-Y33R, the calculation was reviewed for compliance with CPPP-7 interaction equations for threaded rod and insert as specified in Attachment 4-5, Paragraphs 3.2.1 and 3.2.2. The calculation for support CT-1-053-418-C62R was reviewed for compliance with CPPP-7 interaction equations for single tubes as specified in Attachment 4-5, Paragraph 3.3.2. The calculations were found to be in accordance with the applicable CPPP-7 design criteria and are, thus, acceptable.

On the basis of the above discussions, the staff finds that the SWEC methodology for computing Richmond insert and bolt/rod loads is conservative and has been properly implemented and is, thus, acceptable.

1.5 Frame Modeling of Tube-to-Insert Connections

The issue background is provided in External Source Issue Summary ESIS-P-031 (Attachment A to DAP-E-P-031). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A31 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-031 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.28).

The staff evaluation of the frame modelling of tube-to-insert connections is discussed Section 28.2 of this appendix.

1.6 Testing of Richmond Inserts

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.7.2) and is summarized in the piping results report (Section 3.2.3.1).

The staff evaluation of the testing of Richmond inserts will be addressed in conjunction with the staff review of the civil/structural CAP.

1.7 TUGCO Finite Element Study

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.4). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.8.2) and is summarized in the piping results report (Section 3.2.3.1).

The concern was raised by CYGNA in its review of a screening method used previously by TUGCO to justify their simplified design method for Richmond inserts. The concern is no longer applicable to CPSES because the SWEC design methodology for Richmond inserts does not rely on the previous TUGCO work.

1.8 Local Stress at Bolt Holes in Tubing

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.9). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.9.2) and is summarized in the piping results report (Section 3.2.3.1).

CYGNA raised a concern that the local stresses at holes in tube steel under nuts or bolt heads could cause a punching-type failure. SWEC developed a procedure for evaluating local stresses due to nuts bearing on tube steel walls as provided in CPPP-7 Attachment 4-13, Paragraph 4.3. TENERA reviewed the SWEC design methodology and supporting Calculation GENX-023, "Generic Calculation: Development of the Method for Evaluating Local Stress in Pipe Support Members," and found them technically acceptable.

On the basis of the DAP evaluation findings, the staff concludes that the SWEC methodology for calculating local stress at bolt holes in tube steel is acceptable. In addition, the CYGNA review of this issue and resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 4) (Reference A10).

1.9 Fatigue

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.3). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-023 (Section 5.2.1) and is summarized in the piping results report (Section 3.2.3.1).

This issue is addressed in Section 22.1 of this appendix.

1.10 Improper Use of Richmond Allowables

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.11). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.11.2) and is summarized in the piping results report (Section 3.2.3.1).

The concern raised by CASE was that the threaded rods/bolts in Richmond inserts were at times incorrectly evaluated using tension and shear allowables for the insert that had different allowables. The SWEC resolution is to evaluate both the threaded rods/bolts and the inserts using specified allowables and interaction equations.

On the basis of the SWEC methodology evaluating both the threaded rods/bolts and the insert to their separate stress allowables, the concern of using the incorrect allowable is adequately resolved.

1.11 Spacing at Richmond Inserts

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.6). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.14.2) and is summarized in the piping results report (Section 3.2.3.1).

The staff evaluation of this issue will be addressed in conjunction with the staff review of the civil/structural CAP.

1.12 Shear Distribution at Richmond Inserts

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.10). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.12.2) and is summarized in the piping results report (Section 3.2.3.1).

The primary concern was that when a hole is drilled through the tube steel, the resulting gap between the Richmond insert threaded rod (which is inserted through the hole) and the tube steel wall would cause an unequal shear load distribution among other threaded rods in the tube steel. The SWEC procedure accounts for this unequal shear load distribution and requires a doubling of the shear load ratio (V/Va) (where V is the calculated shear load and Va is the allowable shear load) when the shear ratio exceeds 0.25.

The DAP evaluation found that the Richmond insert-to-tube steel connections behave in a ductile manner and therefore the assumption of equal shear load distribution in the threaded rods and insert is reasonable. Because the SWEC methodology requires a doubling of the shear ratio when it exceeds 0.25, the

SWEC method assumes the shear is twice as large as calculated and is, thus, conservative.

The staff finds the SWEC method for calculating shear loads in Richmond inserts and threaded rods acceptable.

1.13 LOCA Thermal Expansion of Tube Steel

The issue background is provided in External Source Issue Summary ESIS-P-001 (Attachment A to DAP-E-P-001). The SWEC resolution methodology is provided in the piping PSRs (Subappendix A1 Section 2.8). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-001 (Section 5.13.2) and is summarized in the piping results report (Section 3.2.3.1).

CASE raised a concern that under loss-of-coolant accident (LOCA) environmental conditions, long tube steel frames anchored to the concrete by Richmond inserts would thermally expand and overstress the threaded rods in the inserts. The SWEC procedure for evaluating the thermal rods is based on an RLCA report RLCA/P142/01-86-009, "Richmond Insert/Structural Tube Steel Connections, Effect of Thermal Expansion of Tube Steel on Richmond Inserts and Bolts." The SWEC approach establishes the maximum lengths for long tube steel pipe support members with Richmond inserts for tube steel sizes up to and including TS 8 x 8 x 1/2-inch. The SWEC approach also contains guidelines for limiting the maximum spacings between threaded rods for large frame-type hangers mounted to the concrete with Richmond inserts.

In audits conducted by the staff (Appendix D to this supplement - Events 34 and 36), the staff selected a feedwater frame support located inside the containment that consisted of 19 individual pipe supports on a long tube steel frame attached to the containment wall with Richmond inserts. The primary support is FW-1-099-001-C62S. The staff reviewed the support calculations to verify that the maximum lengths of the tube steel frame were in compliance with CPPP-7, Attachment 4-5. The staff found that a reduction in the overall length of the tube steel frame has been implemented and the CPPP-7 design criterion is being used to establish the maximum tube steel lengths and spacings between Richmond inserts. The staff finds the overall process used to determine the acceptability of thermal expansion in long tube steel frames inside the containment using Richmond inserts results in reasonable lengths of interconnected tube steel and is, thus, acceptable.

1.14 Conclusions

Based on the above evaluations concerning Richmond insert design, the staff concludes that the concerns associated with the design of Richmond inserts have been adequately resolved. The generic technical issue related to Richmond inserts in piping systems is, therefore, closed for CPSES.

2 LOCAL STRESS IN PIPING

Several concerns were raised relating to the localized effects of pipe support designs on piping at CPSES. In its December 28, 1983 Memorandum and Order (Reference A6) (page 1434), the ASLB expressed its concern regarding local stresses in piping induced by pipe supports. Subsequently, the CPRT third-party (TENERA, L.P.) identified 51 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-002, "Local Pipe Stresses," TENERA categorized these concerns into four primary issues:

(1) integral welded attachments and pads
(2) radial loads on piping
(3) line loads on piping
(4) welded attachments on girth butt welds

2.1 Integral Welded Attachments and Pads

The issue background is provided in the DAP External Source Issue Summary ESIS-P-002 (Attachment A to DAP-E-P-002). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A2 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-002 (Section 5.2) and is summarized in the piping results report (Section 3.2.3.2).

The primary concern was that local stresses at welded attachments to piping (e.g., lugs, trunnions, stanchions) were not being adequately evaluated. The SWEC analysis methods for the evaluation of local pipe stresses induced by welded attachments are provided in CPPP-7 Attachment 4-6A. TENERA has reviewed the SWEC acceptance criteria for local stresses and found them to be consistent with the FSAR. CPPP-7 also allows the use of ASME Code Cases N-318-2 and N-392 (References A11 and A12) and TENERA found them acceptable for attachments on straight pipe. For trunnions on elbows, SWEC developed a calculation to justify an evaluation method for attachments on long-radius elbows. TENERA's review of this calculation found it acceptable.

Local pipe stresses are calculated using computer programs PILUG, PITRUST, and PITRIFE. PILUG and PITRUST are used for evaluating the effects of standard lugs and trunnions, respectively, using an established analytical method based on WRC Bulletin 107 (Reference A13). PITRIFE is used for evaluating the effects of trunnion sizes larger than those covered by WRC Bulletin 107 and is based on finite element results. TENERA reviewed the SWEC generic calculation that justifies the expanded application range of WRC Bulletin 107 used in PITRIFE and found it acceptable.

Some existing non-standard trunnion designs unique to specific supports were qualified by SWEC using special finite element analyses. Five special analyses have been reviewed by TENERA in DAP-E-P-002 and were found acceptable. In addition, TENERA reviewed the SWEC method for evaluating local stress at pads as provided in CPPP-7 Paragraph 4.6.5. SWEC has performed finite element analyses to justify its analysis method for trunnions with pads. TENERA's review of the SWEC calculation found it to be acceptable.

The staff conducted several audits to assess the adequacy of design guideline implementation by SWEC. (Appendix D to this supplement - Events 31 and 36.) The staff selected SWEC Calculation GENX-173 "Load Rating for Service Water Support Modification," to review the qualification of pads on large diameter piping used to minimize the effects of bearing loads on the pipe. In addition, the staff reviewed the local bending stresses and thermal gradients that would occur in integral welded attachments (IWA) on the main steam and feedwater piping. In an internal letter from R. P. Klause (SWEC) to L. D. Nace (TU Electric) dated July 24, 1987, the results of a fatigue analysis including thermal gradients at worst-case locations at welded attachments were documented. Based on its review of the results presented in the study, the staff finds that the maximum fatigue usage factors for IWA on the main steam and feedwater piping are 0.840 and 0.344, respectively, and thus satisfy the ASME Code allowable of 1.0. The results of our audits found that the local pipe stresses have been calculated in accordance with CPPP-7 guidelines and satisfy the ASME Code allowable stress limits and are, thus, acceptable.

On the basis of the DAP evaluation findings and the staff review and audits discussed above, the staff concludes that the SWEC design methods for evaluating the local pipe stresses caused by welded attachments are in accordance with ASME Code requirements using generally recognized engineering methods, were found to be applied in a technically appropriate manner, and are, thus, acceptable. In addition, the CYGNA review of this issue and resolution has resulted in its closure in Revision 4 to the pipe stress review issues list (Items 11 and 26) (Reference A14).

2.2 Radial Loads on Piping

The issue background is provided in the DAP External Source Issue Summary ESIS-P-002 (Attachment A to DAP-E-P-002). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A2 Sections 2.1.1 and 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-002 (Section 5.3) and is summarized in the piping results report (Section 3.2.3.2).

The primary concern was that pipe stresses caused by radial loads induced by zero-gap box frames, cinched U-bolts, and opposing-trunnion anchors were not properly evaluated previously by TUGCO. The SWEC resolution methodology has eliminated or modified the zero-clearance box frames. The modifications to the zero-clearance box frames are discussed in the staff evaluation provided in Section 4.1 of this appendix and were found to be acceptable.

The concern in regard to local pipe stresses caused by cinched U-bolts is discussed further in Section 11 of this appendix.

Local pipe stresses caused by stiff pipe clamps as identified in Board Notification BN-82-105A (Reference A15) have been evaluated by SWEC using Project Memorandum PM-139 "Procedure for Evaluating Pipe Stresses at Stiff Clamp Supports." The methods therein are consistent with the methods used by other nuclear design organizations to evaluate stiff pipe clamp effects. The DAP evaluation found the SWEC methods reasonable in comparison to previous work on cinched U-bolts.

For opposing trunnion anchors, the local pipe stress due to differential radial thermal expansion between the pipe and support is calculated and added to the local pipe stress at the attachment due to support restraint of pipe thermal expansion, and both local stresses are added to the piping general bending stress due to thermal expansion. The SWEC method for combining pipe stresses caused by thermal loadings is conservative and is therefore acceptable. The DAP evaluation also found the SWEC finite element analyses to evaluate radial thermal expansion at two types of anchors to be acceptable.

The staff conducted an audit to assess the adequacy of SWEC's application of the methods for opposing trunnions. (Appendix D to this supplement - Events 34 and 36.) The staff selected a support (MS-1-007-009-C72K) with an opposing double trunnion design and reviewed the local stress calculation. The staff found that the calculation was performed in accordance with CPPP-7, Paragraph 4.6.4.1, and is, thus, acceptable.

On the basis of the DAP evaluation findings and the staff review and audit discussed above, the staff concludes that the SWEC resolution methodology for addressing radial loads on piping is consistent with industry practice and is thus acceptable. In addition, the CYGNA review of this issue has resulted in its closure in Revision 4 to the pipe support review issues list (Items 1 and 38) (Reference A10).

2.3 Line Loads on Piping

The issue background is provided in DAP External Source Issue Summary ESIS-P-002 (Attachment A to DAP-E-P-002). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A2 Section 2.1.2). The DAP evaluation is provided in the Engineering Evaluation DAP-E-P-002 (Section 5.4) and is summarized in the piping results report (Section 3.2.3.2).

The concern was raised regarding the consideration of local pipe stresses caused by the pipe bearing on the pipe support (line loads). The SWEC design method as provided in CPPP-7, Attachments 4-6B and 4-6C, addresses longitudinal and circumferential bearing stresses in piping. The method was reviewed by TENERA and found to be conservative as demonstrated by a collapse load analysis performed by Robert L. Cloud Associates in Calculation No. RLCA/P142/01-86-005, "Acceptable Support Bearing Loads on Pipe Based on Plastic Analysis."

On the basis of the DAP finding that the SWEC method predicts stresses higher than actual stresses, the staff finds that the SWEC analytical methods for evaluating line loads on piping are acceptable. In addition, the CYGNA review of this issue and resolution has resulted in its closure in Revision 4 to its pipe support review issues list (Item 37) (Reference A10).

2.4 Welded Attachments on Girth Butt Welds

The issue background is provided in External Source Issue Summary ESIS-P-002 (Attachment A to DAP-E-P-002). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-002 (Section 5.2.2).

The primary concern was that welding trunnions, pads, or lugs over girth butt welds in the piping were in violation of ASME Code, Section III (Reference A16). The DAP reviewed this issue and concluded that the ASME Code, Section III does not contain any provisions that would prevent welding a pad or trunnion over a girth weld. The objection that the girth weld under the attachment cannot be inspected to ASME Code Section XI (Reference A17) requirements was addressed in the DAP evaluation by clarifying that the inservice inspection program under ASME Code Section XI does not require all welds to be inspected. The inspections are performed on a sampling basis. General industry practice does encourage providing clearances around girth welds to facilitate inservice inspection; however, this practice is not possible for all welds. All ASME Code Class 2 and 3 piping welds are required to be hydrostatically tested to ensure the integrity of the piping pressure boundary. The staff has reviewed the DAP evaluation and concurs in its discussion of code requirements and industry practice.

On the basis of the DAP evaluation, the staff finds that the concerns associated with welded attachments on piping girth welds have been adequately resolved.

2.5 Conclusions

Based on the above evaluations, the staff concludes that the concerns associated with local stresses in piping have been adequately resolved. The generic technical issue concerning local pipe stresses is, therefore, closed for CPSES.

3 LARGE FRAMED WALL-TO-WALL AND FLOOR-TO-CEILING SUPPORTS

Several concerns were raised relating to the design of large framed pipe supports at CPSES. In its December 28, 1983 Memorandum and Order (Reference A6) (p. 1443), the ASLB identified a concern regarding differential seismic displacement associated with supports spanning from wall to wall or floor to ceiling. Subsequently, the CPRT third-party (TENERA, L.P.) identified 47 related concerns from various source documents associated with these supports and corner supports. In its Engineering Evaluation DAP-E-P-003, "Large Framed Wall-to-Wall and Floor-to-Ceiling Supports," TENERA categorized these concerns into three areas and provided a detailed evaluation of the three areas of concern for wall-to-wall and floor-to-ceiling supports as well as for corner supports. The three areas of concern are (1) thermal expansion effects, (2) relative differential displacement effects, and (3) cumulative relative movements and building structure effects and are all evaluated in the issue below.

3.1 Thermal Expansion and Relative Differential Displacement Effects

The issue background is provided in External Source Issue Summary ESIS-P-003 (Attachment A to DAP-E-P-003). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A Sections 2.1 and 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-003 (Sections 5.2.1.2 and 5.3.1.2) and is summarized in the piping results report (Section 3.2.3.3).

In accordance with NF-3231.1(a) of the ASME Code, Section III, support member thermal expansion effects need not be included in the design of linear-type component supports. However, Appendix XVII-2271.3 of the ASME Code states that adequate provision shall be made for expansion and contraction appropriate to the function of the support. At CPSES, frame member supports were designed spanning from wall to wall and floor to ceiling without slip joints. These designs raised concerns regarding their ability to withstand thermal expansion effects and relative displacement effects between the building and support.

Currently at CPSES only eight supports, that span wall to wall or floor to ceiling without slip joints remain. These eight supports are all located in the service water tunnel and are identified as follows:

SW-1-011-016-F33R
SW-1-011-017-F33R
SW-1-011-018-F33R

SW-1-011-019-F33R
SW-1-011-020-F33R
SW-1-011-021-F33R
SW-1-011-022-F33R
SW-1-011-029-F33R

All eight supports have been analyzed for thermal expansion, floor live loads, and relative building seismic displacements due to both the operating basis earthquake and the safe shutdown earthquake. Differential displacement between the floor and the wall due to long-term concrete creep is evaluated for floor-to-ceiling supports only because its effect does not affect the wall-to-wall supports.

TENERA has evaluated the acceptability of the SWEC analysis methods for evaluating wall-to-wall, floor-to-ceiling, and corner supports for the cumulative relative movements and building structural effects and found them to be technically adequate.

The staff audited the application of the design criteria for wall-to-wall/floor-to-ceiling supports (Appendix D of this supplement - Event 32). The staff reviewed the calculations for all eight wall-to-wall/floor-to-ceiling supports remaining in the service water tunnel to verify the actual stresses and the compliance of the calculations to Attachment 4-19 of CPPP-7. The staff found that the stresses were within the CPP-7 allowables and are, thus, acceptable. In addition, the staff found that a special task group was formed within SWEC to perform the calculations for these eight supports because of their uniqueness and complexity. The formation of the special task group ensures consistency in the application of the CPPP-7 criteria associated with the wall-to-wall/floor-to-ceiling supports.

3.2 Conclusions

Based on the above evaluation, the staff concludes that the concerns associated with the design of wall-to-wall, floor-to-ceiling, and corner supports have been adequately resolved. The generic technical issue concerning large framed wall-to-wall and floor-to-ceiling supports including corner supports is, therefore, closed for CPSES.

4 STABILITY OF PIPE SUPPORTS

A number of concerns were raised associated with potentially unstable pipe support design at CPSES. In its Memoranda and Orders dated December 28, 1983 and February 8, 1984 (References A6 and A18), the ASLB expressed its concerns about pipe support instability. Subsequently, the CPRT third-party (TENERA, L.P.) identified 61 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-004, "Support/System Stability," TENERA categorized these concerns into five categories of potentially unstable pipe support configurations:

(1) box frames connected to struts or snubbers
(2) U-bolts with single struts or snubbers
(3) trapeze supports
(4) column/strut assemblies
(5) trunnion/strut assemblies

4.1 Box Frames Connected to Struts or Snubbers

The issue background is provided in the DAP External Source Issue Summary ESIS-P-004 (Attachment A to DAP-E-P-004). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A4 Sections 2.1.1 and 2.1.3). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-004 (Section 5.3.2.1) and is summarized in the piping results report (Section 3.2.3.4).

At CPSES, the concept of instability as exemplified by these non-standard pipe supports involved a support that could potentially shift - by rotating around or sliding along the piping - to an unqualified position. The SWEC resolution methodology involves either eliminating or modifying these potentially unstable pipe supports. The modifications to zero-clearance box frames supported by single or multiple struts or snubbers consist of removing the box frame and replacing it with a standard pipe clamp or changing it to a rigid frame with gaps. For multistrutted gang support frames, the modification results in a rigid frame with gaps. The SWEC modifications result in a support configuration typically used in the nuclear industry and are thus acceptable. In addition, the CYGNA review of this issue and resolution has resulted in its closure in Revision 4 to its pipe support review issues list (Item 6) (Reference A10).

The staff audited the implementation of the SWEC modifications to several box frames connected with struts or snubbers (Appendix D of this supplement - Events 32 and 36). The supports selected by the staff were initially identified in the August 1982 deposition of CASE witness J. Doyle (CASE Exhibits 669/669B). The staff found that supports CC-1-028-034-S33R, CC-1-028-039-S33R, and CC-1-020-001-A33K have been deleted. Multi-strutted gang frames CC-1-136-704-E63R and CC-1-041-710-A63R have been subsequently modified to a rigid frame. The modifications are in accordance with the CPPP-7, Paragraph 4.2.4 and Attachment 4.9, and are thus acceptable.

4.2 U-Bolts With Single Struts or Snubbers

The issue background is provided in the DAP External Source Issue Summary ESIS-P-004 (Attachment A to DAP-E-P-004). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A4 Section 2.1.2 and Subappendix A11 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-004 (Section 5.3.2.2) and is summarized in the piping results report (Section 3.2.3.4).

Many concerns were identified in the use of U-bolts with single struts and snubbers. All cinched and uncinched U-bolts on single struts or snubbers have been eliminated by SWEC in safety-related piping systems at CPSES Units 1 and 2. Therefore, the concerns are not applicable to CPSES and the SWEC resolution acceptability resolves the U-bolt concerns for CPSES.

The staff audited the implementation of the SWEC resolution for several supports using U-bolts with single struts or snubbers previously identified in CASE Exhibits 669/669B. Supports MS-1-003-013-C72K, MS-1-001-002-S72R, and MS-1-004-005-S72K have been eliminated. For support CC-1-019-004-A33R, the U-bolt has been replaced with a stiff clamp. Support MS-1-001-005-S72R has been modified to a integrally welded piping stanchion. Support CC-1-257-005-C53R has been modified by replacing the U-bolt with a standard pipe clamp. The SWEC modifications are in accordance with CPPP-7 Paragraph 4.2.4 and Attachment 4-9, and are thus acceptable.

4.3 Trapeze Supports

The issue background is provided in the DAP External Source Issue Summary ESIS-P-004 (Attachment A to DAP-E-P-004). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A4 Section 2.1.4). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-004 (Section 5.3.2.3) and is summarized in the piping results report (Section 3.2.3.4).

Many concerns were raised in use of U-bolts in trapeze type pipe supports. All trapeze supports with U-bolts were eliminated by SWEC or are being modified. The modifications include replacing the support with a single strut/snubber and standard pipe clamp or redesigning the support as a rigid frame consistent with standard industry practice. A third option involves modifying the support to one of three redesigns. The first redesign involves replacing the U-bolt with a strap and adding shear lugs to the pipe. The second redesign involves replacing the U-bolt with a strap and adding clamp anchors to the pipe. The third redesign involves replacing the U-bolt with a strap and adding a pair of stabilizing struts parallel to the pipe centerline normal to the trapeze crosspiece. The staff finds the three redesign options adequately preclude support rotation around or movement along the pipe axis and thus are stable configurations.

The staff audited the implementation of the SWEC resolutions for several trapeze supports with U-bolts previously identified by CASE in Exhibits 669/669B. Supports CC-1-234-017-C53R, RH-1-008-008-S22K, and CC-1-008-019-A33K have been deleted. Support CS-1-239-007-A42R has been redesigned to a strap with shear lugs. Support CT-1-008-010-S22K has been modified to a rigid frame. Support MS-1-150-047-C52K has been modified to a single snubber with standard pipe clamp. The SWEC modifications are in accordance with CPPP-7, Attachment 4-8, and are thus acceptable.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 6) (Reference A10).

4.4 Column/Strut Assemblies

The issue background is provided in DAP External Source Issue Summary ESIS-P-004 (Attachment A to DAP-E-P-004). The SWEC resolution is provided in the piping project status reports (Subappendix A4 Section 2.1.5). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-004 (Section 5.3.2.4) and is summarized in the piping results report (Section 3.2.3.4).

The primary concern was that long struts at CPSES that were susceptible to column buckling were modified to a rigid column (e.g., tube steel) and shorter strut. However, for the modification, the buckling of the rigid column was analyzed independent of the strut. The SWEC resolution methodology evaluates column buckling as a function of the ratio of the strut to the column length as documented in SWEC Calculation GENX-019, "Column Strut Assemblies." TENERA reviewed this calculation by performing an alternative calculation as documented in DAP-C-P-002, "Alternate Calculation: Calc 019 Review," and the SWEC calculation was found to be conservative.

On the basis of the DAP review of the SWEC methodology, the staff concludes that the SWEC methodology for evaluating column/strut assemblies is acceptable.

4.5 Trunnion/Strut Assemblies

The issue background is provided in DAP External Source Issue Summary ESIS-P-004 (Attachment A to DAP-E-P-004). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A12 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-004 (Section 5.3.2.5) and is summarized in the piping results report (Section 3.2.3.4).

CASE identified a concern regarding the potential instability of a strut or snubber on a single trunnion welded to the pipe. The eccentric line of action for a strut or snubber on a single trunnion is modeled by SWEC in the pipe stress analysis. Any potential instabilities resulting from this eccentric line of action is thus analytically predicted in the piping computer program. The staff finds that the SWEC resolution acceptably resolves this concern.

4.6 Conclusions

Based on the above evaluations, the staff concludes that the concerns associated with pipe support instability have been adequately resolved. The generic technical issue concerning stability of pipe supports is therefore closed for CPSES.

5 GENERIC STIFFNESS OF PIPE SUPPORTS

Concerns were raised that the pipe support stiffness values were not adequately considered in the piping stress analyses. In its December 28, 1983 Memorandum and Order (Reference A6) (p. 1443), the ASLB expressed its concern regarding the use of generic stiffness values at CPSES. Subsequently, the CPRT third-party (TENERA, L.P.) identified 49 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-005, "Generic Stiffness," TENERA categorized these concerns into two areas:

(1) use of generic stiffness values
(2) inclusion of support component flexibility effects

5.1 Actual Versus Generic Stiffness Values

The issue background is provided in DAP External Source Issue Summary ESIS-P-005 (Attachment A to DAP-E-P-005). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A5 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-005 (Section 5.2) and is summarized in the piping results report (Section 3.2.3.5).

ASME Code, Section III (Reference A16), does not provide specific requirements to be used in the modelling of support stiffness in piping analyses. The ASME Code states in both NB-3672.7(d) and NC/ND-3673.2(d), "where simplifying assumptions are used in calculations... the likelihood of underestimation of forces, moments, and stresses... shall be evaluated." In this regard, there is no provision in the ASME Code that would prohibit the use of generic pipe support stiffnesses, provided the actual support stiffness and flexibility do not significantly affect the validity of the piping analysis results.

In its resolution methodology, SWEC has developed a set of generic stiffness values for pipe supports to be used in the piping stress analysis. These stiffnesses were developed to more accurately reflect the actual stiffnesses of the pipe support designs found at CPSES. CPPP-7, Paragraph 3.10.8, provides the guidelines for stiffness representations of pipe supports. The stiffness values of pipe supports commonly found at CPSES are tabulated in Attachment 4-18 of CPPP-7.

The DAP evaluation of the SWEC generic stiffness approach reviewed the acceptance criteria used by SWEC - which permitted a 15 percent increase in responses due to actual stiffness compared to generic stiffnesses - in conjunction with two SWEC documents: (1) SWEC report, "Generic Pipe Support Stiffness Values for Piping Analysis," and (2) SWEC Calculation GENX-117 "Verification of the Generic Stiffness Criteria in the Analysis of Piping Systems," which summarizes the sample verification results from five comparison piping stress analyses. The DAP concluded that the two SWEC documents reasonably justify the basis and verification of the generic stiffness approach for CPSES.

The staff audited the adequacy of the SWEC resolution implementation (Appendix D to this supplement - Events 32, 34,36). The staff reviewed four supports (CT-1-124-418-C72R, MS-1-001-005-C72K, AF-1-001-035-Y33R, and CT-1-013-012-S32R) to verify the appropriateness of the support stiffness calculated for each support configuration. The staff also selected three supports (CC-1-107-008-E23R, MS-1-001-005-C72K, and CC-2-011-001-A63R) to verify that the calculated support stiffnesses were used properly in the corresponding piping stress analyses. The staff found the calculations to be adequate.

In addition to the above, the staff reviewed the circumstances when actual pipe support stiffnesses would be used in lieu of the generic stiffnesses as specified in CPPP-7. This led to a staff review of SWEC Project Memorandum (PM)-187 (Appendix E of this supplement) which controls when actual stiffnesses are to be used and specifies that actual stiffnesses will be used during final reconciliation of the as-built piping conditions. The staff finds that PM-187 ensures that the stiffness values used at CPSES reflect actual support configurations.

The staff reviewed a CPRT third-party finding related to the improper use of generic stiffnesses by SWEC which has been subsequently transferred to the TU Electric Technical Audit Program. The CPRT found examples where pipe support stiffnesses used in piping analyses were not accordance with CPPP-7 guidelines. On the basis of its review of SWEC calculations, the staff concluded that the CPRT finding was the result of isolated analyst errors and that, overall, the CPPP-7 guidelines for generic stiffnesses are being properly implemented.

On the basis of the DAP conclusions on the SWEC validation of the generic approach and values used for pipe support stiffnesses, and the staff review and audits of the approach implementation, the staff concludes that the generic stiffness methodology used by SWEC for the CPSES piping design validation establishes representative stiffness values for the pipe supports at CPSES, allows the piping system loads to be adequately predicted, and is, thus, acceptable.

The CYGNA review of this issue and resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 13) (Reference A10).

5.2 Local Flexibility Effects

The issue background is provided in DAP External Source Issue Summary ESIS-P-005 (Attachment A to DAP-E-P-005). The SWEC resolution methodology is provided in CPPP-7, Paragraph 4.3.2.2 and Attachment 4-18. The DAP evaluation is provided in Engineering Evaluation DAP-E-P-005 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.5).

The primary concern was that local flexibilities of composite members in pipe supports at CPSES may preclude the support from performing its function (i.e., restrain the piping from dynamic loadings). The local flexibility of composite members (e.g., plates, tube steel walls, webs in wide flanges) is not addressed in the SWEC generic stiffness approach because of the numerous variations of parameters involved. The SWEC resolution to addressing local flexibilities is to evaluate each support stiffness by inspection or comparison to similar designs with known stiffnesses, simple hand calculations, or detailed analysis. The method is determined by the analyst performing the calculation and is checked by independent reviewers.

On the basis of its review, the staff finds that the SWEC review of each support provides assurance of the appropriateness of the stiffness values to be used, and is, thus, acceptable.

5.3 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with pipe support generic stiffness and local flexibilities have been adequately resolved. The generic technical issue concerning generic stiffness is, therefore, closed for CPSES.

6 UNCINCHED U-BOLTS ACTING AS TWO-WAY RESTRAINTS

Several concerns were raised relating to the use of U-bolts as rigid pipe support members. The CPRT third-party (TENERA, L.P.) review of this issue identified 22 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-006 "U-Bolts Acting As Two-Way Restraints," TENERA summarized these concerns as follows:

(1) Pipe stresses and support loads are not accurately predicted because of the unanalyzed (lateral) restraint caused by the U-bolt,

(2) U-bolts are not adequately designed for actual loads.

6.1 Modeling of U-Bolts in Piping Analysis

The issue background is provided in DAP External Source Issue Summary ESIS-P-006 (Attachment A to DAP-E-P-006). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A6 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-006 (Section 5.3) and is summarized in the piping results report (Section 3.2.3.6).

The primary concern was that in some cases uncinched U-bolts attached to rigid frames were modeled and analyzed as one-way restraints (i.e., restraining the pipe in the direction parallel to the axis of the U-bolt legs) but will actually behave as a two-way restraint (i.e., also providing a lateral restraint perpendicular to and in the plane of the U-bolt legs). The SWEC resolution methodology is to model all uncinched U-bolts on a rigid support as two-way restraints. SWEC has eliminated all uncinched U-bolts on rigid frames for piping 8 inches (nominal pipe size) and greater. The SWEC resolution ensures that all uncinched U-bolts on rigid frames are properly modeled and analyzed in a consistent manner and is, thus, acceptable.

The staff performed an audit of the U-bolt modeling as a part of our implementation review (Appendix D to this supplement - Events 32 and 34). The staff reviewed the modeling of supports CC-1-007-040-A63R and CC-X-025-005-A43R which utilized U-bolts on a rigid support. The staff found the U-bolts to be modeled as a two-way restraint in accordance with CPPP-7 and are, thus, acceptable.

6.2 Qualification of U-Bolts

The issue background is provided in DAP External Source Issue Summary ESIS-P-006 (Attachment A to DAP-E-P-006). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A6 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-006 (Attachment C) and is summarized in the piping results report (Section 3.2.3.6).

A related concern was that U-bolts were not properly qualified to restrain the pipe in a lateral direction (i.e., perpendicular to and in the plane of the U-bolt legs) when U-bolts were modeled as two-way restraints. The SWEC resolution methodology involved developing stiffness values and allowable U-bolt load ratings based on STRUDL analyses. The SWEC U-bolt qualification was reviewed by TENERA in its review of SWEC Calculation No. 15454-NZ(c)-GENX-005A, "Qualification of U-Bolts For Use As 2-Way Restraints For Pipe Supports," and was found to be in compliance with ASME Code, Section III (Reference A19), paragraph NF-3330 which permits design by analysis.

On the basis of the DAP conclusions, the staff finds that the qualification of U-bolts at CPSES is in accordance with ASME Code, Section III, and is, thus, acceptable.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 43) (Reference A10).

6.3 Conclusion

Based on the evaluations discussed above, the staff concludes that the concerns associated with U-bolt acting as two-way restraints have been adequately resolved. The generic technical issue concerning uncinched U-bolts acting as two-way restraints is, therefore, closed for CPSES.

7 FRICTION FORCES

Concerns were raised that friction effects between the pipe and pipe supports were not adequately evaluated. The CPRT third-party (TENERA, L.P.) review of this issue identified 27 related concerns from various source documents. In its Engineering Evaluation DAP-E-007, "Friction Forces," TENERA summarized these concerns as follows:

(1) The coefficient of friction was incorrect.

(2) Friction was neglected for pipe movements less than 1/16 inch.

(3) The reduction in friction loads based on support stiffness was improper.

(4) Friction was not evaluated for dynamic loads.

The above concerns are discussed in the issue below.

7.1 Friction Considerations in Piping Analysis

The issue background is provided in DAP External Sources Issue Summary ESIS-P-007 (Attachment A to DAP-E-P-007). The SWEC resolution methodology is provided in the piping project status reports (Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-007 (Section 5.0) and is summarized in the piping results report (Section 3.2.3.7).

The primary concerns relating to the consideration of friction forces in pipe support designs at CPSES included the use of an appropriate coefficient of friction and a reduction or no evaluation of friction under certain cases. The SWEC resolution methodology involves applying a coefficient of friction of 0.3 to evaluate friction loads for static loadings at all sliding surfaces regardless of the pipe displacement magnitude. The calculated friction force is not reduced on the basis of support stiffness. The use of a coefficient of friction of 0.3 is consistent with industry practice.

For dynamic loadings, industry practice generally assumes that friction effects are negligible. Friction forces under sliding conditions are by nature lower than static friction forces. Furthermore, under vibratory conditions of seismic and dynamic transient conditions, the pipe tends to lose contact with the surface and any friction forces developed are thus relieved.

Because of the inclusion of friction forces in the pipe support calculations, the staff finds the SWEC methodology to be acceptable.

The staff audited the inclusion of friction forces in the pipe support calculation as a part of its implementation review (Appendix D to this supplement - Event 34). The staff's review of the calculation for support CC-1-028-044-S33R found that the friction forces were calculated in accordance with CPPP-7 and are, thus, acceptable.

In addition, the CYGNA review of this issue and resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 29) (Reference A10).

7.2 Conclusion

On the basis of its review and audit of this issue resolution, the staff concludes that the concerns associated with the inclusion of friction forces in pipe support calculations have been adequately resolved. The generic technical issue concerning friction forces is, therefore, closed for CPSES.

8 AWS VERSUS ASME WELD DESIGN

CASE contended that many provisions from American Welding Society Code AWS D1.1 Code (Reference A20) were applicable to the design of pipe supports at CPSES. In its December 28, 1983 Memorandum and Order (Reference A6) (p. 1435), the ASLB questioned the extent to which certain weld design requirements of AWS D1.1 that were not addressed in the ASME Code, Section III (Reference A19) were applicable to pipe support design. Subsequently, the CPRT third-party (TENERA, L.P.) identified 40 related concerns from various source documents associated with the applicability of AWS D1.1 to CPSES pipe supports. In its Engineering Evaluation DAP-E-P-008 "AWS versus ASME," TENERA listed 10 specific areas identified by CASE as follows:

(1) pre-heat requirements for welds on plates over 3/4 inch thick
(2) drag angle and work angles
(3) Beta factor for tube-to-tube welds
(4) multiplication factor and reduction factor for skewed "T" weld joints
(5) limitations on angularity for skewed "T" joints
(6) calculations for punching shear on step tube joints
(7) lap joint requirements
(8) design of tube-to-tube joint with Beta equal to 1.0
(9) calculation for effective throat of flare bevel welds
(10) limitations on weld sizes relative to plate thicknesses

8.1 Pre-heat Requirements for Welds on Plates Over 3/4 Inch Thick

The issue background is provided in the DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A27 Section 2.8). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-008 (Section 5.2) and is summarized in the piping results report (Section 3.2.3.8).

This issue is related to the welding procedures used at CPSES and is not directly associated with the TU Electric Corrective Action Program for design. Nonetheless, the concerns related to welding procedures at CPSES have been addressed in an ASLB Memorandum and Order dated June 29, 1984 (LBP-84-25, 19 NRC 1589) (Reference A21). Therein, the ASLB concluded, "Applicants compliance with ASME Code has been adequate to assure the safety of its welding procedures with respect to welding parameters in issue." Thus, the staff finds this issue closed.

8.2 Drag Angles and Work Angles

The issue background is provided in the DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A27 Section 2.8). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-008 (Section 5.2) and is summarized in the piping results report (Section 3.2.3.8).

The staff evaluation of this issue is the same as that in Section 8.1.

8.3 Beta Factor for Tube-to-Tube Welds

The issue background is provided in the DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A21 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-021, "Local Stress in Pipe Support Members" (Section 5.4.3) and is summarized in the piping results report (Section 3.2.3.20).

The concern was that the previous TUGCO design procedures did not consider the effects of tube steel diameter ratios (Beta factor) for the evaluation of tube-to-tube welds. SWEC design criteria in CPPP-7, Attachment 4-13, Paragraphs 4.2 and 4.4, explicitly include the provisions from AWS D1.1 for this evaluation. Thus, the staff finds this concern to be adequately resolved.

8.4 Multiplication Factor and Reduction Factor for Skewed T-Joint Welds

The issue background is provided in the DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A8 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-027, "Welding" (Section 5.6.2) and is summarized in the piping results report (Section 3.2.3.25).

The concern was that the previous TUGCO design procedures did not consider multiplication and reduction factors for skewed T-joint welds. SWEC design criteria in CPPP-7, Attachment 4-2 (Table 2.6.2), contain the multiplication and reduction factors for skewed T-joint welds. Thus, the staff finds this concern to be adequately resolved.

8.5 Limitations on Angularity for Skewed T-Joints

The issue background is provided in DAP External Source Issue Summary ESIS-E-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A8 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-027, "Welding" (Section 5.6.2) and is summarized in the piping results report (Section 3.2.3.25).

The concern was that the previous TUGCO design procedures did not consider the angularity limits of skewed T-joint welds. SWEC design criteria in CPPP-7, Attachment 4-2, Paragraph 2.6, include loss factors for welds at angles between 60 and 30 degrees and a weld-length reduction for angles between 135 and 150 degrees. For weld angles greater than 150 degrees or less than 30 degrees, SWEC excludes the weld from the analysis and thus no credit is taken for the weld strength. The staff finds the SWEC design criteria consistent with AWS D1.1 provisions and, therefore, the concern has been adequately resolved.

8.6 Calculations for Punching Shear on Step Tube Joints

The issue background is provided in DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A21 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-021 (Section 5.4.3) and is summarized in the piping results report (Section 3.2.3.20).

The concern was that the previous TUGCO design procedures did not consider the punching shear effects of stepped tube steel connections. SWEC design crtieria in CPPP-7, Attachment 4-13, Paragraphs 4.2, 4.3, and 4.4 contain explicit guidelines for evaluating local stresses in pipe supports including punching shear effects. The staff finds the SWEC design criteria consistent with AWS D1.1 provisions and, therefore, this concern is resolved.

8.7 Lap Joint Requirements

The issue background is provided in DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A27 Section 2.8). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-008 (Section 5.2) and is summarized in the piping results report (Section 3.2.3.8).

The staff evaluation of this issue is the same as that in Section 8.1.

8.8 Design of Tube-to-Tube Joints with Beta Equal to 1.0

The issue background is provided in DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A21 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-021, "Local Stresses in Pipe Support Members," (Section 5.4.3) and is summarized in the piping results report (Section 3.2.3.20).

The concern was that the previous TUGCO design procedures did not contain adequate guidelines for evaluating tube-to-tube joints when the tubes are of equal sizes (Beta equal to 1.0). The SWEC design criteria CPPP-7 Attachment 4-13 (Sections 4.2 and 4.4) contain explicit guidelines for evaluating the tube steel connections when Beta equals 1.0. The staff finds the SWEC design criteria consistent with AWS D1.1 provisions and they are, thus, acceptable.

8.9 Calculation for Effective Throat of Flare Bevel Welds

The issue background is provided in DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A10 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-008 (Section 5.3) and is summarized in the piping results report (Sections 3.2.3.8 and 3.2.3.10).

Several concerns were raised regarding the appropriate effective throat to be used for flare bevel welds in tube steel connections. Based on a SWEC survey documented in SWEC Report No. 15454-N(c)-004, "Survey of Structural Tube Steel Dimensions to Verify the Effective Throat of Flare Bevel Welds," March 1987, the SWEC methodology uses an effective throat equal to t-1/16 inch for all tube steel sizes except for TS 2x2 where an effective throat equal to t-1/8 inch is used. AWS D1.1 specifies an effective throat equal to t, the thickness of the tube steel wall. The SWEC resolution is based on actual weld sizes which can be achieved at CPSES and is more conservative than AWS D1.1 provisions and is, thus, acceptable.

The staff conducted an audit to verify the adequacy of the design criteria application (Appendix D to this supplement - Event 36). The staff reviewed three support calculation packages (FW-1-098-007-C62R, CC-1-057-006-A33R, and CC-1-048-009-A33R) to confirm that an appropriate throat dimension was used for flare bevel weld designs. The staff review confirmed that the throat dimensions used for flare bevel welds were in accordance with CPPP-7, Attachment 4-2, and Project Memorandum PM-140 and are, thus, acceptable.

8.10 Limitations on Weld Sizes Relative to Plate Thickness

The issue background is provided in DAP External Source Issue Summary ESIS-P-008 (Attachment A to DAP-E-P-008). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A27 Section 2.1). The DAP evaluation is provided in the Engineering Evaluation DAP-E-P-027, "Welding" (Section 5.4.2) and is summarized in the piping results report (Section 3.2.3.25).

The concern was that the previous TUGCO design procedures did not contain adequate guidelines for limiting the base metal thickness for various fillet weld sizes for prequalified joints. The SWEC design criteria in CPPP-7 incorporate ASME Code Case N-413, "Minimum Size of Fillet Welds for Subsection NF Linear Type Supports, Section III, Division 1," (Reference A22) which removed the minimum fillet weld size requirements based on the ASME requirements that all welded construction joints be qualified in accordance with Section IX of the ASME Code. The NRC staff has accepted the use of the ASME Code Case in Regulatory Guide 1.84, "Design and Fabrication Code Case Acceptability, ASME Section III, Division 1," Revision 24 dated June 1986 (Reference A23). Thus, the staff finds the concern in regard to minimum fillet weld sizes to be resolved.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 21) (Reference A10).

8.11 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with differences in weld requirements between AWS D1.1 and the ASME Code have been adequately resolved. The generic technical issue concerning AWS versus ASME is therefore closed for CPSES.

9 A500 GRADE B TUBE STEEL

Concerns were raised regarding the use of American Society for Testing and Materials (ASTM) A500 Grade B material for pipe supports at CPSES. In its October 6, 1983 Memorandum and Order (Reference A24), the ASLB identified a need to demonstrate the safety margin in pipe supports in which A500 Grade B tube steel was used. Subsequently, the CPRT third-party (TENERA, L.P.) identified seven related concerns from various source documents. In its

Engineering Evaluation DAP-E-P-009 "A500 Grade B Tube Steel," TENERA summarized these concerns into two primary aspects:

(1) material yield strength
(2) material ductility

9.1 Material Properties for A500 Grade B Tube Steel

The issue background is provided in DAP External Source Issue Summary ESIS-P-009 (Attachment A to DAP-E-P-009). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A2 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-009 (Section 5.0) and is summarized in the piping results report (Section 3.2.3.9).

The primary issue as discussed in the ASLB hearings concerned the appropriate yield strength to be used in the design of pipe supports utilizing A500 Grade B tube steel. ASME Code Case N-71-9 (Reference A25) specified a yield strength of 42 ksi and was used initially in the CPSES pipe support design. Subsequently, the yield strength was revised to 36 ksi in ASME Code Case N-71-10. CASE contended that since the yield strength was decreased to 36 ksi, the CPSES pipe supports may be inadequate using a 42 ksi yield strength. This resulted in the ASLB concern that the safety margins be demonstrated in pipe supports using A500 Grade B tube steel.

The SWEC resolution methodology is to design validate all ASME Code Class 1, 2, and 3 pipe supports that utilized A500 Grade B tube steel by using a yield strength of 36 ksi. However, certain pipe supports in which stresses exceeded the allowables based on a yield strength of 36 ksi were design validated to allowables based on a 42 ksi yield strength.

The use of a 36 ksi yield strength at 100°F for A500 Grade B tube steel (as specified in Code Cases N-71-10 through N-71-14) provided more stringent requirements believed to be justified by the staff until the currently available test data established that there was no significant reduction of the yield strength of the cold-formed material in the heat-affected zone of weldments. As a result of these test data, the yield strength was revised by the ASME Code Committee in Code Case N-71-15 and increased from 36 ksi to 46 ksi.

Although the NRC staff at this time has not yet finalized its review of the acceptability of using an increased yield strength of 46 ksi for A500 Grade B tube steel, (as specified in Code Case N-71-15), the staff finds that the use of a 42 ksi yield strength at 100°F (as previously specified in Code Case N-71-9 and approved by the staff) can be implemented without undue risk to the public health and safety and is, thus, acceptable. The staff acceptance of 42 ksi for the design of pipe supports at CPSES using A500 Grade B tube steel was provided in a letter from C. Grimes to W. Counsil, dated January 15, 1988 (Reference A26).

The coldforming process used in manufacturing A500 tube steel increases material yield strength but reduces its ductility. Ductility is related to the amount of plastic deformation a material can undergo before it fails. A related concern was that A500 Grade B material may not be adequate for dynamic application (i.e., seismic pipe supports). NRC Regulatory Guide 1.85, "Materials Code Case Acceptability, ASME Section III, Division 1," Revision 24

(Reference A27), approves for use ASME Code Case N-71-13. A500 Grade B material is included in the Code Case. Regulatory Guide 1.85 does not place any limitations or restrictions in the use of A500 material and, thus, its use is acceptable for seismic pipe supports in nuclear facilities.

9.2 Conclusion

Based on the above evaluation, the staff concludes that the concerns associated with A500 Grade B tube steel have been adequately resolved. The generic technical issue concerning A500 Grade B tube steel is, therefore, closed for CPSES.

10 TUBE STEEL SECTION PROPERTIES

Concerns were raised that the section properties used in the design of pipe supports using tube steel were inappropriate. The CPRT third-party (TENERA, L.P.) identified 28 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-010 "Section Properties," TENERA summarized these concerns into two primary aspects:

(1) variations in tube steel section properties
(2) effect of bolt holes on section properties

10.1 Variations in Tube Steel Section Properties

The issue background is provided in DAP External Source Issue Summary ESIS-P-010 (Attachment A to DAP-E-P-010). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A10 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-010 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.10).

Although the CPSES safety-related pipe supports are designed to ASME Code, Section III, Subsection NF (Reference A19), the ASME Code does not specify explicit section properties for tube steel therein. Common practice in the nuclear industry is to use the section properties specified in the American Institute of Steel Construction (AISC) Manual of Steel Construction (AISC Code) (Reference A28). Other catalogs and manuals containing tube steel section properties or rules for cold-formed steel design are also acceptable sources (e.g., AISI Cold-Formed Steel Design Manual) (Reference A29).

At CPSES, the pipe supports previously designed by TUGCO used various sources of tube steel section properties during different time periods. These sources (and the time periods used) were the AISC Code, 7th Edition (Reference A28) (before January 1981); the 1974 Welded Steel Tube Institute's "Manual of Cold Formed Welded Structural Steel Tubing" (Reference A30) (January 1981 to January 1982); and the AISC Code 8th Edition (Reference A31) (January 1982 to July 1985). Section properties from these various sources varied by as much as 25 percent. The variations resulted primarily from the tube steel (with square cross-section) corner radius used to calculate the section properties. The AISC Code, 7th Edition, assumes a 3t corner radius; the AISC Code, 8th Edition (Reference A31), assumes a 2t corner radius; and the WSTI manual 1st Edition assumes a 1t corner radius. Concerns were raised that the inconsistent use of section property values was improper and may lead to inappropriate values being used for tube steel manufactured during the different time periods.

The SWEC resolution methodology involved conducting a survey of the American Institute of Steel Construction and Welded Steel Tube Institute to determine what differences existed in the manufacturing of tube steel between 1974 and 1984. SWEC determined that the standard milling tolerances did not change during the time structural tube shapes were procured for CPSES, and that the product delivered during this time period conforms to the AISC Code, 8th Edition. SWEC surveyed tube steel corner dimensions for installed pipe supports at CPSES and confirmed that the tube steel at CPSES have a nominal 2t corner radius. SWEC design criteria in CPPP-7 use the section properties from the AISC Code, 8th Edition, for the design validation of all ASME Code Class 1, 2, and 3 pipe supports. The DAP evaluation confirmed that the standard mill practice did not change between the 7th and 8th Editions of the AISC Code.

On the basis of its review of the SWEC resolution methodology, the staff finds that the tube steel section properties as specified in the AISC Code, 8th Edition, are appropriate for use in the design of pipe supports at CPSES and are, thus, acceptable.

The staff conducted an audit to verify the adequacy of the design criteria application (Appendix D to this supplement - Event 36). The staff found that the tube steel section properties are compiled in and then extracted from Table HSSTUBE of the STRUDL computer program. The data in this table were verified to be in accordance with the 8th Edition of the AISC Code, and are, thus, acceptable.

10.2 Effect of Bolt Holes on Section Properties

The issue background is provided in DAP External Source Issue Summary ESIS-P-010 (Attachment A to DAP-E-P-010). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A10 Section 2.3). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-010 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.10).

The concern was that reductions in member section properties for holes drilled in the tube steel were not considered for pipe supports using Richmond inserts and tube steel. The SWEC methodology as stated in CPPP-7, Paragraph 4.3.2.1, provides no reduction in section properties for holes drilled through critical bending sections, except in cases where the reduction of area by such holes in a particular side of the member exceeds 15 percent of the gross area of that side. Only the excess above 15 percent is deducted. The SWEC methodology is in accordance with ASME Code Section III (Reference A32) paragraph XVII-2231 and is, thus, acceptable.

10.3 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with tube steel section properties have been adequately resolved. The generic technical issue concerning tube steel section properties is, therefore, closed for CPSES.

11 U-BOLT CINCHING

Several concerns were raised that stresses caused by tightening the nuts on the threaded end of U-bolts (U-bolt cinching) were detrimental to the pipe and U-bolt. In its December 28, 1983 Memorandum and Order (Reference A6) (p.

1430), the ASLB expressed its concerns about several unanswered questions related to cinched U-bolts. The CPRT third-party (TENERA, L.P.) identified 50 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-011 "U-bolt Cinching," TENERA categorized these concerns into two primary areas:

(1) cinching of standard U-bolts
(2) stiff pipe clamps

11.1 Cinching of Standard U-bolts

The issue background is provided in DAP External Source Issue Summary ESIS-P-011 (Attachment A to DAP-E-P-011). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A11 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-011 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.11).

There were several issues related to U-bolt cinching including the stability of the cinched U-bolt supports, local stresses induced in the pipe, forces and stresses in the U-bolt and crosspiece (including local stresses, various loads to be considered such as preload, thermal expansion, pressure, and pipe reaction), relaxation characteristics of SA-36 material, use of SA-36 and A307 material for cinched U-bolts, and fatigue considerations of SA-36 U-bolt material that were subsequently identified by various other external sources. SWEC's resolution of the U-bolt cinching issues was to remove all cinched U-bolts and to replace the U-bolts with some other support component as specified in Paragraph 4.2.5.1 of CPPP-7.

Because of the elimination of all cinched U-bolts in safety-related pipe support designs at CPSES, the staff finds that the issues associated with cinched U-bolts are no longer applicable to the structural integrity of the CPSES pipe supports and the resolution is thus acceptable.

The staff audits (Appendix D of this supplement - Events 32 and 36) focused on the application of the CPPP-7 guidelines to replace cinched U-bolts. The design drawings for two supports (CT-1-124-418-C72R and CC-1-048-009-A33R) were selected in the audit and both support designs were found to have been modified from a cinched U-bolt to a standard pipe clamp type. Other U-bolt supports that have been modified by SWEC were audited by the staff and are discussed in Sections 4.2 and 4.3 of this appendix. One support modification (CT-1-124-418-C72R) was further verified by the staff in a plant walkdown (Appendix D of this supplement - Event 35) to ensure that the installed design was in accordance with the modified design drawings. The staff found the U-bolt supports had been modified in accordance with CPPP-7 guidelines and are, thus, acceptable.

11.2 Stiff Pipe Clamps

The issue background is provided in DAP External Source Issue Summary ESIS-P-011 (Attachment A to DAP-E-P-011). The SWEC resolution methodology is provided in Project Memorandum PM-139 "Procedure for Evaluating Pipe Stresses at Stiff Clamp Supports." The DAP evaluation is provided in Engineering Evaluation DAP-E-P-011 (Section 5.3.2) and is summarized in the piping results report (Sections 3.2.3.2 and 3.2.3.11).

The staff evaluation is provided in Section 2.2 of this appendix.

11.3 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with U-bolt cinching have been adequately resolved. The generic technical issue concerning U-bolt cinching is, therefore, closed for CPSES.

12 AXIAL/ROTATIONAL RESTRAINTS

A number of concerns were raised regarding pipe support designs which could potentially restrain the piping in an axial or torsional direction (axial/rotational restraints). These concerns related to the following three types of axial and/or trapeze-type supports which utilize welded lugs or trunnions to transfer loads to frames or component standard supports (i.e., snubbers or struts):

(1) single or double integrally welded trunnions with dual component standard supports

(2) non-trunnion type supports

- Trapeze supports with U-bolts

- Riser clamp and integrally welded lugs with dual component standard supports

- Riser clamp and integrally welded lugs with single eccentric component standard support

(3) frame with integrally welded lugs type supports.

TENERA identified 35 separate issues related to these restraints during their review of external source documents. These issues were categorized by TENERA in Engineering Evaluation DAP-E-P-012 "Axial/Rotational Restraints," into 6 broad areas of concern.

(1) component support design load for dual supports
(2) stress and load allowables
(3) lug load dstribution
(4) cinched U-bolts on trapeze supports
(5) load point application on frames from lugs
(6) eccentricity of single/double trunnion supports

The above six concerns are discussed in the seven issues below which have been reformatted for clarity.

12.1 Rotational Restraint Effects in Piping Systems

This issue is described in DAP External Source Issue Summary ESIS-P-012 (Section 1.6). The SWEC resolution methodology is provided in the Piping project status reports (Section 2.1 of Subappendix A12). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-012 (Section 5.7.2) and is summarized in the piping results report (Sections 3.2.3.12).

The primary concern was that support designs using dual struts/snubbers were not adequately modeled in the piping analyses and could restrain the rotation of the pipe and cause local overstress at the welded attachment. The SWEC resolution methodology requires that the rotational restraints due to (1) integrally welded trunnion type supports with dual component standard supports and (2) the eccentricities of riser clamp and single trunnion both with single component standard supports be modeled in the piping stress analyses. In addition, nonintegral (i.e., riser clamp with lugs) axial type supports with dual component standard supports are required to be modeled as translational restraints at the pipe centerline or modified and modeled as eccentric supports with a single component standard support. Procedures for determining the appropriate alternative are based on criteria for the stiffnesses of the two legs of the dual component standard type support.

Based on the modeling procedures for integrally welded trunnion type supports with dual component supports, and riser clamp and single trunnion with a single eccentric component standard support, the staff finds that rotational restraint effects have been adequately included in the piping and pipe support design methodology. The procedures provide assurance that for piping systems containing such supports, the response of and stresses in the piping systems and loads in the component standard supports under the applicable service loading conditions will be reasonably predicted. However, the staff finds that piping system stresses and pipe support loads may be underpredicted in long straight runs of pipe with a series of adjacent integrally welded dual trunnion type supports (or single stanchion trapeze type supports) modeled with moment restraining capability. The SWEC modeling procedure will be conservative for supports at the ends of the series but will be unconservative at supports interior to the series. The staff finds that the SWEC resolution methodology is acceptable for consideration of rotational restraint effects with the above noted limitation. The staff requires that any such piping and pipe support configuration identified in the CPSES design validation be subject to a case-by-case evaluation and the resolution be provided to the staff for its review.

Based on the modeling and modification procedures and stiffness criteria for nonintegral (riser clamp with lugs) axial type supports with dual component supports, the staff finds that rotational restraint effects have also been adequately included in the piping and pipe support design methodology. The stiffness criteria for the two legs of these supports provide an acceptable basis for identifying supports with rotational restraining capability. These criteria were also reviewed by TENERA and found to be acceptable. Supports of this type with negligible rotational restraining capability are modeled as translational restraints at the pipe centerline. As previously noted, the staff finds a limitation in the SWEC methodology with underpredictions of piping stresses and pipe support loads in long straight runs of piping with axial supports. The staff finds that the SWEC resolution methodology is acceptable for the consideration of rotational effects in these types of supports subject to confirmation that the preceding described piping and pipe support configuration be identified to the staff for final resolution.

12.2 Rotational Restraint Effects on Component Standard Design Loads

This issue is described in DAP External Source Issue Summary ESIS-P-012 (Section 1.6). The SWEC resolution methodology is provided in the piping project status reports (Sections 2.1 and 2.2 of Subappendix A12). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-012 (Sections 5.2.2 and 5.7.2) and is summarized in the piping results report (Section 3.2.3.12).

The primary concern was that support designs using dual struts or snubbers could restrain the piping system and cause an increase in the design loads for the struts and snubbers. The SWEC resolution methodology requires that the design loads for component standard supports be based on the loads obtained from the piping and pipe support system stress analyses as follows depending on the support type.

For supports with riser clamp or single trunnion and single eccentric component standard support, the component standard supports are to be modeled as eccentric translational restraints in the piping and pipe support system stress analysis and their design loads are to be assumed to be equal to the loads obtained in the stress analysis.

For dual trunnion type supports with dual component standard supports modeled with rotational restraints in the piping and pipe support system stress analysis, the design loads in struts and snubbers are to be assumed to be equal to 100 percent and 120 percent, respectively, of the loads obtained in the stress analysis. The 20 percent increase for snubbers is to account for the effects of differential snubber lockup.

For supports with riser clamp and dual component standard supports modeled as translational restraints in the piping and pipe support system stress analysis, the design load of each of the component standard supports is to be assumed to be equal to 75 percent of the load obtained in the stress analysis. The 75 percent design factor was supported by calculations in SWEC Calculation No. 15454-NZ(c)-GENX-042 "Justification of Design Loads for Struts/Snubbers and Lugs Unsed in Conjunction with Riser Clamps" (GENX-042). These calculations conservatively assumed that the load is unequally distributed between the component standard supports due to bearing of the riser clamp against two lugs only, four lugs are typically used. The 75 percent factor was determined to be the bounding factor over the range of geometrical configurations considered. This calculation was reviewed by the staff and found to be acceptable. In addition, TENERA reviewed the SWEC calculation and documented its review in Engineering Evaluation DAP-E-P-057, "Review of Calc GENX-042." The DAP concluded that the SWEC method is adequate since it is based on application of simple statics.

The staff finds that the modeling techniques and the basis for determining the design loads for component standard supports in the axial/rotational type supports are acceptable. For long runs of pipe with a series of dual trunnion type supports or axial type supports, the staff finds that loads in the piping and pipe supports may be underpredicted and the resolution of any such identified configurations should be evaluated on a case-by-case basis and provided to the staff for its review.

The staff conducted an audit to verify the adequacy of the design criteria application in the design validation (Appendix D to this supplement - Event 37). The staff inspected Design Drawings FW-2-100-406-C52R, Revision 1; FW-2-101-404-C62R, Revision 1; FW-2-105-410-S62R, Revision 4; and AF-2-096-445-S43R, Revision 1. These designs were of riser clamp and lugs with dual component standard supports. The staff found during their review of SWEC

Calculation GENX-042 that the load distributions in supports of this type were based on the assumption that the axis of symmetry of the two halves of the clamp was oriented at 45° to adjacent lugs. TENERA had found that the load distribution in the support would vary significantly depending on the lug/clamp orientation. The staff found that the lug/clamp orientation in the drawings inspected was controlled and consistent with the orientation assumed in SWEC Calculation GENX-042. Accordingly, the staff found that the lug/clamp orientation in riser clamp and lugs with dual component standard supports appears to be controlled to ensure that the load distribution assumed in their design is in accordance with the distribution as calculated in SWEC Calculation GENX-042, and is thus acceptable.

12.3 Differential Snubber Lock-up and End Clearances Effects on Snubber Design Loads in Dual Snubber Supports

This issue is described in DAP External Source Issue Summary ESIS-P-012 (Section 1.1). The SWEC resolution methodology is provided in the piping project status reports (Sections 2.2 and 2.3 of Subappendix A12). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-012 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.12).

Concerns were raised that the design loads for dual snubber supports did not adequately consider the effects of differential lock-up, support steel stiffness variations, support clearances, and dual support clearance differences. The SWEC resolution methodology requires that (1) for integral dual trunnion supports, the design load for each snubber and its supporting structure be increased by 20 percent above the loads obtained from the piping and pipe support system stress analysis, (2) for nonintegral dual snubber supports, each snubber is designed for 75 percent of the total support load obtained from the piping and pipe support system stress analysis, and (3) snubber pairs in dual snubber supports will be matched in accordance with the Department of Energy Nuclear Standard NE-E7-9T "Mechanical and Hydraulic Snubbers for Nuclear Application," (Reference A33).

Based on the 20 percent increase for integral dual trunnion supports, the 50 percent (75 percent versus 50 percent) increase of half of the total load for non-integral dual snubber supports, and the commitment to match paired snubbers in accordance with Standard NE-E7-9T, the staff finds that the SWEC resolution methodology procedures are acceptable to resolve the effects of differential snubber lock-up in dual snubber supports. These procedures have also been reviewed by TENERA and found to be acceptable. The 20 percent increase in design load is consistent with manufacturer's recommendations and is usually applied when snubbers are matched in accordance with Standard NE-E7-9T.

In the case of the effects of differential end fitting clearances on (1) load sharing and (2) the validity of the results of linear methods of analyses as described in NUREG/CR-2175 "Snubber Sensitivity Study" (Reference A34), the SWEC resolution methodology does not impose any limitation on differential end fitting clearances in dual snubber supports. TENERA has conducted a detailed review of the NUREG/CR-2175 test data in its Engineering Evaluation DAP-E-P-068 "Differential Snubber Lock-up of Dual Snubber Assemblies," and found that the NUREG provided sufficient data to conclude that strut/snubber end clearances can have an effect on predicted loads. However, it was concluded that the NUREG did not provide sufficient basis with which to establish the magnitude of such effects or specific criteria to account for such effects in the design process. The Standard Review Plan (NUREG-0800) (Reference A36) states in Section 3.9.3 "the snubber end fitting clearance and lost motion must be minimized and should be considered when calculating snubber reaction loads and stress which are based on a linear analysis of the system or component... Equal load sharing of multiple snubber supports should not be assumed if mismatch in end fitting clearance exists." The NRC staff identified end fitting clearances as an unresolved item in Inspection Report 50-445/88-11, 50-446/88-09 (Reference A35). The resolution to this item will be addressed in a followup inspection report.

In the piping project status reports (Section 2.3 of Subappendix A12) the SWEC methodology is to match snubber pairs used in dual component type applications in accordance with Standard NE-E7-9T. The staff reviewed SWEC Calculation 15454-NZ(c)-GENX-242, "Parallel Snubbers" for the matching of such snubber pairs. Standard NE-E7-9T requires that (1) differential lost motion between the snubber pair shall not exceed 0.02 in. and (2) differential activation level between the snubber pair shall not exceed 0.005g or 50 percent of the smallest of the activation levels of the snubber pair. The staff review found that of the 235 supports evaluated: (1) the 0.02 in. differential lost motion criterion was satisfied in 100 percent of the supports, and (2) the differential activation level was satisfied in 83 percent of the supports. The SWEC calculation concluded that supports not in compliance with the differential activation level criterion were acceptable on the basis that matching of activation levels for proper load sharing in snubber pairs was not industry practice. The staff review finds that the differential lost motion (and mismatch of end fitting clearance) has a greater effect on the load sharing of these snubbers than does the mismatch of activation level as stated in Standard Review Plan NUREG-0800 (Reference A36) in Section 3.9.3. This is particularly evident for mechanical snubbers subjected to rapid cyclic loadings such as earthquake loadings. In NUREG/CR-2175 (Reference A34), the test results indicate for zero end fitting clearance and any combination of activation level, equal load sharing (50/50) was observed to an accuracy of 3 percent. Thus, the matching of all 235 mechanical snubber pairs for only the differential lost motion not exceeding 0.02 inch provides a sufficient basis to conclude that the snubber design loads will be reasonably predicted.

12.4 Design Allowables for Dual Component Standard Supports

The issue is described in DAP External Source Issue Summary ESIS-P-012 (Section 1.2). The SWEC resolution methodology is provided in the piping project status reports (Section 2.1 of Subappendix A12). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-012 (Section 5.3.2) and summarized in the piping results report (Section 3.2.3.12).

A concern was raised regarding the treatment by Gibbs and Hill of support loads resulting from rotational restraint of the piping seismic displacements as secondary loads. As secondary loads, the resulting support allowables were increased by a factor of three. The SWEC resolution methodology requires that loads in dual component standard supports modeled as rotational restraints be classified as primary loads. The staff finds that this classification is acceptable to resolve the concern. The ASME Code three times increase in allowable stresses for the constraint of free end displacement is not invoked.

12.5 Cinched U-bolts in Trapeze Supports

The issue is described in DAP External Source Issue Summary ESIS-P-012 (Section 1.5). The SWEC resolution methodology is provided in the piping project status reports (Section 2.2 of Subappendix A12). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-012 (Section 5.5.2) and summarized in the piping results report (Section 3.2.3.11).

Several concerns were raised in the use of cinched U-bolts in trapeze type supports. The SWEC resolution methodology requires that trapeze supports with cinched U-bolts be eliminated or modified to provide stable support configurations. Proposed modifications include replacement of the U-bolt with a strap and replacement of snubbers with struts if resulting piping stresses are acceptable. In addition, SWEC resolution methodology procedures require that a pair of axial struts or two clamp anchors or three pairs of lugs be utilized with the special strap for stability. The staff evaluation of the proposed modifications is provided in Section 4.3 of this appendix.

12.6 Lug Load Distribution

The issue description is provided in DAP External Source Issue Summary ESIS-P-012 (Section 1.3). The SWEC resolution methodology is provided in the piping project status reports (Sections 2.2 and 2.4 of Subappendix A12). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-012 (Section 5.4.2) and summarized in the piping results report (Section 3.2.3.12).

The concerns relate to the distribution of load lugs in (1) frame with lugs and (2) riser clamp and lugs, both with component standard support types of supports.

For frames with lugs type supports, the SWEC resolution methodology requires that the load be conservatively distributed to one-half, but no more than two, of the total number of lugs. The staff finds that the load distribution methodology conservatively assumes that the minimum number of lugs is effective and is thus acceptable.

For riser clamp and lugs with dual component supports modeled as translational restraints at the piping centerline, the SWEC resolution methodology requires that each lug be designed for 50 percent of the support load - four lugs are typically used. For riser clamp and lugs with single component standard support type supports modeled as eccentric translational restraints, the SWEC resolution methodology requires that the load for each lug is calculated assuming that the entire moment is reacted at the lugs. The resistance of the pipe-to-clamp connection is conservatively neglected. The method was developed by SWEC in Calculation GENX-042. The development of this formula was reviewed by the staff and TENERA (DAP-E-P-057) "Review of Calc GENX-042," and found to be acceptable. The staff finds that the lug load distribution for supports with riser clamp and lugs with dual component standard supports or single eccentric component standard support is conservative and thus acceptable.

12.7 Load Point Application on Frames with Lugs

The issue is described in DAP External Source Issue Summary ESIS-P-012 (Section 1.5). The SWEC resolution methodology is provided in the piping project status reports (Sections 2.4 and 2.5 of Subappendix A12). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-012 (Section 5.6.2) and summarized in the piping results report (Section 3.2.3.12).

The primary concern was the load point application on frame type supports from lugs welded on the piping. The SWEC resolution methodology requires that the total load be applied to the frame at the lug location that will produce the most critical stress in the frame. The staff finds that the load application procedure is acceptable to resolve the concern. In addition, evaluations by SWEC of potential rotational restraint due to supports of frame with lugs-type supports have been performed and documented in Calculation GENX-281, "Potential Binding of Lugs in Axial Supports." These evaluations are to be based on the anticipated rotation of the piping at the supports and the gap between the lugs and the frame. The staff finds that the methodology for the assessment of rotational restraint of this type is also acceptable.

The staff conducted an audit of the adequacy of the design criteria application in the design validation activities (Appendix D to this supplement - Event 37). The staff reviewed SWEC Calculation 15454-NZ(c)-GENX-281, "Potential Binding of Lugs in Axial Supports," for the development of criteria for the evaluation of potential binding and hence, moment restraining capability, of lugs in axial type supports. These criteria are provided in SWEC Project Memorandum PM-154 (Appendix E to this supplement) which requires that this evaluation be performed for all axial restraints with lugs. The staff's review of the development of the criteria for the evaluation of potential binding of lugs in axial restraints found that the assumptions and methodology utilized provided an acceptable basis for the criteria. The 1/16-inch lug/support clearance assumed in the development is consistent with the construction tolerance and the methodology is based on geometrical considerations.

12.3 Conclusion

Based on the above evaluations, the staff finds the concerns associated with axial/rotational restraints have been adequately resolved. The generic technical issue concerning axial/rotational restraints is, therefore, closed for CPSES.

13 GAPS

Several concerns were raised regarding excessive gaps associated with concrete anchorages and clearances between piping and pipe supports. The CPRT third-party (TENERA, L.P.) identified 23 related concerns from various external source documents. In its Engineering Evaluation DAP-E-013, "Gaps," TENERA categorized these concerns into four areas:

(1) use of linear elastic analysis technique
(2) concrete anchorage gaps
(3) U-bolt gaps
(4) pipe/support clearances

13.1 Use of Linear Elastic Analysis Techniques

The issue background is discussed in DAP External Source Issue Summary ESIS-P-013 (Attachment A to DAP-E-P-013). The SWEC resolution methodology is provided in Appendix A to the piping project status reports. The DAP evaluation is provided in Engineering Evaluation DAP-E-P-013 (Section 5.2.2).

The primary concern was the appropriateness of using linear elastic analysis methods to predict piping system response when the actual system contains gaps and clearances that could result in a nonlinear response. The concern was initially raised at CPSES in conjunction with certain pipe support designs and construction practices that did not conform to codes and standard industry practice (i.e., the designs and/or construction tolerances resulted in a less stringent fit than standard practice). The SWEC resolution methodology is to design validate all ASME Code Class 1, 2, and 3 pipe supports. In that process, SWEC has modified many pipe support designs and reestablished construction tolerances at CPSES to conform to (or exceed) those established by codes or standard industry practice. The tolerances established by SWEC are discussed further in Sections 13.2, 13.4, and 27. The design modifications are discussed in Sections 1, 2, 4, 6, 11, 12, 13, and 20. Accordingly, the use of linear elastic analysis methods is a widely accepted practice and recognized by ASME Code, Section III in the load combinations, allowable stresses, and design equations established therein.

On the basis of the pipe support designs and because tolerances conforming to codes and standard industry practice, the staff finds the use of linear elastic analysis techniques acceptable.

13.2 Concrete Anchorage Gaps

The issue background is discussed in DAP External Source Issue Summary ESIS-P-013 (Attachment A to DAP-E-P-013). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A13 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-013 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.26).

ASME Code (1974), Section III (Reference A19), Paragraph NF-4721 states "Holes for nonfitted bolts shall be 1/16 inch larger than the nominal diameter of the bolt for bolt sizes up to and including 1 inch and 1/8 inch larger than the nominal diameter of the bolt for bolt sizes larger than 1 inch."

At CPSES, the following tolerances were used for the bolt holes in baseplates:

- For bolt sizes less than or equal to 3/4 inch, the hole size shall be equal to the bolt diameter plus 1/16 inch.
- For bolt sizes 1 inch to 1-1/2 inch, the hole size shall be equal to the bolt diameter plus 1/8 inch.

Thus, the concern with oversized bolt holes was only applicable to CPSES anchor bolts of 1 inch diameter where the CPSES tolerance was 1/16 inch larger than the 1974 ASME Code requirement.

The SWEC approach in the pipe support design validation uses ASME Code, Section III, 1985 Summer Addenda subparagraph NF-4721(a). The Summer 1985 Addenda revised paragraph NF-4721(a) to specifically address anchor bolts and states, "For anchor bolts set in concrete or concrete expansion anchor bolts, the hole sizes indicated in the Subsection may be increased by 1/16 inch." Thus, using the Summary 1985 Addenda, the CPSES tolerances for anchor bolts meet Code requirements and are, thus, acceptable. The use of a paragraph from a later Code edition is permitted by paragraph NA-1140 of ASME Code, Section III, provided all related requirements are met. The staff review of the related requirements was performed in conjunction with its review of the SWEC NA-1140 report as discussed in this supplement in Section 4.1.2.2 and found the use of this later Code provision acceptable.

13.3 U-Bolt Gaps

The issue background is discussed in DAP External Source Issue Summary ESIS-P-013 (Attachment A to DAP-E-P-013). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A6 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-006 (Attachment C).

U-bolts were initially designed at CPSES as one-way restraints (restraining the pipe in the direction parallel to the U-bolt legs). The gap between the U-bolt legs and the pipe varied up to 1/16 inch. The concern was that when pipe movement exceeded 1/16 inch in this lateral direction, the resulting constraint of the pipe was not considered in the piping analysis.

The SWEC resolution methodology is to consider U-bolts as two-way restraints. The staff evaluation of this issue is discussed in Section 6 of this appendix.

13.4 Pipe/Support Clearances

The issue background is discussed in DAP External Source Issue Summary ESIS-P-013 (Attachment A to DAP-E-P-013). The SWEC resolution methodology is provided in CPPP-7, Attachment 4-11. The DAP evaluation is provided in Engineering Evaluation DAP-E-P-013 (Section 5.5.2) and is summarized in the piping results report (Section 3.2.3.13).

The primary concern was that CPSES clearances between the pipe and the support (up to 3/16 inch) were less conservative than clearances commonly used in industry practice (1/8 inch). The SWEC approach establishes a maximum clearance between the pipe and rigid frame type support of 1/8 inch in the hot condition and a minimum clearance of 0.01 inch in the hot condition. The clearances are provided in the cold position to facilitate installation and vary with the size of the pipe and the temperature. The staff finds that the SWEC clearances result in a maximum clearance of 1/8 inch consistent with common practice and a minimum clearance of 0.01 inch to preclude thermal binding between the pipe and the support and are, thus, acceptable.

13.5 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with gaps and clearances in piping and pipe support members have been adequately resolved. The generic technical issue concerning gaps is, therefore, closed for CPSES.

14 SEISMIC DESIGN LOAD SPECIFICATION

Several issues concerning the seismic analysis of CPSES piping systems previously performed by Gibbs & Hill, Incorporated, were raised. The CPRT third-party (TENERA, L.P.) identified 17 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-014 "Seismic Design Load Specification," TENERA categorized these concerns into three primary areas:

(1) piping computer analysis seismic load input
(2) structural response spectra definition
(3) equivalent static analysis dynamic amplification factor

14.1 Piping Computer Analysis Seismic Load Input

The issue background is provided in DAP External Source Issue Summary ESIS-P-014 (Attachment A to DAP-E-P-014). The SWEC resolution methodology consists of a complete design validation (reanalysis) of ASME Code Class 2 and 3 piping systems which were previously analyzed by Gibbs & Hill Incorporated. The ASME Code Class 1 piping systems were analyzed by Westinghouse and are not a part of the Corrective Action Program design validation as such. The DAP evaluation is provided in Engineering Evaluation DAP-E-P-014 (Section 5.2) and is summarized in the piping results report (Section 3.2.3.14).

The primary issues were related to inappropriate damping values used as input in the CPSES piping computer analyses performed before the SWEC design validation. The SWEC design validation uses damping values based on Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants," (Reference A37) or ASME Code Case N-411, "Alternative Damping Values for Response Spectra Analysis of Class 1, 2, and 3 Piping Systems, Section III, Division 1" (Reference A38). As discussed in Section 4.1.2.2 of this supplement, the staff has approved the use of Code Case N-411 damping values for CPSES in a letter from V. Noonan (NRC) to W. Counsil (TU Electric) dated March 13, 1986 (Reference A39). Thus, the damping values used by SWEC are acceptable.

The CYGNA review of this issue and its resolution with respect to piping input errors has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe stress (Items 13 and 15) (Reference A14).

14.2 Seismic Response Spectra Definition

The issue background is provided in DAP External Source Issue Summary ESIS-P-014 (Attachment A to DAP-E-P-014). The SWEC resolution methodology involves a validation of the CPSES seismic response spectra as part of the civil/structural CAP design validation. The DAP evaluation is provided in Engineering Evaluation DAP-E-P-014 (Section 5.3.2).

The staff evaluation of the adequacy of the CPSES seismic response spectra definition will be addressed in conjunction with the staff review of the civil/structural CAP design validation.

14.3 Equivalent Static Analysis Dynamic Amplification Factor

The issue background is provided in DAP External Source Issue Summary ESIS-P-014 (Attachment A to DAP-E-P-014). The SWEC resolution methodology is provided in CPPP-7, Paragraph 3.4.5.4.1. The DAP evaluation is provided in Engineering Evaluation DAP-E-P-002 (Section 5.4.2) and is summarized in the piping results report (Section 3.2.3.14).

The primary concern was that the previous Gibbs & Hill analysis procedure specified a dynamic amplification factor of 1.0 in the equivalent static analysis of small bore piping without justification. The SWEC resolution methodology involves a design validation of small bore piping using a 1.5 dynamic amplification factor when equivalent static analysis is used. The SWEC methodology is in conformance with the NRC Standard Review Plan (Reference A36) Section 3.9.2 and is, thus, acceptable. This issue is discussed further in this supplement in Section 4.1.2.2.

14.4 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with piping damping values and equivalent static analysis dynamic amplification factors have been adequately resolved. The generic technical issue concerning seismic design load specification for piping systems is, therefore, closed for CPSES.

15 SUPPORT MASS EFFECTS ON PIPING ANALYSIS

Concerns were raised that the Gibbs & Hill piping analyses did not adequately evaluate the effects of pipe support mass on the piping stresses. The CPRT third-party (TENERA, L.P.) identified 10 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-015 "Support Mass Effects on Piping Analysis," TENERA summarized these concerns into three primary areas:

(1) support mass criteria
(2) support mass modeling method
(3) effect on piping dynamic response/thermal hydraulic loads

15.1 Support Mass Criteria, Modeling, and Dynamic Effects

The issue background is provided in DAP External Source Issue Summary ESIS-P-015 (Attachment A to DAP-E-P-015). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A15 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-015 (Sections 5.2, 5.3, and 5.4) and is summarized in the piping results report (Section 3.2.3.15).

ASME Code Section III (Reference A16), states in paragraph NC/ND-3623 for Class 2 and 3 piping systems, "Piping systems shall be supported to provide for the effects of live and dead weights.... The dead weight shall consist of the weight of the piping, insulation, and other loads permanently imposed upon the piping."

The staff understands these requirements to mean that the designer should consider the effects of the support mass in the piping stress analysis. The staff does not view these requirements to imply that an explicit calculation must be performed to ensure stress compliance unless the support dead weight load can significantly affect the accuracy of the analysis.

The primary concern was that there were no Gibbs & Hill procedures specifying when support mass should be included in the piping analysis although support masses were found to be modeled in selected piping systems (e.g., main steam).

The SWEC methodology requires all piping analyses to consider contributing support mass. A procedure was developed by SWEC detailing the support mass or portion of the mass to be included in the piping analytical model. The SWEC procedure for determining mass inclusion has been reviewed by TENERA and found to be acceptable allowing for a 10 percent deviation in support mass for subsequent modifications. The DAP evaluation found that this 10 percent deviation will generally amount to a shift in piping frequency of less than 5 percent. The staff finds a 5 percent shift in piping frequency to be within acceptable tolerance limits.

The SWEC mass modeling methods have been reviewed by TENERA. The DAP evaluation found the SWEC guidelines for modeling component supports to be acceptable. Furthermore, the DAP reviewed the coupling effects of cantilever supports on piping response and found that the SWEC criteria which do not require addition of support mass to the piping analysis when the support weight is not directly supported by the piping system are adequate for common supports of this type. In addition, TENERA reviewed the SWEC criteria for predicting support mass effects in time history dynamic response analyses and found them to be acceptable.

On the basis of the DAP conclusions discussed above, the staff finds that the SWEC methodology for considering pipe support mass effects in piping analyses satisfies the applicable requirements of the ASME Code and is, thus, acceptable.

The staff audited the application of the mass criteria in two pipe stress calculation packages RH-1-069 and MS-1-003 (Appendix D of this supplement - Event 32). The staff found that the pipe supports were modelled in the pipe stress analyses in accordance with CPPP-7 and are thus acceptable.

In addition, the CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues lists for pipe stress (Items 9, 19) and pipe supports (Item 5) (References A14 and A10, respectively).

15.2 Conclusion

Based on the above evaluation, the staff concludes that the concerns associated with mass criteria, mass modelling and mass dynamic effects have been adequately resolved. The generic technical issue concerning pipe support mass effects on piping analysis is, therefore, closed for CPSES.

16 MASS POINT SPACING

Concerns were raised that the piping stress analyses previously performed by Gibbs & Hill did not satisfy project criteria for modeling lumped mass points in the piping analytical model. The CPRT third-party identified seven related concerns from various source documents. In its Engineering Evaluation DAP-E-P-017, "Mass Point Spacing," TENERA summarized these concerns into two areas:

(1) inadequate application of mass point spacing criteria
(2) ADLPIPE Version C computer program concerns

The above two concerns are addressed in the issue below.

16.1 Mass Point Spacing Criteria and Computer Application

The issue background is provided in DAP External Source Issue Summary ESIS-P-017 (Attachment A to DAP-E-P-017). The SWEC resolution is provided in the piping project status reports (Subappendix A17 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-017 (Section 5.0) and is summarized in the piping results report (Section 3.2.3.16).

The issue was raised in the CYGNA Independent Assessment Program, Phase 3 (Reference A40) as a part of CYGNA's review of the Gibbs & Hill piping stress analyses for CPSES. The TU Electric CAP for piping includes a complete reanalysis, using SWEC computer program NUPIPE-SW, of all ASME Code Class 2 and 3 piping systems previously analyzed by Gibbs & Hill. The ADLPIPE computer program is not used by SWEC in the piping design validation. The SWEC modeling guidelines for locating mass points in the piping analytical model are provided in Paragraph 3.10.6.1 and Attachment 3-7 of CPPP-7. A checklist item was added to include mass point spacing in CPPP-6, Attachment 9-9. TENERA has reviewed SWEC Calculation GENX-012, "Lumped Mass Spacing for Piping System Dynamic Analysis," which forms the basis for the mass point spacing criteria developed by SWEC and found the equation used to calculate the mass point spacing requirement to be adequate for frequencies up to 200 Hz.

The staff audited the application of the mass point spacing criteria for pipe stress calculation package RH-1-069 (Appendix D to this supplement - Event 32). The staff found the modelling to be in accordance with CPPP-7 guidelines and is, thus, acceptable.

CYGNA has subsequently closed this issue in Revision 4 to its pipe stress review issue list (Item 1) and pipe support review issues list (Item 5) (References A14 and A10, respectively).

16.2 Conclusion

Based on the above evaluation, the staff concludes that the concerns associated with mass point spacing have been adequately resolved. The generic technical issue concerning mass point spacing in piping analysis is, therefore, closed for CPSES.

17 HIGH FREQUENCY MASS PARTICIPATION

Concerns were raised that the piping seismic response spectra analyses previously performed by Gibbs & Hill did not include a sufficient number of modes to comply with the FSAR commitment that the inclusion of higher order modes not increase the system response by more than 10 percent. The CPRT third-party (TENERA, L.P.) identified 11 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-018, "High Frequency Mass Participation," TENERA summarized these concerns into two primary areas:

(1) insufficient modes
(2) computer program concerns

17.1 Insufficient Modes and Computer Program Concerns

The issue background is provided in DAP External Source Issue Summary ESIS-P-018 (Attachment A to DAP-E-P-018). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A18 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-018 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.17).

The issue was raised in the CYGNA Independent Assessment Program, Phase 3 (Reference A40) as a part of CYGNA's review of the Gibbs & Hill piping stress analyses for CPSES. The TU Electric CAP for piping includes a complete reanalysis, using SWEC computer program NUPIPE-SW, of all ASME Code Class 2 and 3 piping systems previously analyzed by Gibbs & Hill. The SWEC resolution methodology consists of two analysis options to address high-frequency mass participation as specified in Paragraph 3.10.6.8 of CPPP-7:

(1) Perform seismic amplifed response spectrum modal analysis with 50-Hz cutoff frequency, including a high-frequency missing mass correction option, by using NUPIPE-SW (V04/L02) or later issue.

(2) Perform an equivalent static analysis by using the zero-period acceleration values in all three directions. Combine these results by the square-root-of-the-sum-of-the-squares method with the results of the seismic analysis with a 50-Hz cutoff frequency that did not include the high-frequency missing mass correction.

TENERA reviewed the above two SWEC methods and found them to be technically adequate based on the SWEC procedures providing guidance relative to missing mass correction and the methods complying with the applicable FSAR commitments.

On the basis of the DAP conclusions on the adequacy of the two methods used by SWEC to address high-frequency mass participation, the staff finds the SWEC methodology acceptable. CYGNA has subsequently closed this issue in its pipe stress review issue list (Item 1) and pipe support review issues list (Item 5) (References A14 and A10, respectively).

17.2 Conclusion

Based on the above evaluation, the staff concludes that the concerns associated with high frequency mass participation have been adequately resolved. The generic technical issue concerning high frequency mass participation is, therefore, closed for CPSES.

18 FLUID TRANSIENTS

Concerns were raised that dynamic effects from piping fluid transient loadings were not adequately evaluated. The CPRT third-party (TENERA, L.P.) identified eight related concerns from various source documents. In its Engineering Evaluation DAP-E-P-019 "Fluid Transients," TENERA categorized these concerns into two aspects:

(1) main steam safety/relief valve (S/RV) load modeling
(2) fluid transient analysis methodology

18.1 Main Steam S/RV Load Modelling

The issue background is discussed in DAP External Source Issue Summary ESIS-P-019 (Attachment A to DAP-E-P-019). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A25 Section 2.1).

The DAP evaluation is provided in Engineering Evaluation DAP-E-P-019 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.18).

The primary concern was identified in the CYGNA Independent Assessment Program for CPSES in its review of the Gibbs & Hill main steam piping analyses. The Crosby S/RVs on the main steamline have a dual-port outlet configuration. The issue of concern was the assumptions used to account for any unbalanced flow that could result in higher moment loads at the main steam header-to-valve connection.

On the basis of discussions between SWEC and Crosby, an equal (50/50) flow distribution ratio was verified to be an adequate assumption. For conservatism, SWEC assumes a 55/45 S/RV flow distribution ratio to calculate blowdown force. The DAP evaluation found the 55/45 assumption acceptable. TENERA also reviewed SWEC Calculation 1545-NP(N)-MS-1-023D "Main Steam Pipe Stress Calculation," and found the 55/45 flow distribution was correctly applied and the resulting thrust variations were properly included in the main steam header-to-valve connection.

In a related issue, TENERA reviewed the SWEC assumption used in the multiple-valve-opening sequence. SWEC assumes all five S/RVs open simultaneously consistent with Regulatory Guide 1.67, "Installation of Overpressure Protection Devices," (Reference A41) and is, thus, acceptable.

On the basis of the DAP conclusions that the flow distribution ratio is conservative and the multiple-valve-opening sequence is in compliance with Regulatory Guide 1.67, the staff finds the SWEC methodology for evaluating the main steam S/RV dynamic loads acceptable. The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe stress (Item 19) (Reference A14).

18.2 Fluid Transient Analysis Methodology

The issue background is discussed in DAP External Source Issue Summary ESIS-P-019 (Attachment A to DAP-E-P-019). The SWEC resolution methodology is provided in the piping project status reports (Subappendix 19 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-019 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.18).

In a public meeting held on February 26, 1985 (Board Notification BN-85-026A) (Reference A42), the staff expressed a concern about a lack of review of the dynamic effects resulting from steam and water-hammer. SWEC identified the fluid transient loadings applicable to CPSES in Attachment 1 of CPPP-10 (see Appendix D to this supplement) using the guidelines of NUREG-0582, "Water Hammer in Nuclear Power Plants," dated July 1979 (Reference A43). Fluid transient forcing functions were developed by SWEC, and the applicable piping systems were analyzed for their effects.

The DAP reviewed the identification of the fluid transient events and the development of the fluid transient loadings including the computer methods and the analytical models used. The DAP found the SWEC procedures provide adequate guidelines to identify the fluid transient events applicable to CPSES consistent with industry practice. The DAP also found the development of fluid transient forcing functions acceptable consistent with industry practice. The DAP reviewed SWEC Calculation 15454-NP(B)-GENX-207 "Evaluation of Fluid

Transient Cutoff Forces and Development of Screening Criteria for Piping Systems," which developed a fluid transient force limit below which no further evaluation is required and found it acceptable.

The staff also conducted audits of the methodology used by SWEC to identify and develop fluid transient loadings (Appendix D to this supplement - Events 10, 33, and 34). The staff review of the adequacy of application of transient forcing function was included in its review of the implementation of the issue resolution related to fluid transients. The staff selected four piping stress problems that included an analysis for fluid transient loadings. The staff reviewed the stress problems to ensure that the fluid transient forcing functions were input properly in the piping stress analyses. The staff found the forcing functions for the system operating transients were properly applied in the piping stress analyses.

As a result of its audits, the staff identified two items from its review of two chemical and volume control piping systems (Calculation Nos. F-15 and F-16). Both piping calculations consist of pipe runs with relief valves located within their analytical boundaries. In Calculation No. F-15, the inlet lines from the main header to the relief valves are approximately 75 feet in length. The staff identified an issue regarding the potential water-column separation and resulting waterhammer loads in the lines. A second issue identified by the staff for Calculation Nos. F-15 and F-16 was related to the consequences of the potential water column separation affecting the ability of the relief valves to perform their intended functions. The SWEC resolution of these issues is currently addressed in a test program to establish the valve opening characteristics. The test program will establish the valve opening times. If the valves open slowly enough, water column separation will not occur in the inlet lines. This will eliminate the concern of waterhammer loads in the inlet lines and valve operability under column separation. The staff finds the test program approach to be an acceptable resolution. However, if the test program cannot establish acceptable valve opening characteristics, then the staff requires that alternative corrective actions be provided to the staff for further review and approval.

On the basis of the DAP conclusions discussed above and on the staff review and audits, the staff finds the SWEC methodology used to identify and develop fluid transient forcing functions is consistent with the approach provided in NUREG-0582. The application of the forcing functions in the piping stress analyses is a widely used analysis technique to calculate the limiting stresses and strains in the piping system under dyanmic loadings and is, thus, acceptable.

The CYGNA review of this issue and resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe stress (Items 8 and 20) (Reference A14).

18.3 Conclusion

Based on the above evaluation, the staff concludes that the concerns associated with analysis methods used to evaluate fluid transient effects have been adequately resolved. The generic technical issue concerning fluid transients in piping systems at CPSES is, therefore, closed.

19 SELF-WEIGHT EXCITATION

Several concerns were raised that pipe support calculations generally did not include the pipe support dead weight nor the self-weight seismic excitation loads. The CPRT third-party (TENERA, L.P.) identified 23 related issues from various source documents. In its Engineering Evaluation, DAP-E-P-020, "Self-Weight Excitation," TENERA categorized these concerns into two primary areas:

(1) dead weght loads
(2) seismic self-weight excitation

19.1 Dead Weight Loads

The issue background is discussed in DAP External Source Issue Summary ESIS-P-020 (Attachment A to DAP-E-P-020). The SWEC resolution methodology is provided in CPPP-7 Paragraph 4.3. The DAP evaluation is provided in Engineering Evaluation DAP-E-P-020 (Section 5.2.2) and is summarized in the Piping Results Report (Section 3.2.3.19).

The primary issue was that dead weight load of the pipe support itself was not included in the pipe support calculations. Generally, the pipe support dead weight is much smaller than the piping loads to which the support is designed. At CPSES, the concern was that certain supports were relatively large compared to the piping being supported.

ASME Code, Section III (Reference A19), paragraph NF-3111 states "the loadings that shall be taken into account in designing a component support include...weight of the component support." The staff understands this requirement to mean that the designer should consider the effects of the support weight on the support design. The staff does not view this requirement to imply that an explicit calculation must be performed to ensure stress compliance unless the dead weight load can be a significant load contributor and can affect the accuracy of the analysis.

The SWEC resolution methodology includes the dead weight load of any support component in the piping analysis model or in the support calculation. Where a support component dead weight load is considered negligible, the assumption is required to be included in the calculation. The staff finds that the inclusion of the support dead weight load in either the piping analysis or support calculation properly accounts for the component support weight in the support design and is, thus, acceptable. The required statement of assumed negligibility provides a means to verify that all support components have been accounted for in the calculation and is, thus, acceptable.

19.2 Seismic Self-Weight Excitation

The issue background is discussed in DAP External Source Issue Summary ESIS-P-020 (Attachment A to DAP-E-P-020). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A20 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-020 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.19).

The concern was that the inertial loads developed in a pipe support during an earthquake (self-weight excitation) were not included in the pipe support calculations. Similar to the dead weight loads issue discussed above, the concern at CPSES was that relatively large pipe supports were designed using piping loads that were small compared to the pipe support self-weight excitation loads.

ASME Code, Section III (Reference A19), paragraph NF-3111 states "The loadings that shall be taken into account in designing a component support include ... (d) dynamic loads; including loads caused by earthquake and vibration." Furthermore, in subparagraph NF-3112.2, the ASME Code provides an explicit requirement indicating that the designer must consider the effects of earthquakes in the design of component supports.

The staff understands these requirements to mean that the effects of earthquakes whether from the piping load contribution or the pipe support load contribution must be included in the design of pipe supports when the load contribution can be significant.

The SWEC resolution methodology includes the seismic self-weight excitation load in the support evaluation for all frame supports. SWEC does not require a calculation of seismic self-weight excitation for certain support hardware associated with supports without structural frames (i.e., snubber rear brackets) because of its rigid characteristics and small mass. The SWEC procedure does require modeling a portion of the support mass in the piping model for these types of supports.

TENERA has reviewed three SWEC methods for statically analyzing supports for seismic loads and one dynamic method. The status methods use a 1.5 multimode multiplication factor with the peak acceleration values from the applicable seismic response spectrum. TENERA also reviewed SWEC Calculation (15454.05-NZ(c)-GENX-006) "Methods for Calculating Seismic Stresses Due to Acceleration of Pipe Support Mass." The DAP evaluation found the SWEC methods and supporting calculation to be acceptable.

On the basis of the DAP conclusions on the acceptability of the methods used to evaluate seismic self-weight excitation of pipe supports, the staff finds the SWEC resolution methodology properly accounts for the earthquake effects in the pipe support design and is, thus, acceptable.

The CYGNA review of this issue and resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 12) (Reference A10).

19.3 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with the support weight and self-weight excitation loads in the design of pipe supports have been adequately addressed. The generic technical issue concerning self-weight excitation is, therefore, closed for CPSES.

20 LOCAL STRESS IN PIPE SUPPORT MEMBERS

Several concerns were raised that pipe support designers at CPSES were not adequately evaluating the localized effects of pipe loadings on pipe support members. The CPRT third-party (TENERA, L.P.) identified 28 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-021, "Local Stress in Pipe Support Members," TENERA categorized these concerns into five technical areas:

(1) zero-gap and cinched U-bolt designs
(2) highly constrained pipe anchors
(3) structural connections and localized loadings
(4) short/deep beams
(5) support deflection and flexibility

20.1 Zero-Gap and Cinched U-Bolt Design

The issue background is discussed in DAP Engineering Evaluation DAP-E-P-021 (Section 5.2.1). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A21 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-021 (Section 5.2.3) and is summarized in the piping results report (Section 3.2.3.20).

The zero-gap box frame designs and the cinched U-bolt designs have been either eliminated or modified by SWEC. The staff evaluations of these modifications are discussed in Sections 4.1 and 11 of this appendix, respectively.

20.2 Highly Constrained Pipe Anchors

The issue background is discussed in DAP Engineering Evaluation DAP-E-P-021 (Section 5.3.1). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A2 Section 2.2). The DAP evaluation is provided in the Engineering Evaluation DAP-E-P-021 (Section 5.3.3) and is summarized in the piping results report (Section 3.2.3.20).

The primary concern was that certain piping anchors consisting of two or four opposing trunnions on the pipe in a box frame would constrain the thermal radial expansion of the pipe and the resulting loads were not considered in the pipe support design. The SWEC approach as described in Paragraph 4.6.4.1 of CPPP-7 requires the piping restraint of free end displacement loads to be combined with the piping radial thermal expansion loads to evaluate the support structure adequacy. The SWEC procedure conservatively considers these pipe-induced thermal loads as primary loads and is, thus, acceptable.

20.3 Structural Connections and Localized Loadings

The issue background is discussed in DAP Engineering Evaluation DAP-E-P-021 (Section 5.4.1). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A21 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-021 (Section 5.4.3) and is summarized in the piping results report (Section 3.2.3.20).

The DAP identified seven local stress concerns related to structural connections and localized pipe support member loadings:

(1) tube steel to tube steel connections
(2) rear bracket to tube steel connections
(3) rear bracket to end plate connections
(4) web crippling of I-shape members
(5) flange bending of I-shape members

(6) bolt and U-bolt nuts bearing against washet plate/tube steel cord face
(7) main member edge distance at structural connections

Concerns 1, 2, and 7 are related to provisions in AWS D1.1 (Reference A20) and are discussed in Section 8 of this appendix. Concern 3 is related to local flexibility in pipe support members and is discussed in Section 5.2 of this appendix. Concern 6 is related to local stress at bolt holes in tube steel and is discussed in Section 1.8 of this appendix.

Concerns 4 and 5 are related to local stresses in wide flange members. Web crippling of wide flange members is evaluated by SWEC using Paragraph XVII-2215.5 of the ASME Code, Section III, and is, thus, acceptable. Flange bending guidelines are provided in CPPP-7, Attachment 4-13 Paragraph 4.7.1 and utilize basic engineering principles in the development of the equations.

The development of the SWEC methodologies to evaluate the seven local stress concerns listed above is documented in SWEC Calculation 15454-NZ(c)-GENX-023, "SWEC Generic Calculation: Development of the Method for Evaluating Local Stress in Pipe Support Members." The DAP review of the SWEC GENX-023 calculation is documented in Engineering Evaluation DAP-E-P-070, "Local Stress in Pipe Support Members." The DAP evaluation concluded that GENX-023 provides an acceptable development of methodologies for evaluating local stress in structural connections and at points of localized loading on structural members.

On the basis of the staff review discussed above and the DAP review of GENX-023, the staff finds that the SWEC approach to evaluating local stress in structural connections and points of localized loadings is acceptable.

20.4 Short/Deep Beams

The issue background is discussed in DAP Engineering Evaluation DAP-E-P-021 (Section 5.5.1). The SWEC resolution methodology is provided in the piping project status report (Subappendix A21 Section 2.3). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-021 (Section 5.5.3) and is summarized in the piping results report (Section 3.2.3.20).

The primary concern was that the flexure equations for calculating bending stresses in beams are not appropriate for short/deep structural members to which pipe support components (e.g., struts, snubbers) are attached. The SWEC methodology as provided in Paragraph 5.0 of Attachment 4-13 of CPPP-7 requires a localized evaluation of member stresses when the member length to depth ratio is less than one. The staff finds the SWEC procedure provides a limitation in the application of flexural equations to short/deep beams and is, thus, acceptable.

20.5 Support Deflection and Flexibility

The issue background is discussed in DAP Engineering Evaluation DAP-E-P-021 (Section 5.6.1). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A5 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-021 (Section 5.6.3) and is summarized in the piping results report (Section 3.2.3.20).

The staff evaluation of support deflection and flexibility is provided in Section 5.2 of this appendix.

20.6 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with local stresses in pipe support members have been adequately resolved. The generic technical issue concerning local stress in pipe support members is, therefore, closed for CPSES.

21 SAFETY FACTORS

Concerns were raised that the cumulative effects of ignoring various design loadings could have an adverse impact on piping and pipe supports. The CPRT third-party (TENERA, L.P.) identified 11 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-022, "Safety Factors," TENERA identified the following items as potentially having an adverse effect on safety factors with respect to the piping and pipe support analyses performed prior to the TU Electric CAP design validation for piping:

(1) pipe analysis assumptions/methods
(2) material properties
(3) oversized bolt holes
(4) self-weight excitation of pipe supports
(5) relative differential support building attachment motion effects
(6) friction effects
(7) axial/rotational restraints
(8) local stresses in piping and pipe supports
(9) unstable pipe support effects
(10) design code applicability
(11) certain designs using Richmond inserts
(12) certain designs using Hilti fasteners

21.1 Cumulative Effect of Issues

The issue background is provided in DAP External Source Issue Summary DAP-E-P-022 (Attachment A to DAP-E-P-022). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A22 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-022 (Section 5.3) and is summarized in the piping results report (Section 3.2.3.21).

The SWEC resolution methodology is to develop explicit design guidelines to evaluate the impact of design loadings previously assumed to be negligible. The design guidelines are provided in CPPP-7, "Design Criteria for Piping and Pipe Supports" (Reference A4). The DAP reviewed the SWEC design guidelines for compliance with the applicable FSAR commitments, codes, standards, and regulatory guides. When specific rules or requirements were not available, acceptance criteria were developed which included a minimum acceptable factor of safety (as applicable to the procedure). Small potential load variations are expected to occur from installation tolerances established by standard industry practice which inherent design margins established by codes and standards are intended to cover. Safety factors for seismic design of piping are discussed further in a report by E. C. Rodabaugh, "Realistic Seismic Design Margins of Pumps, Valves, and Piping," NUREG/CR-2137, Battelle Columbus Laboratories, June 1986 (Reference A44).

On the basis the SWEC methodology evaluating the contribution of the various design loadings described above and the DAP evaluations ensuring that appropriate acceptance criteria are used, the staff finds that the safety factors in the SWEC design validation of piping and pipe supports at CPSES provide adequate margin to ensure that the piping and pipe supports will maintain their structural integrity and functional capability during normal operation and design basis accident conditions as required and are, thus, acceptable.

21.2 Conclusion

Based on the above evaluation, the staff concludes that the concerns associated with the cumulative effects of neglecting design loadings have been adequately resolved. The generic technical issue concerning safety factor is, therefore, closed for CPSES.

22 SA-36 AND A-307 BOLTING MATERIAL

Several concerns were raised regarding the appropriateness of using ASTM A-307 material in friction-type connections at CPSES. In its February 8, 1984 Memorandum and Order (Reference A18) the ASLB expressed its views regarding the extent to which clamping forces exerted by cinched U-bolts made from SA-36 (or A-307) material can prevent rotation of the pipe. The CPRT third-party (TENERA, L.P.) identified 12 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-023, "SA-36 and A-307 Steel," TENERA categorized these concerns into five areas:

(1) SA-36 used in dynamic application
(2) SA-307 material used in dynamic application
(3) violation of Regulatory Guide 1.124 limits
(4) SA-36 steel used and referred to as SA-307
(5) use of low strength (A563 Grade A) nuts with high strength (SA-193 Grade B7) bolting

22.1 SA-36 Used in Dynamic Application

The issue background is discussed in DAP External Source Issue Summary ESIS-P-023 (Attachment A to DAP-E-P-023). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A23 Section 2.3). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-023 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.22).

The primary concern was that SA-36 steel has been used, although not recommended, for dynamic applications in which fatigue might occur. The SWEC resolution methodology utilizes SA-36 material in U-bolts designed as two-way restraints and SA-36 threaded rods in Richmond insert/tube steel joints and are designed in accordance with ASME Code, Section III Appendix XVII (linear-type supports) and the AISC Code, respectively. ASME Code, Section III, and the AISC Code both establish a lower bound limit of 20,000 cycles below which no reduction in stress allowable is required for fatigue considerations. SWEC further demonstrated that for pipe supports at CPSES that the number of loading cycles (considering thermal, seismic, and fluid transients) is less than 20,000 cycles. The DAP reviewed SWEC Calculation 15454-NP(c)-GENX-103 "Fatigue Cycle Determination for Pipe Supports" which established the number of cycles applicable to pipe supports and found the methodology conservative and the results reasonable.

Because the number of cycles applicable to pipe supports at CPSES are less than 20,000 cycles, the staff finds that there is no reduction in stress allowables required for fatigue considerations. On this basis, the concern of using SA-36 material in dynamic applications in which fatigue might occur has been adequately addressed and the SWEC resolution is, thus, acceptable.

22.2 <u>SA-307 Material Used In U-Bolts and Richmond Inserts</u>

The issue background is described in DAP External Source Issue Summary ESIS-P-023 (Attachment A to DAP-E-P-023). The SWEC resolution methodology is discussed in the piping project status reports (Subappendix A23 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-023 (Sections 5.3.2 and 5.5.2) and is summarized in the piping results report (Section 3.2.3.22).

The primary concern was that A-307 (or SA-307) material had been used in friction-type connections such as cinched U-bolts on piping. Its use was not permitted by the ASME Code of record (Reference A19) as stipulated in ASME Code, Section III, Appendix XVII, Table XVII-2461.1-1 Note 1. In a related concern, SA-36 material was often referred to as "SA-307 material" and the ASLB extended its views concerning A-307 material to SA-36 material as well, since the materials are similar.

The SWEC resolution methodology eliminated all cinched U-bolts from the ASME Code Class 1, 2, and 3 pipe supports. U-bolts used as two-way restraints do not rely on friction to prevent rotation of the pipe. Richmond insert joints were designed as bearing connections and do not rely on friction for load transfer capability.

10 CFR 50 Appendix B (III. "Design Control"), states in part that "Measures shall also be established for the selection and review for suitability of application of materials, parts, equipment, and process are essential to the safety-related functions of the structures, systems, and components." In Table XVII-2461.1.1 of the 1974 ASME Code, Section III, appendices, the allowable bolt tension and shear stresses are provided for various bolt specifications. For SA-307 bolt material, the shear allowable is provided for both (1) friction-type connections and (2) bearing-type connections. For bearing-type connections, the Code allows the use of 30 percent of the yield strength. For friction-type connections, the Code provides the above referenced statement in Note 1, "Friction type connections loaded in shear are not permitted. The amount of clamping force developed by SA-307 bolts is unpredictable and generally insufficient to prevent complete slippage."

A properly made friction connection is highly dependent on the yield strength of a bolt since the material yield strength controls its ability to maintain the connection, whereas a bearing connection is dependent on the shear strength of the bolt since shear strength governs failure in this mode. It should also be noted that the allowable values established in Table XVII-2461.1-1 were developed on the basis of testing of straight-headed bolts, and thus, were not intended to apply specifically to U-bolts.

Although SA-36 and SA-307 materials have equivalent material properties, a major difference between the SA-36 and SA-307 specification is that SA-307 requires, as a mechanical requirement, only a tensile strength test (i.e., minimum ultimate tensile stress). SA-36 requires both a test for the tensile strength and a test for the minimum yield point of the material.

Consequently, SA-307 material, although similar to SA-36 material, has the potential for a lower yield point than SA-36. Thus, it is evident that the Code statement "clamping force developed by SA-307 bolts is unpredictable" is referring to the fact that the yield point of SA-307 bolt is uncertain because the SA-307 material specification does not require its testing. However, the SA-36 material specification does require the test for minimum yield point. Thus, the staff believes the clamping force developed by SA-36 material for U-bolts is not unpredictable, and if an SA-307 bolt receives a supplemental test to establish its yield stress, it would also not be unpredictable.

ASME Code Case N-249-4, (Reference A45) allows the use of A-307 material for bolting in Subsection NF component supports with the following additional requirement: "When the ASTM specification referenced in Tables 1 through 4 does not specify minimum tensile and yield strengths, the value listed under the appropriate columns shall be met by the material." For A-307 bolting material, the appropriate column in Code Case N-249-4 establishes a minimum yield strength of 36 ksi to be met. NRC Regulatory Guide 1.85 (Reference A27) approves for use ASME Code [illegible] N-249-4. The Regulatory Guide does not place any limitations or restrictions in the use of A307 bolting material provided its suitability of application has been established.

The SWEC resolution methodology to eliminate all cinched U-bolts acceptably resolves the concern of using U-bolts as friction connections. The design of bolts and threaded rods (using A36 material) in Richmond insert joints as bearing connections is further discussed in Section 26.1 of this appendix.

On the basis of the above discussion, the staff finds the concerns regarding SA-307 material used in U-bolts and Richmond inserts has been adequately resolved.

22.3 Use of Low-Strength Nuts With High-Strength Bolting

The issue background is discussed in DAP External Source Issue Summary ESIS-P-023 (Attachment A to DAP-E-P-023). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A23 Section 2.5). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-023 (Section 5.6.2) and is summarized in the piping results report (Section 3.2.3.22).

The primary concern was raised by CYGNA in its Independent Assessment Program for CPSES. The issue was that TUGCO pipe support designers previously did not follow the recommendation of American Society for Testing and Materials (ASTM) Specification A563 that Grade A (low-strength) nuts be restricted for use with low-strength bolting although when not using high-strength nuts the designers did specify double nuts with both nuts tightened snugly. The SWEC approach per CPPP-7, Attachment 4-5, Paragraph 1.2, specifies that the tensile allowable load for high-strength bolts (A193 Grade B7) using low-strength nuts (A563 Grade A) is to be multiplied by a reduction factor of 0.6. The basis for the

0.6 factor was established in SWEC Calculation 15454-NZ(c)-GENX-008 "Documentation of Use of Low Strength A-563 Grade A Double Nuts on High Strength SA-193 Grade B7 Rod for Richmond Inserts." SWEC GENX-008 Calculation was reviewed by the DAP. In DAP Alternate Calculation DAP-C-P-004, "DAP Alternate Calculation: Use of Low Strength (A-563 Grade A) Nut with High Strength (SA-193 B7) Rod," the DAP confirmed that SWEC's reduced allowable loads are acceptable.

On the basis of the DAP evaluation of the SWEC reduction factor, the staff finds that the concerns with the use of low-strength nuts with high-strength bolting have been adequately resolved, and the SWEC approach is acceptable. CYGNA has subsequently closed this issue based on its review of SWEC's reduction factor as summarized in Revision 4 to CYGNA's review issues list for pipe supports (Item 28) (Reference A10).

22.4 Allowable Stresses in Bolting Material

The issue background is discussed in DAP External Source Issue Summary ESIS-P-023 (Attachment A to DAP-E-P-023). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A23 Section 2.4). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-023 (Section 5.4.2) and is summarized in the piping results report (Section 3.2.3.22).

The concern was that bolt designs in CPSES piping supports were in violation of NRC Regulatory Guide 1.124 (Reference A46) which limited shear stresses to 1.5 times the Service Level A limits. The SWEC resolution methodology utilizes the tension and shear requirements for bolting design under the faulted (Service Level D) conditions as specified in the ASME Code, Section III, subparagraph NF-3225 1983 Edition including Summer 1983 Addenda. The staff review of the use of this subparagraph from the later Code edition was performed in conjunction with our review of the SWEC NA-1140 report as discussed in this supplement in Section 4.1.2.2 and its use was found acceptable.

On the basis of our review of the CPSES allowable stresses in bolting material used for pipe support design validation, the staff finds that these stresses are in accordance with the ASME Code, Section III, and are, thus, acceptable.

22.5 Conclusion

Based on the above evaluations, the staff finds that the concerns associated with SA-36 and A-307 bolting material have been adequately resolved. The staff concludes that the generic technical issues regarding SA-36 and A-307 bolting material used in CPSES pipe support designs is, therefore, closed.

23 VALVE AND FLANGE QUALIFICATION/VALVE MODELING

Several issues were identified by CYGNA in the Independent Assessment Program related to (1) valve and flange loads and (2) valve modelling. The CPRT third-party (TENERA, L.P.) identified the following three primary issues in its Engineering Evaluation DAP-E-P-025 "Valve & Flange Qualifications & Valve Modelling":

(1) main steam relief valve qualification
(2) modelling of supported valves
(3) valve and flange qualification

23.1 Main Steam Relief Valve Qualification

The issue background is discussed in DAP External Source Issue Summary ESIS-P-025 (Attachment A to DAP-E-P-025). The SWEC resolution methodology is discussed in the piping project status reports (Subappendix A25 Section 2.2.). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-025 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.23).

CYGNA identified that snubbers on Fisher main steam relief valves were not qualified to as-built loads. This led to the concern regarding the qualification of the main steam relief valves themselves for the as-built loads. The SWEC validation of the Fisher relief valve branch connection piping model included the effects of the snubbers on the valve. SWEC procedures require both valve accelerations and support loads to be provided to the equipment qualification organization (Impell Corporation) performing design validation or to Westinghouse for validation as applicable. The staff finds the SWEC procedures provide specific guidelines to ensure that design-validated loads imposed on the Fisher valves are used in the design validation of the valves and are, thus, acceptable. CYGNA has also reviewed this issue and resolution and has subsequently closed it in Revision 4 to the review issues list for pipe stress (Item 6) (Reference A14).

23.2 Modeling of Supported Valves

The issue background is discussed in the DAP External Source Issue Summary ESIS-P-025 (Attachment A to DAP-E-P-025). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A25 Section 2.3). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-023 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.23).

CYGNA raised questions about the stiffness used in the modeling of the yoke on Fisher valves. SWEC developed a cantilever-based equation as provided in paragraph 3.10.6.5 of CPPP-7 to determine a yoke moment-of-inertia using the valves fundamental frequency. The DAP review of this equation as provided in DAP-E-P-023 found it results in a reasonable, fundamental frequency-based valve model. Similarly, the DAP review of the valve mass distribution found that it is a relatively common method and provides a reasonable discrete mass model of a distributed mass component.

On the basis of the DAP conclusions, the staff finds the modeling of Fisher valves to be adequately resolved. CYGNA also reviewed the SWEC modeling method and found it has adequately addressed its questions as summarized in the pipe stress review issues list (Item 18) (Reference A14).

23.3 Valve and Flange Qualification

The issue background is discussed in DAP External Source Issue Summary ESIS-P-025 (Attachment A to DAP-E-P-025). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A25 Section 2.4). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-025 (Section 5.4.2) and is summarized in the piping results report (Section 3.2.3.23).

The concern raised by CYGNA was that the Gibbs & Hill sampling process to determine the worst-case valve or flange loads in a piping stress analysis might not have been sufficient to ensure that all valves and flanges were properly qualified. The SWEC methodology requires that all valves be qualified for applicable acceleration and end load allowables, and all flange joints be qualified for moment loadings including ASME qualification of the flange bolts.

On the basis all valve and flanges being qualified to their respective allowable limits, the staff finds the SWEC methodology acceptable. CYGNA also reviewed the SWEC procedures and has found this issue was adequately addressed as summarized in the CYGNA pipe stress review issues list (Item 21) (Reference A14).

23.4 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with valve modeling and valve/flange qualification have been adequately resolved. The generic technical issue concerning valve and flange qualification and valve modelling is, therefore, closed for CPSES.

24 PIPING MODELING

Several concerns about piping modeling were raised in the CYGNA Independent Assessment Program for CPSES which could have affected more than one specific pipe stress analysis package. The CPRT third-party (TENERA, L.P.) identified 13 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-026, "Piping Model," TENERA summarized these concerns into four areas:

(1) pipe support locations
(2) stress intensification factors (SIF)
(3) valve and flange insulation and fluid mass
(4) snubbers adjacent to equipment nozzles

24.1 Pipe Support Locations

The issue background is discussed in DAP External Source Issue Summary ESIS-P-026 (Attachment A to DAP-E-P-026). The SWEC resolution methodology is provided in the piping project status reports (Section 5.1.1.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-026 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.24).

A number of pipe support locations modeled in the Gibbs & Hill piping stress analyses differed from the actual installed location by more than the tolerance limits. The SWEC methodology involves the use of as-built drawings for all CPSES piping analysis performed in the CAP design validation. In addition, SWEC verified the accuracy of as-built data including support location in a preliminary walkdown of selected piping systems conducted in accordance with CPPP-5 (Appendix E to this supplement) before initiating stress analyses. The staff evaluation of the CPPP-5 walkdown as discussed in Section 4.1.2.1 of this supplement found the SWEC walkdown adequate in verifying support locations shown on piping as-built drawings.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues lists for pipe stress (Item 14) and pipe supports (Item 44) (References A14 and A10, respectively).

24.2 Stress Intensification Factors (SIFs)

The issue background is discussed in DAP External Source Issue Summary ESIS-P-026 (Attachment A to DAP-E-P-026). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A26 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-026 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.24).

CYGNA identified instances of incorrect SIFs used in the Gibbs & Hill piping stress analyses. The SWEC resolution methodology used SIFs from more recent ASME Code editions than the piping code of record (Reference A16) as permitted in paragraph NA-1140(f) of ASME Code, Section III. The staff review of the SIFs used in the SWEC piping analyses was performed in conjunction with the staff's audit of the SWEC report, "Documentation of ASME III NA-1140 Review for Piping and Supports" (NA-1140 report). The staff evaluation of the NA-1140 report is discussed in Section 4.1.2.2 of this supplement.

The staff audit of SIFs used by SWEC in the CPSES piping design validation included an assessment of the SIF used to evaluate piping weld shrinkage. The SWEC approach to evaluate weld shrinkage is described in Project Memorandum (PM) - 229 (Appendix E to this supplement).

The rules for ASME Code Class 2 and 3 piping systems do not contain explicit design provisions for evaluating weld shrinkage effects in piping. However, the rules for ASME Code Class 1 piping systems do address weld shrinkage in NB-3683.4(b). The stress indices therein are not applicable when x/t is greater than 0.25 where x is the radial shrinkage measured from the nominal outside diameter.

At CPSES, weld shrinkage is defined in piping where x/t is greater than 0.5. The SWEC Project Memorandum PM-229 provides specific guidelines for cases where weld shrinkage exists. The guidelines provide screening rules to determine when weld reinforcement is required including the analysis rules to be used. The guidelines also require re-work of the weld when x/t is greater than 1.0. Additionally, the guidelines provide a stress intensification factor (i) for evaluating welds with radial weld shrinkage with no weld reinforcement. The SIF value and the range of applicable x/t values are based on a report by S. E. Moore entitled "ASME Code Stress Intensification Factors for Comanche Peak Steam Electric Station, Units 1 and 2" (Moore report). The conclusions in the Moore report were verified by SWEC using finite element analysis methods.

SWEC performed a walkdown at the CPSES site to determine the extent of weld shrinkage that actually exists. Seven cases were found with a radial shrinkage due to welding (x) that resulted in a ratio of x/t greater than or equal to 0.5. In addition to measuring shrinkage, SWEC personnel mapped the length over which the shrinkage occurred. The result was a detailed configuration of the wall thickness and diametrical geometry in the region of the shrinkage. This allowed SWEC to develop detailed finite element models to evaluate the effect of shrinkage on stress intensification factors and to use those results to compare with the Moore report.

The SWEC finite element analysis, the walkdown to measure and map geometry, and the Moore report indicate weld shrinkage values (x/t) at CPSES are conservatively addressed by SWEC procedures. Based on the above discussion, the staff finds the SIF used to evaluate piping weld shrinkage to be conservative.

The staff review of other SIFs from more recent ASME Code editions as used in the SWEC design validation finds that all applicable related requirements have been adequately addressed per paragraph NA-1140 of ASME Code, Section III, and the SIFs are, thus, acceptable.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe stress (Item 10) (Reference A14).

24.3 Valve and Flange Insulation and Fluid Mass

The issue background is discussed in DAP External Source Issue Summary ESIS-P-026 (Attachment A to DAP-E-P-026). The SWEC resolution methodology is provided in the piping project status report (Subappendix A26 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-026 (Section 5.4.2) and is summarized in the piping results report (Section 3.2.3.24).

The primary issue was that the Gibbs & Hill piping stress analysis model did not include water and insulation mass at valves and flanges. The SWEC design criteria include a general requirement to include mass effects of piping contents and insulation in analyses. The DAP evaluation found that the procedure was adequate to address the issue. The staff finds that the inclusion of piping contents at valves and flanges and the inclusion of insulation weight by SWEC in the piping design validation adequately solve this issue.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe stress (Item 4) (Reference A14).

24.4 Snubbers Adjacent to Restrained Piping Locations

The issue background is discussed in DAP External Source Issue Summary ESIS-P-026 (Attachment A to DAP-E-P-026). The SWEC resolution methodology is provided in CPPP-7, Paragraph 3.10.6.10. The DAP evaluation is provided in Engineering Evaluation DAP-E-P-026 (Section 5.5.2) and is summarized in the piping results report (Section 3.2.3.24).

CYGNA identified certain snubbers on piping located close to rigid attachment points (e.g., equipment nozzles). The concern was that piping dynamic displacements intended to be restrained by the snubber may be insufficiently small to activate the snubbers. The SWEC approach is to evaluate the piping displacement at snubbers in close proximity to anchors and equipment to determine if the snubbers can be activated as assumed in the analysis. The staff finds that the SWEC guidelines provide a sufficient cautionary note for the piping analyst to verify the snubber modeling assumptions and are, thus, acceptable.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues lists for pipe stress (Item 7) (Reference A14).

24.5 Minimum Pipe Wall Thickness Violations

The NRC's technical review team (TRT) and intervenor CASE discussed this issue on November 7, 1984. The concern was that a large amount of piping received at CPSES before 1982 had wall thickness less than the minimum wall thickness allowed by the piping specification and that the nonconformance reports (NCRs) did not adequately resolve the deviations.

The SWEC resolution methodology includes a review of all minimum pipe wall violations documented in NCRs. The NCRs are reconciled with the piping stress analyses to ensure that any stress increase resulting from the reduced wall thickness is within Code allowable stresses.

The SWEC design criteria in CPPP-7, Attachment 3-14, contain specific guidelines for evaluating localized thinning of the pipe wall in straight pipe sections. The guidelines utilize a factor to evaluate the stress increase based on the ratio of the manufacturer's required minimum wall thickness to the actual wall thickness. The factored stress approach is an acceptable method to evaluate pipe wall thinning because the potential stress increase is linearly proportional to the change in wall thickness. In addition, Project Memorandum (PM)-137 does not allow an evaluation of pipe wall thickness less than the minimum wall thickness required by ASME Code, Section III, in Paragraph NC/ND-3640 for pressure design. Any pipe wall thicknesses less than the Code minimum is reported to the SWEC Options Review Committee for resolution on a case-by-case basis. To date, no pipe wall thicknesses less than the Code minimum have been identified.

On the basis of the SWEC methodology ensuring that minimum pipe wall thickness violations are appropriately evaluated, the staff finds the concerns regarding previous erroneous closure of the NCRs related to pipe minimum wall violations have been adequately resolved. In addition, CYGNA has reviewed the SWEC methodology for addressing pipe wall thickness violations and found it acceptable as summarized in the CYGNA pipe stress review issues list (Revision 4) Issue 27 (Reference A14).

24.6 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with piping modeling have been adequately addressed in the piping design validation activities. The generic technical issue is, therefore, closed for CPSES.

25 DESIGN OF WELDS

Several concerns were raised regarding the adequacy of the design methods used for sizing welds and evaluating weld stresses in pipe supports at CPSES. The CPRT third-party (TENERA, L.P.) identified 20 related issues from various source documents. In its Engineering Evaluation DAP-E-P-027, "Welding," TENERA categorized these issues into five design areas:

(1) unsymmetrical welds (eccentricity of three-sided welds)
(2) cover plate welds
(3) minimum weld size (undersize fillet welds)
(4) combination bolt and welded connections
(5) skewed T-joint welds

The staff evaluation of minimum weld size is discussed Section 8.10 of this appendix.

The staff evaluation of skewed T-joint welds is discussed in Sections 8.4 and 8.5 of this appendix.

Further evaluations of the design of welds with respect to specific provisions of AWS D1.1 applying to ASME Code, Section III, pipe supports is discussed in Section 8 of this appendix.

25.1 Unsymmetrical Welds (Eccentricity of Three-Sided Welds)

The issue background is discussed in DAP External Source Issue Summary ESIS-P-027 (Attachment A1 to DAP-E-P-027). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A27 Section 2.3). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-027 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.25).

The primary concern was that TUGCO pipe support designers did not consistently evaluate the eccentricity between the member center of gravity and the weld center of rigidity when determining weld loads to be used in the design. The SWEC approach is to evaluate the weld eccentricities using the guidelines and equations provided in CPPP-7 Paragraphs 3.1.2, 4.6, and 4.7. The DAP evaluation found the SWEC guidelines and equations technically adequate. On the basis of the DAP conclusions on the adequacy of the CPPP-7 guidelines and equations, the staff finds that specific methods for evaluating weld eccentricities have been developed and implemented in the pipe support design validation and are, thus, acceptable.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 22) (Reference A10).

25.2 Cover Plate Welds

The issue background is discussed in DAP External Source Issue Summary ESIS-P-027 (Attachment A1 to DAP-E-P-027). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A27 Section 2.6). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-027 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.25).

The concern as identified by CYGNA in its Independent Assessment Program was that the weld design for cover plates welded to tube steel or wide flanges did not consistently evaluate all applicable loads. The SWEC guidelines for evaluating cover plate welds for shear flow are provided in CPPP-7, Attachment 4-2, Paragraph 3.1.5, and for evaluating weld stresses in general are provided in CPPP-7, Attachment 4-2, Paragraph 4.0. The staff review of the SWEC design criteria finds that the procedures require an evaluation of cover plate welds for all applicable loads and are, thus, acceptable. CYGNA has subsequently closed this issue in Revision 4 to the pipe support review issue list (Issue 23) (Reference A10).

25.3 Combination Bolt and Welded Connections

The issue background is discussed in DAP External Source Issue Summary ESIS-P-027 (Attachment A1 to DAP-E-P-027). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A27 Section 2.5). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-027 (Section 5.5.2) and is summarized in the piping results report (Section 3.2.3.25).

The ASME Code Section III (Reference A32) states in Appendix XVII-2442, "SA-307 bolts or high strength bolts used in bearing type connections shall not be considered as sharing the stress in combination with welds. Welds, if used, shall be provided to carry the entire stress in the connection." The SWEC methodology requires that welds in combination welded/bolted connections be designed for the entire shear force. For pipe support baseplates (including the Richmond insert/tube steel designs), the staff finds the SWEC guideline is in accordance with the above-stated ASME Code Section III, requirement, since the direction of bearing on bolts in baseplates is also the shear direction in the baseplates. The Code provision was intended to address the deformation incompatibility between welds and bearing connections in the direction of bolt bearing. The staff understands that tensile loads (perpendicular to the plane of the baseplate) are assumed by SWEC to be shared between the weld and the bolt. This practice is acceptable provided weld deformation is compatible with the bolt tensile deflection.

Because the SWEC guidelines satisfy the applicable ASME Code requirement, as qualified above, the staff finds that the SWEC method for evaluating the welds in combination with bolts satisfies the ASME Code requirement and is, thus, acceptable.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe supports (Item 2) (Reference A10).

25.4 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with weld sizing and weld stress evaluation have been adequately addressed. The generic technical issue concerning the design of welds is, therefore, closed for CPSES.

26 ANCHOR BOLTS

Several concerns were raised regarding the adequacy of pipe support designs using concrete expansion anchor bolts. The CPRT third-party (TENERA, L.P.) identified 38 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-028, "Anchor Bolts," TENERA categorized these concerns into three areas:

(1) Baseplates fastened to concrete with Hilti expansion anchors should be designed as friction-type rather than as bearing-type connections.

(2) Anchor bolt location tolerance may result in increased bolt loads and baseplate stress that have not been accounted for in design procedures.

(3) Installed anchor bolt embedment length in concrete may not be properly considered in design and as-built reconciliation procedure.

26.1 Friction Versus Bearing Connections

The issue background is discussed in DAP External Source Issue Summary ESIS-P-028 (Attachment A to DAP-E-P-028). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A13 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-028 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.26).

The AISC Code (7th Edition) (Reference A28) Commentary states:

> 1.5.2.1 Shear
>
> Connections which transmit load by means of shear in their fasteners are categorized as "friction-type" or "bearing-type." The former depend upon sufficiently high clamping force to prevent slip of the connected parts. The latter depend upon contact of the fasteners against the sides of their holes to transfer the load from one connected part to another.

Many questions and issues were raised as to whether baseplates fastened with concrete expansion anchors (e.g., Hilti Kwik-Bolts) should be designed as friction or bearing connections. In a related concern, the pipe support designers in some cases were using a bolt hole size with 1-inch diameter bolts in concrete anchorages that was 1/16 inch larger than permitted by ASME Code, Section III (Reference A19). Both issues are related to whether shear loads in concrete anchor bolts can be shared equally among the bolts in the baseplate. A concern was also raised that bearing connections are not permitted to be used in dynamic load applications.

The SWEC methodology has adopted Paragraph NF-4721(a) of the ASME Code Section III, 1985 Summer Addenda. Therein, the Code provided an additional 1/16-inch increase in the hole size for concrete anchor bolts of 1 inch diameter. Using this later Code provision, the bolt hole sizes for CPSES pipe supports satisfy ASME Code requirements. As such, the evaluation of the concrete anchor bolts in baseplates assumes an equal sharing of the baseplate shear load by all bolts as a bearing connection.

The staff finds the SWEC approach to evaluate concrete anchor bolts as bearing connections to be consistent with industry practice. The acceptability of using the later ASME Code paragraph has been reviewed by the staff as a part of its review of the SWEC NA-1140 report as discussed in this supplement in Section 4.1.2.2 and found acceptable.

TENERA in conjunction with the DAP evaluation has reviewed the acceptability of using bearing connections in dynamic load applications. On the basis of TENERA's review of the Westinghouse Report No. HEDL-7246, "Final Report, USNRC Anchor Bolt Study, Data Survey, and Dynamic Testing," (Reference A47) TENERA concluded that the Westinghouse dynamic tests demonstrate that bolt preload has no influence on the ultimate strength of the expansion anchors (including shear) and only a slight influence on load-displacement characteristics. Further review by TENERA of the CPSES Hilti installation procedure found that the procedures require fairly high preload corresponding to a level at which Westinghouse tests show that preload has no effect on load-displacement behavior. On the basis of the DAP evaluation, the staff finds that the Westinghouse dynamic tests demonstrate that concrete anchor bolts when used as bearing-type connections in pipe support baseplates are acceptable for dynamic load applications. In addition, an evaluation of a bearing connection with a 1-1/8 inch bolt hole size for a 1-inch diameter anchor bolt (assuming shear with no friction) was performed by CYGNA and addressed in the ASLB hearings in "CASE Question: Doyle #16" (Appendix F to this supplement) and found to be acceptable.

The staff finds that concrete anchor bolts when tested as bearing-type connections satisfactorily perform their intended functions during dynamic loadings. The design of baseplates fastened with concrete expansion anchors as bearing-type connections, are, thus, acceptable.

26.2 Baseplate Edge Distance

The issue background is discussed in DAP External Source Issue Summary ESIS-P-028 (Attachment A to DAP-E-P-028). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A28 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-028 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.26).

The issue raised by CYGNA in its Independent Assessment Program that anchor bolt edge distance tolerances could result in a 15 percent increase in baseplate stresses for baseplate designs with struts, springs, or snubbers with a 5-degree offset. SWEC performed a bounding analysis of the effects of edge distance tolerances on bolt loads and plate stresses using as-built dimensions. The SWEC analysis showed that the highest bolt interaction ratio increase was 5 percent and the baseplate stress increase was 1 percent. The DAP evaluation found the baseplate edge distance tolerances to be acceptable on the basis of the SWEC analysis results.

On the basis of the DAP conclusions, the staff finds the concerns to be adequately addressed. In addition, CYGNA has subsequently reviewed the SWEC analysis and on the basis of the SWEC result has also closed this issue in Revision 4 to the pipe support review issues list (Issue 11) (Reference A10).

26.3 Embedment Lengths

The issue background is discussed in DAP External Source Issue Summary ESIS-P-028 (Attachment A to DAP-E-P-028). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A28 Section 2.3). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-028 (Section 5.4.2) and is summarized in the piping results report (Section 3.2.3.26).

The issue was raised in the CYGNA Independent Assessment Program pertaining to the discrepancy between the embedment lengths of Hilti Kwik-Bolts shown on the design drawings and the embedment lengths used in the support calculations. Although this issue was previously closed by CYGNA (pipe support review issues list, Item 17), the SWEC resolution methodology addresses this issue for the

CAP design validation by using the embedment lengths shown on the drawings in the SWEC pipe support calculations. Because of the SWEC use of embedment lengths from the design drawings in the support calculations, the staff finds that the issue identified by CYGNA has been adequately addressed in the piping design validation.

26.4 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with anchor bolts have been adequately resolved. The generic technical issue concerning anchor bolts is, therefore, closed for piping systems at CPSES.

27 STRUT ANGULARITY

Concerns were raised that the angular orientation of pipe supports (i.e., snubbers and struts) relative to the pipe was not properly considered in the piping and support designs at CPSES. The CPRT third-party (TENERA, L.P.) identified nine related concerns from various source documents. In its Engineering Evaluation DAP-E-P-029 "Strut Angularity," TENERA categorized these concerns into two areas:

(1) design considerations for strut angularity (kick load)
(2) justification for an angularity tolerance of 5 degrees

27.1 Design Considerations for Strut Angularity (Kick Load)

The issue background is discussed in DAP External Source Issue Summary ESIS-P-029 (Attachment A to DAP-E-P-029). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A27 Sections 2.1 and 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-029 (Sections 5.2.2 and 5.4.2) and is summarized in the piping results report (Section 3.2.3.27).

When a strut or snubber is installed on a piping system at an angle not perpendicular to the pipe axis, a load component in the direction of the pipe axis results ("kick load"). The concern raised was whether this kick load had been adequately considered in the piping and pipe support designs.

The SWEC piping analysis input includes as-designed support angularities in the piping analytical model. In this manner, any system instabilities or kick loads are calculated. If the swing angle deviation from the stress analyzed orientation exceeds 5 degrees, then an evaluation is required to ensure the proper function and load rating of the strut/snubber assemblies including consideration of the additional load component. The swing angle consists of the sum of the installation deviation plus the angular swing due to thermal, seismic, and dynamic transients (as applicable). Walkdowns were conducted to verify all strut/snubber orientations and those that exceeded 2 degrees were noted in the as-built drawings. The effect of a kick load for angular deviations less than 5 degrees from the analyzed position is not evaluated on a system basis. However, because significant changes are being made to bring the CPSES piping and pipe support design into conformance with accepted industry practice (e.g., snubber optimization and elimination of small snubbers on large diameter piping), the impact of kick loads is significantly reduced (e.g., kick loads from large snubbers will not cause failure to small snubbers on the same system).

On the basis of the design considerations discussed above, the staff finds that the SWEC evaluation of kick loads exceeds common industry practice because no evaluation is generally performed for support angular deviations less than 5 degrees and is, thus, acceptable.

The staff performed several audits to assess the adequacy of SWEC's implementation of CPPP-7 angularity guidelines (Appendix D to this supplement - Events 2, 28, 32, 34, and 35). The staff selected five supports to review the analytical modeling of the support angularity and subsequently verified the as-installed support angularity in the CPSES plant. The staff found that the support angularities were in accordance with the CPPP-7 guidelines and tolerances and are thus acceptable.

27.2 Justification for 5 Degree Angular Tolerances

The issue background is provided in Appendix F to this supplement (Issue 5). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-029 (Section 5.3.2).

The staff recognizes that an angular change in support orientation can significantly affect the support loads calculated in the piping stress analysis and was a major factor to be considered in Office of Inspection and Enforcement (IE) Bulletin 79-14 (Reference A48). IE Bulletin 79-14 addressed as-built piping systems and recognized that excessive construction and installation deviations might exist and must be reconciled with the design analyses. The staff acknowledges that construction and installation tolerances are a necessity in order to proceed with construction in a reasonable manner. A 5-degree construction tolerance was established by the applicant for pipe support angular deviation. There are several reasons of which the staff is aware for the basis of the 5-degree tolerance:

(1) The pipe support manufacturers provide functional tolerance in their catalogs for pipe clamps and brackets to account for installation misalignment. This tolerance is typically ± 5-degree or a 10 degree to 12 degree cone of action. Loading beyond this tolerance is not recommended and could exceed the load rating of the catalog item. Thus, the installation tolerance should account for the functionality of support hardware.

(2) The angular tolerance should not result in a significant load increase that can invalidate the calculated loads. On the other hand, the installation tolerance should not be so restrictive as to exceed the accuracy of the calculation itself. A 5-degree offset will, in most cases, result in a load increase (or decrease) of less than 10 percent (i.e., sin 5-degree = 0.087).

(3) Although the staff does not dispute the fact that a "kick" load exists as a result of skewed restraints, the staff does not believe that kick loads caused by a 5-degree skew tolerance will result in an unstable collapse of the piping system because of the redundant nature of pipe supports and the inherent ductility of the piping. The staff believes the 5-degree tolerance is an appropriate tolerance as a general rule, but there are

certain exceptions where the practice should be evaluated with due caution. These exceptions include where the 5-degree tolerance can result in a load exceedance of more than 10 percent or where a 10 percent load increase can be considered significant (e.g., near sensitive equipment nozzles).

(4) The 5-degree angular tolerance for pipe support installation is used in many nuclear facilities and has been found to be a reasonable basis for achieving the goals of both design and construction of piping systems and is recommended in WRC Bulletin 316 (Reference A49).

On the basis of the above reasons, the staff finds the 5-degree angular tolerance to be acceptable.

27.3 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with strut and snubber angularity have been adequately addressed. The generic technical issue concerning strut angularity is, therefore, closed for CPSES.

28 STRUCTURAL MODELING FOR FRAME ANALYSIS

Several concerns were identified regarding the modeling assumptions used as input to the computer analyses for CPSES pipe supports. The CPRT third-party (TENERA, L.P.) identified 10 related concerns from various source documents. In its Engineering Evaluation DAP-E-P-031 "Structural Modeling for Frame Analyses," TENERA categorized these concerns into two primary areas:

(1) torsional stiffness of wide flange members
(2) member end restraint and boundary condition modeling

28.1 Torsional Stiffness of Wide Flange Members

The issue background is discussed in the DAP External Source Issue Summary ESIS-P-031 (Attachment A to DAP-E-P-031). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A31 Section 2.1). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-031 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.28).

The primary concern was that the previous pipe support design procedures required the use of an extremely high value (10,000 $in.^4$) for the torsional resistance of wide flange members in order to conservatively calculate wide flange member torsional stress. The procedure, however, could result in unconservative deflections and did not account for local effects in the wide flange members at locations of torsional loading.

The SWEC method uses values for torsional resistance from the AISC Manual of Steel Construction (8th Edition) (Reference A31) and provides equations for evaluating member stresses including local effects due to torsional loading. TENERA reviewed the adequacy of SWEC's methods and found it to be a conservative approach for evaluating wide flange stresses induced by torsion. The DAP evaluation found that the SWEC modeling of wide flange torsional resistance is based on geometric parameters of the section. SWEC guidelines for stiffening wide flange connections validate member end modeling assumptions. Table 4.7.2-3 of CPPP-7 provides equations that evaluate torsional stress in wide flange members. Torsional shear, warping shear, and warping normal stresses are all conservatively evaluated by assuming each stress is produced by the full torsional moment. These stresses are also conservatively combined with other stresses by assuming that all maximum stresses occur at the same point in the wide flange cross section.

The staff review of the DAP evaluation finds it provides an adequate basis for acceptability. On the basis of the DAP conclusions, the staff finds that the SWEC method provides adequate guidelines for evaluating torsional effects in wide flange members and is, thus, acceptable.

28.2 Member End Restraint and Boundary Conditions

The issue background is discussed in DAP External Source Issue Summary ESIS-P-031 (Attachment A to DAP-E-P-031). The SWEC resolution methodology is provided in the piping project status report (Subappendix A31 Section 2.2). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-031 (Section 5.3.2) and is summarized in the piping results report (Section 3.2.3.28).

The primary concern was the inconsistent modeling assumptions used for the tube steel member and constraint of moments at Richmond insert connections. The SWEC method is to model the tube steel frame with a member connecting the centerline of the tube steel frame to the face of the concrete at the Richmond insert connections. This connecting member is modeled with the properties of the threaded rod in the Richmond insert. The two bending moments on the threaded rods are fixed but the torsional moment is released. The SWEC procedure further provides guidelines for modeling the eccentricity between the tube steel centerline and threaded rod. The DAP evaluation of the adequacy of this modeling technique found it results in an acceptable evaluation of member stress and stiffness. The staff review finds the SWEC modeling technique provides an analytical model that is reasonably representative of the actual system behavior and is, thus, acceptable.

28.3 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with torsional considerations in wide flange members and Richmond insert/tube steel modeling have been adequately address. The generic technical issue concerning structural modeling in frame analysis of pipe supports is, therefore, closed for CPSES.

29 COMPUTER VERIFICATION AND USE

Concerns were raised regarding the adequacy and applicability of certain computer programs previously used for pipe support designs at CPSES. The CPRT third-party (TENERA, L.P.) identified nine related concerns from various source documents. In its Engineering Evaluation DAP-E-P-032, "Computer Program Verification and Use," TENERA categorized these concerns in the following two areas:

(1) computer program verification and qualification
(2) computer program version

29.1 Computer Program Qualification

The issue background is discussed in DAP External Source Issue Summary ESIS-P-032 (Attachment A to DAP-E-P-032). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A32 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-032 (Sections 5.2.2 and 5.3.2) and is summarized in the piping results report (Section 3.2.3.29).

The initial concerns were related to the specific computer programs: (1) ADLPIPE Version 2C (a Gibbs & Hill piping stress analysis program), (2) FUB-II (an ITT Grinnell baseplate qualification program), and (3) a Corner and Lada baseplate qualification program. The specific concerns are described below:

(1) The ADLPIPE piping analysis program used Version 2C dated April 1977. That program version date differs from the version date identified in the FSAR, which is September 1972. Also, the version used is based on the 1974 ASME Code, Section III, with Addenda through Winter 1975. This differs from the Code identified in the Gibbs & Hill piping design specification 2323-MS-200, which identifies the 1974 ASME Code, Section III, through Summer 1974 Addenda as the code of record.

(2) FUB-II is an ITT Grinnell program used to qualify pipe support baseplates with unsymmetrical bolt patterns. The specific concern was that the program checks loads at only one of four baseplate bolts.

(3) The Corner and Lada baseplate qualification program assumes rotation about the center of attachment points. There is concern that this assumption is not accurate because of the rigidity at this point.

The above computer programs are not used in the SWEC design validation of piping and pipe supports. The primary computer programs used in the design validation by SWEC are listed in CPPP-7, Section 5.0.

The DAP evaluation found that the SWEC computer programs are controlled by SWEC quality assurance program requirements with regard to verification, technical adequacy, and use of appropriate versions. The DAP concluded that the SWEC methods used to control computer program use are acceptable. The staff review verified that the three computer programs ADLPIPE Version 2C, FUB-II, and the Corner and Lada baseplate programs are not used by SWEC in the CPSES design validation. In addition, the staff review finds that the concern about the Code edition used in the piping stress analysis program being different from the code of record has been addressed in conjunction with its review of the stress intensification factors in Section 24.2 of this appendix and with its review of the SWEC NA-1140 report in Section 4.1.2.2 of this supplement.

The SWEC baseplate program BAP calculates loads for all bolts in the baseplate and, thus, the concern that only one of four bolt loads was calculated is not applicable to the SWEC program.

The concern with the Corner and Lada baseplate program was related to its assumption of a point loading at the center of attachment. The BAP program models the attachment perimeter and considers the stiffening effect of the support attachment. Thus, the concern of a point loading not considering rigidity effects is not applicable to the SWEC program.

The staff finds the specific concerns associated with the ADLPIPE, FUB-II, and Corner and Lada programs are not applicable to the piping stress and baseplate program used by SWEC in the piping and pipe support design validation and, thus, the SWEC computer programs are acceptable.

29.2 Conclusion

Based on the above evaluation, the staff concludes that the concerns associated with ADLPIPE Version 2C, FUB-II, and the Corner and Lada baseplate computer programs are no longer applicable to CPSES piping and pipe support design. The generic technical issue concerning computer verification and use is, therefore, closed for CPSES.

30 HYDROTEST

Concerns were raised that hydrotest loading conditions were not adequately considered for piping and pipe support designs at CPSES. The CPRT third-party (TENERA, L.P.) identified seven related concerns from various source documents. In its Engineering Evaluation DAP-E-P-034 "Hydrotest," TENERA described these concerns as follows:

(1) Damage observed during or subsequent to a hydrotest to the component cooling water system was attributed to the hydrotest. This involved local yielding of support CC-1-116-038-F43R, indicating to the observer that the support had not been adequately designed for the load.

(2) Third-party review by CYGNA indicated hydrotest conditions were not considered in support design calculations and piping analysis. Apparently, design consideration of hydrotest conditions was by a hydrotest temporary support procedure only.

In addition, the NRC's technical review team (TRT) identified a concern that hydrostatic loadings imposed on the main steamlines during flushing conditions may have caused overstress of the piping. This issue is discussed in detail in Supplement 10 (p. N-102 in AP-13) (Reference A50).

30.1 Design Considerations for Hydrotest Conditions

The issue background is discussed in DAP External Source Issue Summary ESIS-P-034 (Attachment A to DAP-E-P-034). The SWEC resolution methodology is provided in the piping project status reports (Subappendix A33 Section 2.0). The DAP evaluation is provided in Engineering Evaluation DAP-E-P-034 (Section 5.2.2) and is summarized in the piping results report (Section 3.2.3.30).

The primary concern was that piping and pipe supports at CPSES were not adequately designed for hydrostatic test loadings. For piping, the SWEC methodology is based on Paragraph NC-6221 of the ASME Code, Section III, 1974 Edition including the Winter 1975 Addenda. The CPSES code of record for piping is the 1974 Edition including the Summer 1974 Addenda. The use of the paragraph from the later Code addenda revised the minimum required hydrostatic test pressure from 1.5 times to 1.25 times the design pressure. As discussed in Code Interpretation III-1-83-96, the requirement for a 1.5 times design pressure was an error and, thus, there are no related requirements affected by this change. The staff review of the use of later Code paragraphs is discussed further in this supplement in Section 4.1.2.2.

For steam piping, as specified in CPPP-7, Paragraph 3.4.5.2, a loading condition is analyzed assuming that the piping is cold but filled with water in order to calculate hydrotest loads and stresses. This hydrotest condition also assumes that spring hangers are locked. The analysis assumptions are consistent with the actual system conditions during hydrotest loadings and are, thus, acceptable. The dead weight load of the pipe and contents during test loading conditions is also specified in the load combinations for pipe supports. Punching shear effects in tube steel members are considered as discussed in Section 8.6 of this appendix (which was the primary concern with support CC-1-116-038-F43R).

On the basis of the above discussions, the staff finds that the SWEC methodology for considering hydrostatic test loadings is in accordance with the ASME Code, Section III, requirements and properly accounts for the associated loads in the design of piping and pipe supports and is, thus, acceptable. The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues list for pipe stress (Item 25) (Reference A14).

30.2 Main Steam Line Flushing

Supplement 10 (Reference A50) provides the results of the staff's evaluation of technical concerns and allegations in the mechanical and piping area regarding construction practices at CPSES. An issue was identified in Supplement 10 concerning the flushing of the main steam piping. The staff required in part that TU Electric assess stresses in the portions of the Unit 1, loop 1 main steam and feedwater lines that were affected in the sequence of events involved during their initial installation, flushing, and final installation. Conditions of concern are those

(a) when the lines were full of water and temporary supports had sagged or settled

(b) when vibrations of the temporary line could have occurred

(c) when forces were applied by the polar crane and come-alongs

Pipe stress analyses were performed by SWEC for loops 1 and 4 main steam lines considering (1) pre-lift phase, (2) disconnect phase, (3) lifting phase, and (4) flushing phase. The CPRT found, in all cases, the maximum stress levels were within ASME Code limits. Thus, the staff finds the results of the stress analyses provide an adequate basis to conclude that the effects of initial installation, flushing, and final installation of the main steam piping did not adversely affect the structural integrity of the piping system and are, thus, acceptable.

30.3 Conclusion

Based on the above evaluations, the staff concludes that the concerns associated with the design considerations used for the hydrostatic test loading conditions have been adequately resolved. The generic technical issue concerning hydrotest is, therefore, closed for CPSES.

31 SEISMIC/NON-SEISMIC INTERFACE

31.1 Seismic Design Considerations for Piping Routed Between Seismic Category I and Non-Seismic Category I Buildings

This issue was initially identified by the NRC staff's technical review team in Supplement 10 (page N-329) (Reference A50). The issue background is provided in the CPRT Program Plan (Revision 3) (Reference A51) under Appendix C, Issue-Specific Action Plan (ISAP) V.c, "Design Considerations for Piping Systems Between Seismic Category I and Non-Seismic Category I Buildings." Because the CAP design validation for piping included provisions for the reanalysis of all seismic Category I piping including the seismic to non-seismic transition regions, this issue was addressed within the CAP design validation activities performed by SWEC. Accordingly, the scope of the ISAP V.c results report (Reference A52) was reduced. The SWEC resolution methodology for this issue is provided in the piping project status reports (Subappendix A34 Section 2.0). The DAP evaluation is provide in Engineering Evaluation DAP-E-P-038, "Seismic/Non-Seismic Interface" (Section 5.0) and is summarized in the piping results report (Section 3.2.3.31).

In Supplement 10, the staff required that TU Electric provide an analysis and documentation that the piping systems routed from Seismic Category I to non-seismic Category I buildings meet the commitments provided in FSAR (Reference A53) Sections 3.7B.3.13.1 and 3.7B.2.8 which include the assumption of a turbine building failure. In CPPP-7, Attachment 4-10, the SWEC criteria and methods for the design of seismic/non-seismic piping interfaces are provided. These interface design criteria are used for the evaluation of anchors on seismic piping in the seismic Category I buildings which are connected to non-seismic piping in the non-seismic Category I buildings (e.g., turbine building). In addition, Project Memorandum PM-203, "Clarification for CPPP-7, Attachment 4-10, Design Methods for Interface Anchors," September 4, 1987, limits the option of seismically analyzing non-seismic piping to only those piping systems located in seismically analyzed buildings.

The staff review of the SWEC design criteria finds that three methods were developed for evaluating the piping routed between seismic Category I and non-seismic Category I buildings. Two of the methods involve seismically analyzing the non-seismic piping (or portions of the non-seismic piping) using alternate seismic design criteria and analysis methods from those used for safety-related ASME Code Class 2 and 3 piping systems. These methods have been reviewed by TENERA and were found accpetable. However, their use for piping in the turbine building would not be acceptable based on the turbine building failure assumption during a safe shutdown earthquake. The third SWEC method assumes the formation of a plastic hinge at the interface anchor and, thus, conservatively considers a building failure assumption. PM-203 ensures that the two methods previously discussed will not be used for piping routed between seismic Category I and non-seismic Category I buildings. The staff finds the three methods described in CPPP-7, Attachment 4-10, as clarified by PM-203 to be acceptable.

As part of its audit on the CAP implementation (Appendix D of this supplement - Event 36), the staff selected a seismic/non-seismic interface anchor in the auxiliary feedwater system to review the methods of analysis applied to the piping systems connected to the anchor. The piping on the seismic side of the anchor used a detailed response spectrum method of analysis (stress problem 1-N015). The piping on the non-seismic (turbine building) side used a simplified calculation based on the plastic hinge moment that would occur in the event of piping system collapse. The methods of analyses are in accordance with CPPP-7 Attachment 4-10 and PM-203, are consistent with the licensing commitments in the FSAR and are, thus, acceptable.

The CYGNA review of this issue and its resolution has resulted in its closure in Revision 4 to the CYGNA review issues lists for pipe stress (Item 28) and pipe supports (Item 45) (Reference A14 and A10, respectively).

31.2 Conclusions

The staff concludes that the SWEC application of their design criteria and methods for the seismic/non-seismic interface anchors is adequate to address the design concerns identified by the TRT in Supplement 10. The generic technical issue associated with the seismic/non-seismic interface is, therefore, closed for CPSES.

32 PROGRAMMATIC ASPECTS AND QA

The CPRT third-party (TENERA, L.P.) identified 99 quality assurance and programmatic concerns from various source documents. In its Engineering Evaluation DAP-E-P-016, "Programmatic Aspects and QA," TENERA categorized these concerns into 10 primary aspects:

(1) interfaces
(2) iterative design
(3) quality assurance
(4) timeliness
(5) field changes
(6) personnel
(7) procedures
(8) construction
(9) calculation errors
(10) miscellaneous

The descriptions of the above 10 QA and programmatic aspects are discussed in DAP External Source Issue Summary ESIS-P-016 (Attachment A to DAP-E-P-016). The SWEC resolution methodologies are provided in the piping project status reports (Subappendix A16 Section 2.0). The DAP evaluations are provided in Engineering Evaluation DAP-E-P-016 (Section 5.0) and are summarized in the piping results report (Section 3.2.3.32).

The staff evaluation of the programmatic aspects and QA issues are provided in Section 5.0 of this supplement.

33 MISCELLANEOUS EXTERNAL SOURCE ISSUES

In conjunction with the CPRT Design Adequacy Program (DAP), a third-party (TENERA, L.P.) review related to the identification, review, and tracking of external source issues was conducted as discussed in Section 4.2.1 of this supplement. As a result of that review, the CPRT third-party generated 781 piping-related discrepancy/issue resolution reports (DIRs). In this appendix, all but 51 of the 781 issues in the piping-related DIRs have been consolidated into the 32 generic technical issues (including 1 programmatic/QA issue) and evaluated herein. The remaining 51 DIRs are listed in Attachment B to the piping results report. The staff reviewed the list of DIRs and finds that TENERA has categorized them as those

(1) with no specific concerns or unsubstantiated concerns
(2) closed outside the DSAP IX review or invalid
(3) not pertinent to CAP resolutions
(4) associated with calculational or procedural concerns
(5) associated with inconsistent or nonstandard criteria
(6) associated with cumulative effects

The staff review of the DAP resolution of each of the 51 DIRs has identified no additional external source issues applicable to the CAP design validation for piping that have not been adequately resolved. However, the resolution of the issues in five DIRs (E-0812, E-1174, E-1198, E-1199, and E-1200) is discussed below.

In DIR E-0812, TENERA identified an issue regarding overthickness in pipe fittings. No specifics were identified in the resolution. The staff review of this issue finds that the concern of overthickness in pipe fittings was raised by an NRC inspection at the Beaver Valley Power Station Unit 2 facility. The concern was evaluated specifically for the Beaver Valley Power Station Unit 2 and generically for typical nuclear facilities by the NRC staff. The results of the staff evaluations were documented in NRC Inspection Report 50-412/85-24, (Reference A54) and the item was closed. No generic implications were identified that would adversely affect the CPSES design validation activities for piping.

In DIR E-1174, TENERA identified a concern regarding piping stresses due to reduced wall thickness. This issue and the staff evaluation are discussed in this appendix in Section 24.5.

In DIRs E-1198, E-1199, and E-1200, TENERA identified three items related to ongoing NRC staff reviews. The issue in DIR-E-1198 concerning asymmetric dynamic loads on the reactor coolant system was subsequently closed out in Supplement 12 (Reference A50). The issue in DIR-E-1199 concerning the use of the WECAN computer program was similarly closed out in Supplement 12. The issues in DIR-E-1200 concerning the TMI Action Plan Items were addressed in Supplement 12, and the status of the staff review is documented therein.

On the basis of our review of the 32 generic technical issues (including 1 programmatic/QA issue), and the 51 other DIRs listed in Appendix B to the piping results report, the staff finds that all external source issues related to piping and pipe supports identified by the CPRT third-party have been adequately addressed in the CPRT activities, in the TU Electric CAP, and/or in NRC staff reviews.

34 APPENDIX A REFERENCES

A1. Stone & Webster Engineering Corporation, "Generic Technical Issues Report," Revision 0, Docket Nos. 50-445/446, June 27, 1986, transmitted in a letter from W. G. Counsil (TU Electric) to V. Noonan (NRC) dated July 9, 1986.

A2. TU Electric, "CPSES Unit 1 and Common Corrective Action Program - Project Status Report Large Bore Piping and Pipe Supports," Revision 0, Docket Nos. 50-445/446, transmitted in a letter from W. G. Counsil (TU Electric) to USNRC dated November 2, 1987.

A3. TU Electric, "CPSES Unit 1 and Common Corrective Action Program - Project Status Report Small Bore Piping and Pipe Supports," Revision 0, Docket Nos. 50-445/446, transmitted in a letter from W. G. Counsil (TU Electric) to USNRC dated November 2, 1987.

A4. Stone & Webster Engineering Corporation, Comanche Peak Project Procedure CPPP-7, "Design Criteria for Pipe Stress and Pipe Supports," Revision 3, February 23, 1987, Docket Nos. 50-445/556, transmitted in a letter from W. G. Counsil (TU Electric) to USNRC dated March 26, 1987.

A5. Comanche Peak Response Team, "Discipline Specific Results Report: Piping and Supports," DAP-RR-001, Revision 1, Docket Nos. 50-445/446, August 27, 1987, transmitted in a letter from W. G. Counsil (TU Electric) to USNRC dated September 29, 1987.

A6. U.S. Nuclear Regulatory Commission, Atomic Safety and Licensing Board Memorandum and Order (Quality Assurance for Design), December 28, 1983, LBP-83-81, 18 NRC 1410 (1983).

A7. ACI 318-71, "Building Code Requirements for Reinforced Concrete," American Concrete Institute.

A8. ACI 349-85, "Code Requirements for Nuclear Safety Related Concrete Structures," American Concrete Institute.

A9. "PCI, Manual on Design of Connections for Precast Prestressed Concrete," Prestressed Concrete Institute, 1973 (including Supplement).

A10. Letter from N. H. Williams (CYGNA) to W. G. Counsil (TU Electric), Subject: Pipe Support Review Issues List - Revision 4, Docket Nos. 50-445/446, September 18, 1987.

A11. "Cases of ASME Boiler and Pressure Vessel Code - Code Cases," N-318-2, "Procedure for Evaluation of the Design of Rectangular Cross Section Attachments on Class 2 or 3 Piping, Section III, Division 1 (1983).*

A12. "Case of ASME Boiler and Pressure Vessel Code - Code Cases" N-392, Procedure for Evaluation of Hollow Circular Cross Section Welded Attachments on Class 2 and 3 Piping, Section III, Division 1 (1983).*

A13. WRC Bulletin 107, "Local Stresses in Spherical and Cylindrical Shells Due to External Loadings," K. R. Wichman, A. G. Hopper, and J. L. Mershon, Welding Research Council, August 1969.*

A14. Letter from N. H. Williams (CYGNA) to W. G. Counsil (TU Electric), Subject: Pipe Stress Review Issues List - Revision 4, Docket Nos. 50-445/446, September 16, 1987.

A15. Board Notification BN-82-105A, Subject: NRC Staff Evaluation Regarding Allegations of Potential Design Deficiencies in Class 1 Piping, September 29, 1983.

A16. "ASME Boiler and Pressure Vessel Code," Section III, Nuclear Power Plant Components, Division 1, Subsections NA, NB, NC, and ND, 1974 Edition up to and including Summer 1974 AddendA, American Society of Mechanical Engineers.*

A17. "ASME Boiler and Pressure Vessel Code, "Section XI, Rules for Inservice Inspection of Nuclear Power Plant Components - Division 1, American Society of Mechanical Engineers.*

A18. U.S. Nuclear Regulatory Commission, Atomic Safety and Licensing Board, Memorandum and Order (Reconsideration Concerning Quality Assurance for Design), February 8, 1984, LBP-84-10, 19 NRC 509 (1984).

A19. "ASME Boiler and Pressure Vessel Code," Section III, Nuclear Power Plant Components, Division 1, Subsection NF, 1974 Edition up to and including Winter 1974 Addendum, American Society of Mechanical Engineers.*

A20. ANSI/AWS D1.1-81, "Structural Welding Code - Steel," American National Standards Institute/American Welding Society.*

A21. U.S. Nuclear Regulatory Commission, Atomic Safety and Licensing Board, Memorandum and Order (Written-Filing Decisions, #1: Some AWS/ASME Issues), June 29, 1984, LBP-84-25, 19 NRC 1589 (1984).

A22. "ASME Boiler and Pressure Vessel Code - Code Cases," N-413, Minimum Size of Fillet Welds, Section III, Division 1 (1983).*

A23. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.84, "Design and Fabrication Code Case Acceptability, ASME Section III, Division 1," Revision 24, June 1986.*

A24. U.S. Nuclear Regulatory Commission, Atomic Safety and Licensing Board, Partial Initial Decision (A500 Steel), October 6, 1983, LBP-83-63, 18 NRC 759 (1983).

A25. "ASME Boiler and Pressure Vessel Code - Code Cases," N-71, Additional Materials for Subsection NF, Classes 1, 2, 3, and MC Component Supports Fabricated by Welding, Section III, Division 1 (1983).*

A26. Letter from C. I. Grimes (NRC) to W. G. Counsil (TU Electric) Subject: Use of ASME Code Case N-71 Revision 15, Docket Nos. 40-445/446, January 15, 1988.

A27. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.85, "Materials Code Case Acceptability, ASME Section III, Division 1," Revision 24, June 1986.

A28. AISC, Manual of Steel Construction, Seventh Edition, 1970, American Institute of Steel Construction.*

A29. AISI, "Specification for the Design of Cold-Formed Steel Structural Members," American Iron and Steel Institute (1980).

A30. Welded Structural Tube Institute, "Manual of Cold Formed Welded Structural Steel Tubing," 1974.*

A31. AISC, Manual of Steel Construction, Eighth Edition, 1980, American Institute of Steel Construction.*

A32. "ASME Boiler and Pressure Vessel Code," Section III, Nuclear Power Plant Components, Division 1, Appendices (1974).*

A33. Nuclear Standard, "Mechanical and Hydraulic Snubbers for Nuclear Application," NE-E7-9T, September 1984, U.S. Department of Energy, Nuclear Energy Program.*

A34. A. T. Onesto, Energy Technology Engineering Center, "Snubber Sensitivity Study," USNRC Report NUREG/CR-2175, July 1981.

A35. U.S. Nuclear Regulatory Commission, Inspection Report No. 50-445/88-11; 50-446/88-09.

A36. U.S. Nuclear Regulatory Commission, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants - LWR Edition," USNRC Report NUREG-0800, Revision 1, July 1981.

A37. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.61, "Damping Values for Seismic Design of Nuclear Power Plants."

A38. "ASME Boiler and Pressure Vessel Code - Code Cases," N-411, Alternative Damping Values for Response Spectra Analysis of Class 1, 2, and 3 Piping, American Society of Mechanical Engineers (1983).*

A39. Letter from V. Noonan (NRC) to W. G. Counsil (TU Electric), Subject: Use of ASME Code Case N-397 and N-411, Docket Nos. 50-445/446, March 13, 1986.

A40. "Independent Assessment Program, Final Report (Phase 3)," TR-84042-01 (Draft) Volumes 1-4, Docket Nos. 50-445/446, July 16, 1984, including Errata and revised pages to "Independent Assessment Program, Final Report (Phase 3)," Docket Nos. 50-445/446, November 20, 1984.

A41. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.67, "Installation of Overpressure Protection Devices."

A42. Board Notification BN-85-026A, Subject: Summary of Meeting Between NRC Staff and Texas Utilities Generating Company Concerning the Design of Piping and Pipe Supports at Comanche Peak, March 11, 1985.

A43. U.S. Nuclear Regulatory Commission, "Water Hammer in Nuclear Power Plants," USNRC Report NUREG-0582, July 1979.

A44. E. C. Rodabaugh, Battelle Columbus Laboratories, "Realistic Seismic Design Margins of Pumps, Valves, and Piping," USNRC Report NUREG/CR-2137, June 1981.

A45. "ASME Boiler and Pressure Vessel Code - Code Cases," N-249, Additional Material for Subsection NF, Classes 1, 2, and 3 Component Supports Fabricated Without Welding, Section III, Division 1," (1983).*

A46. U.S. Nuclear Regulatory Commission, Regulatory Guide 1.124, "Service Limits and Loading Combinations for Class 1 Linear-Type Component Supports."

A47. M. R. Lindquist, Hanford Engineering Development Laboratory, "Final Report, USNRC Anchor Bolt Study Data Survey and Dynamic Testing," USNRC Report NUREG/CR-2999, December 1982.

A48. U.S. Nuclear Regulatory Commission, IE Bulletin 79-14, "Seismic Analysis for As-Built Safety-Related Piping Systems," July 2, 1979 including Revision 1 (July 17, 1979), Supplement 1 (August 15, 1979), and Supplement 2 (September 6, 1979).

A49. WRC Bulletin 316, "Technical Position on Piping Installation Tolerances," Supplement to WRC Bulletin 300, July 1986, Welding Research Council.*

A50. U.S. Nuclear Regulatory Commission, "Safety Evaluation Report Related to the Operation of Comanche Peak Steam Electric Station, Units 1 and 2," (SER) NUREG-0797, July 1981 and Supplements 1 through 4 and 6 through 13.

A51. "Comanche Peak Response Team Program Plan and Issue-Specific Action Plans," Revision 3, January 25, 1986, Docket Nos. 50-445/446, transmitted in a letter from W. G. Counsil (TU Electric) to USNRC dated January 27, 1986.

A52. Comanche Peak Response Team, Results Report ISAP V.c, "Design Considerations for Piping Systems Between Seismic Category I and Non-Seismic Category I Buildings," Revision 1, Docket Nos. 50-445 and 50-446, October 29, 1986.

A53. "Comanche Peak Steam Electric Station - Final Safety Analysis Report," Docket Nos. 50-445/446, up to and including Amendment 65.

A54. U.S. Nuclear Regulatory Commission, Inspection Report No. 50-412/85-24, December 11, 1985.

* Available through public technical libraries and at the NRC Library, 7920 Norfolk Avenue, Bethesda, Maryland.

APPENDIX B

RESOLUTIONS OF OPEN ITEMS FROM NRC INSPECTION REPORTS

B.1 NRC INSPECTION REPORT 50-445/86-19, 50-446/86-16

The following open items were identified in the piping and pipe support disciplines in Inspection Report 50-445/86-19, 50-446/86-16. The Design Adequacy Program (DAP) responses were provided in a followup audit held at TENERA L.P. offices (Berkeley, California) on August 17-20, 1987 (Appendix D to this supplement- Event 29). The staff evaluation follows.

B.1.1 Open Item P-1 (Closed)

DAP-2, Section 4.1.1 states that if an issue has both technical and programmatic components, both will be documented on separate issue records. The inspection team found that programmatic issue records had not been developed concurrently with their related technical issue records.

DAP Response

The inspection team's comment was correct; however, Revision 5 of DAP-2 changed the referenced requirement to permit documentation of both technical and programmatic aspects on the same issue record. No further action is required.

NRC Evaluation

The staff reviewed Section 5 of DAP-2 and found that it addresses the NRC concern.

B.1.2 Open Item P-2 (Closed)

External source documents to be reviewed by TERA Corporation are described in DI-P-002 as "public documents...generated between May 17, 1978 and February 6, 1986 (which) address technical concerns and issues associated with the adequacy of the piping analysis and support design at CPSES." This time limitation appears to be inconsistent with the requirement of Procedure DAP-2 that the identification of issues be an ongoing process.

DAP Response

An apparent inconsistency was noted between DI-P-002 and DAP-2 regarding the duration of the process for identification of issues. DAP-2 requires the process to be ongoing, and DI-P-002 notes that the documents reviewed were generated between May 17, 1978 and February 6, 1986.

The comment is based on a misinterpretation of DI-P-002. DI-P-002 does not prescribe the range of issue dates for external source documents to be reviewed. The dates given above are provided for background; that is, at the time DI-P-002 was issued, the external documents that had been subjected to a DAP-2 review were within that time frame.

The program plan requires that a systematic process be used to identify external source issues from external source documents. DAP-2 implements this requirement but is not prescriptive regarding the process. Discretion was allowed because of the varied nature of the external source documents and the nature of the issues. Briefly, the initial process involved selecting a set of documents that would likely contain the most significant information regarding the issues. The selection was performed by the Discipline Coordinator for Piping and Supports. Documents were selected from the library of information assembled by Texas Utilities Generating Company relating to the hearing process. The review of these documents led to other documents which were, in turn, reviewed. On completion of this selected review, a comparison was made between the reviewed documents and a list of all documents relevant to external sources with dates from March 5, 1979 to December 31, 1985. This list was obtained from the NRC docket accession list for CPSES. Spot-checking of unreviewed external source documents demonstrated that no new issues that would affect the Corrective Action Program were likely to be found in the remaining document. The senior review team (SRT) has determined that further reviews are not necessary (see Revision 4 of the Program Plan). The ongoing process required by DAP-2 was accomplished through periodic updating of the list of documents being reviewed. The resulting issue records generated are processed in accordance with DAP-2. For the piping discipline, the external source issue summaries (ESISs) were prepared in accordance with DAP-DI-P-02. The ESISs were revised to incorporate any additions resulting from that process.

NRC Evaluation

The DAP response clarified the apparent inconsistency between DI-P-002 and DAP-2 and adequately addresses the NRC concerns.

B.1.3 Open Item P-3 (Closed)

As an initial step in assessing TERA's issue identification, the inspection team determined if 11 pertinent external source documents had been documented.

Seven of these documents were identified by TERA as ASLB-12, ASLB-2, ASLB-3, ASLB-6, CASE-22, CASE-2, and NRCT-17 but the following were not identified:

- Atomic Safety and Licensing Board Partial Initial Decision (Change in Materials Properties for A500 Steel), October 6, 1983
- NRC letter "Staff Response to Applicants' Response to Partial Initial Decision Regarding A500 Steel," May 17, 1984
- Applicants' Response to Partial Initial Decision Regarding A500 Steel April 11, 1984.

° NRC Region IV letter requesting information on Level B and Level C allowables dated December 31, 1984

DAP Response

The inspection team's comment is correct. A review was conducted to identify any additional documents that should be included in the review of external source documents. A team of engineers has reviewed all the NRC Public Document Room monthly accession lists starting from March 5, 1979 (the date of the Citizens Association for Sound Energy (CASE) petition for intervention) through December 31, 1985. Documents identified from the lists were further screened to select documents with pertinent content for the review of external source issues. References in the CYGNA issue review transmittals were added to these documents.

From the documents identified in the above process, those that were most likely to contain additional issues were reviewed in accordance with DAP-2. Based on the review of these documents, and other checks of external source documents, the DAP determined that any external source issues contained in the unreviewed documents would likely be enveloped by existing primary issues. Consequently, no new information that would affect corrective actions was likely to be found. The SRT determined that further reviews were not necessary (see Revision 4 of the Program Plan).

NRC Evaluation

The DAP responses to Open Items P-2 and P-3 clarified the DAP process for the identification of external source documents. The DAP responses indicate that the initial process involved the selection of a set of external source documents that would likely contain the most significant information regarding the issues. Reviews of this initial set of documents identified additional external source documents to be reviewed. This expanded set of external source documents was compared against a list of documents relevant to external source doucments with dates between March 5, 1979 and December 31, 1985. This list was obtained from the NRC docket accession list for CPSES. Spot-checking of unreviewed external source documents found that no new issues that would affect the Corrective Action Program were likely to be found in the remaining documents.

In addition, the DAP response to Open Item P-4 indicates that additional reviews were instituted in response to the inspection team's findings. A second-level review was conducted. A subset of external source documents was reviewed by the DAP Quality Assurance (QA) Manager and his staff to independently compare the issues to be documented in the ESISs. This review found that the DAP documentation of the issues raised in the external source documents reviewed was adequate.

Moreover, the DAP responses indicate that the SRT determined that further reviews were not necessary.

A staff review of the external source documents identified in Appendix A to the "Piping and Supports Discipline Specific Results Report," DAP-RR-P-001, Revision 0, July 2, 1987, found that the four unidentified documents were not listed among the documents. However, based on the DAP issue-identification process described above, the staff conducted an additional review to assess the adequacy of the external source documents reviewed by the DAP to identify the issues. A further staff review of DIR reports found that the issues in the four unidentified documents were identified. This item is closed.

B.1.4 Open Item P-4 (Closed)

The inspection team reviewed ASLB-6, CASE-22, CASE-2, and ASLB-2 to determine if specific external source issues were identified in DIRs and related to ESIS. U-bolt cinching was identified as a primary issue in ESIS-E-P-011 (draft). The primary-issue binder contained ASLB-6 and DIR E-0791, documenting the single U-bolt cinching issue. However, the following Board concerns in ASLB-6 were not identified in the above TERA documents:

(1) "the extent to which the items tested by Applicants have been representative of the steels actually employed at the plant." (p. 4)

(2) "the extent to which the configurations in the plant are the same as those tested." (pp. 5-6)

DAP Response

The comments are correct; however, the ESISs reviewed by the inspection team were in draft form and had not yet been subjected to the controls established to ensure the adequacy of a document. Before a document is issued, the originator must first review the DIRs and the external source document on which it is based. The checker repeats the process, confirming that all DIRs referenced in the DIR are addressed. Finally, approval requires both a confirmation that the process has been followed and a technical overview based on broader knowledge of the issues. None of these steps had been taken when the audit was performed.

To address the inspection team's comments on the DIRs and to measure the effectiveness of the process for preparing and issuing an ESIS, a second-level review has been conducted. A subset of the total listing of external source documents was reviewed by the DAP QA Manager and his staff. A sample of the external source documents in the ESISs was reviewed. Based on that review, it was determined that DAP documentation of the issues raised in public documents was adequate.

NRC Evaluation

The DAP responses to Open Items P-2, P-3, and P-4 clarified the DAP process for the identification of external source issues. Furthermore, as noted in the DAP response to Open Item P-4, the ESISs reviewed during the inspection were in draft form. The second-level review discussed above provides additional assurance that DAP identification and documentation of issues raised in public documents were adequate.

Subsequently, a staff review of selected issues found that the issues had been identified. The issues regarding the following - 1) the extent to which the items tested were representative of the steels actually employed at the plant, and 2) the extent to which the configurations in the plant are the same as those tested - were not identified in DAP ESIS-P-023 and ESIS-P-016 and other DIRs external source issues.

However, these issues are identified in the large bore piping and pipe supports project status report in the "SA-36 and A307 Steel" external source issue (Subappendix A23). This item is closed.

B.1.5 Open Item P-5 (Closed)

Description

With respect to U-bolt cinching issues, there was no DIR for Mr. Doyle's concern (CASE-22, pp. 4-5) regarding the applicability to cinched U-bolt designs of the provisions of 10 CFR 34(a)(2) and (a)(8) pertaining to preliminary safety analysis report requirements for unique designs, nor for the issues in CASE-2, pp. 195-212.

DAP Response

See response to Open Item P-4.

NRC Evaluation

The DAP responses to Open Items P-2, P-3 and P-4 clarified the DAP process for the identification of external issues. In addition, the DAP response to Open Item P-10 clarified the extent to which issues were to be identified. Aspects of issues that would not affect the basis for the acceptable criteria established for resolution of the issue were not included in DAP external source issues. Moreover, the ESISs reviewed by the team during the inspection were in draft form.

Accordingly, the staff performed a review to assess the extent to which the issues have been identified. The review found that the issue regarding the applicability of the provisions of 10 CFR 34 was not identified but the technical issues in external source document CASE-Z, pp. 195-122, had been identified in the cinched U-bolt external source issue. The 10 CFR 34 issue will not affect the basis for the acceptance criteria for technical resolution of the cinched U-bolts external source issue. The identification of the 10 CFR 34 and CASE-Z issues was consistent with the DAP response to Open Item P-10. This issue is closed.

B.1.6 Open Items P-6 (Closed)

Mr. Doyle's concern (CASE-22, p. 2) that the design of the U-bolts should have been based on the manufacturer's allowable loads (i.e., design by load rating in accordance with NF-3260 of Subsection NF of the ASME Code) and not be a stress analysis (i.e., design by analysis per NF-3260 of Subsection NF of the ASME Code) was incorrectly characterized in DIR E-0604, Revision 0. The DIR stated: "TUGCO should not assume stress relaxation (due to yielding) occurs in U-bolts since the manufacturer's established load limits restrict loading to 1/4 yield versus the 1/2 yield required for this phenomenon to occur." The issue was also incorrectly summarized in draft ESIS-P-011 as: "the question was raised that U-bolt stress may be higher than the manufacturers allowable of 1/2 yield."

DAP Response

See response to Open Item P-4

NRC Evaluation

See NRC evaluation of Open Item P-4.

B.1.7 Open Item P-7 (Closed)

The inspection team reviewed the primary-issue binder and associated draft ESIS-P-023 for the A36 and A307 steel primary issue and found that the ASLB issue (ASLB-2, p. 28) regarding the improper use of SA307 U-bolts in friction-type, cinched U-bolt connections was not identified in a DIR or in the ESIS.

DAP Response

See response to Open Item P-4.

NRC Evaluation

The ESISs reviewed during the inspection were in draft form only. A subsequent staff review of the SA-36 and SA-307 steels external source issue found that the issues not identified during the inspection have since been identified. This item is closed.

B.1.8 Open Item P-8 (Closed)

CASE-2, pp. 81-86, identified a design feature of a pipe support that was not in compliance with Section XI of the ASME Code and Gibbs & Hill Specification No. 2323-MS-46A. TERA misinterpreted this issue, believing that it related only to the acceptability of welding attachments over girth welds, and incorrectly transferred the issue to the primary issue relating to local stresses (ESIS-E-P-002).

DAP Response

See response to Open Item P-4.

NRC Evaluation

See NRC evaluation of Open Item P-4.

B.1.9 Open Item P-9 (Closed)

The inspection team's review of the draft ESIS-E-P-009 for the A500 Grade B tube steel primary issue found that it did not identify the Board issue that the "Applicant has not demonstrated that welded supports using A500 steel have been designed with adequate safety margins." This issue was contained in ASLB Partial Initial Decision (Change in Material Properties for A500 Steel), October 6, 1983, which, as noted for Open Item P-3, was not among the external source documents reviewed by TERA. Apparently this issue was not identified during TERA's review of other external source documents.

DAP Response

See response to Open Item P-4.

NRC Evaluation

The DAP response to Open Item P-10 clarified the extent to which issues were identified. Nonidentification of this external source issue is consistent with the clarification that aspects of issues that will not affect the basis for the criteria for the resolution of issues will not be identified. This issue is closed.

B.1.10 Open Item P-10 (Closed)

The inspection team identified several cases where ASLB concerns did not result in DIRs. TERA stated that ASLB interpretations of issues will be included to the extent that they affect a basis for the acceptance criteria in resolving the issue. Addressing the ASLB interpretation of information previously presented is a hearing issue, not a technical issue affecting the design. The team noted that DSAP IX, Section 4.2.1, states that issue identification "involves the identification of all applicable issues...." The above distinction is not reflected in DSAP IX. The team believes that this apparent difference between DSAP IX and actual practice should be clarified. In addition, the above open items pertaining to Board concerns should be resolved in a manner consistent with this clarification.

DAP Response

The inspection team's comment is based on a misinterpretation of DSAP IX. The team has identified an apparent inconsistency between DSAP IX and the TERA interpretation of the level of detail required for the documentation of external source issues. TERA has not included aspects of the issue that will not affect the basis for the acceptance criteria for issue resolution. DSAP IX uses the terminology "all applicable issues" to describe the intent of the review of external source issues.

It was TERA's intent when DSAP IX was written to distinguish between "issues" and the total set of information related to the issues. The issue can be identified without stating the total set of information that exists in pertinent documents. The DIRs typically contain more information than that which is essential for issue identification, but DSAP IX does not impose a requirement to include information that does not affect the basis for resolving the issue. Furthermore, the DIR is intended to be a roadmap back to the original source documents. For example, the preparation of ESISs requires that the original source documents be referenced.

NRC Evaluation

The DAP response clarifies the extent to which aspects of external source issues were identified. This item is closed.

B.1.11 Open Item P-11 (Closed)

Engineering Evaluation DAP-E-009 (A500 Grade B Tube Steel), Section 4.0, Acceptance Criteria, stated that the resolution of the A500 Grade B tube steel primary issue required the identification of the design yield strength for A500 Grade B tube steel defined in ASME Code 1974 Edition through Winter 1974 Addenda and ASME Code Case N-71, as adopted in Specification No. 2323-MS-46A, "Nuclear Safety Class Pipe Hangers and Supports" (MS-46A). It stated that Code Case 164-9 (N71) permitted the use of 42 ksi for the design yield strength for A500 Grade B tube steel, but MS-46A adopted portions of a later revision of this Code Case (N-71-10) which reduced the yield strength to 36 ksi. The evaluation concluded that the yield strength used in the qualification of supports should have been 36 ksi, in accordance with Code Case N-71-10. This conclusion is incorrect because the portion of the Code Case that reduced the yield strength to 36 ksi was not invoked by the specification. The team noted that the use of the 36 ksi design yield strength is consistent with an ASLB concern that the more conservative value should be used in order to ensure safety, but the evaluation report did not reflect this specific aspect.

DAP Response

The comments of the inspection team are generally correct; however, the documents reviewed were in the early draft stage and, therefore, were not representative of the level of detail anticipated for the final product.

The comments of the team will, however, be considered before the evaluations are approved.

NRC Evaluation

The DAP response noted that the documents reviewed during the inspection were in the early draft stage.

A subsequent staff review of "Discipline Specific Results Report: Piping and Supports" found that the technical issue has since been correctly identified. The basis for the yield strength of A500 Grade B tube steel was identified correctly as ASME Code Case 71-10. Moreover, the lack of identification of the ASLB safety aspect of the issue was consistent with the DAP clarification of the extent to which aspects of external source issues were identified. This item is closed.

B.1.12 Open Item P-12 (Closed)

Engineering Evaluation DAP-E-012 (Axial/Rotational Restraints) did not provide the basis for concluding that SWEC Project Procedure CPPP-7 was adequate to address the issue.

DAP Response

See response to Open Item P-11.

NRC Evaluation

The documents reviewed during the inspection were in draft form. A subsequent staff review found that the basis for concluding that SWEC Project Procedure CPPP-7 was adequate to address the concerns has been provided. Engineering Evaluation DAP-E-P-012 (Axial/Rotational Restraints) now provides references to specific sections of CPPP-7 documenting the SWEC approaches to resolution of the issues as well as DAP evaluations of the SWEC approaches. These evaluations were based in part on a review of supporting SWEC calculations and of the adequacy of the SWEC approaches to resolve the issue and were found acceptable. This issue is closed.

B.1.13 Open Item P-13 (Closed)

For Engineering Evaluation DAP-E-P-013 (Gaps), TERA's acceptance criteria for resolving issues concerning gaps in bearing-type connections were based on ASME Code Subsection NF, 1983 Edition through Summer 1985 Addenda. However, TERA has not addressed gap-related concerns raised by the intervenors regarding unequal load sharing, change in stiffness and natural frequency of support, effect on piping analysis, etc. In resolving this open item, TERA should determine whether these concerns are covered by DIRs and the issue identification/tracking system.

DAP Response

See response to Open Item P-11.

NRC Evaluation

The document reviewed during the inspection was in draft form. A subsequent staff review of Engineering Evaluation DAP-E-P-013 (Gaps) found that the issues have been identified either specifically or in general. The extent to which the issues have been identified is consistent with the clarification provided in the DAP response to Open Item P-10. This item is closed.

B.1.14 Open Item P-14 (Closed)

The inspection team reviewed the Piping Analysis/Support Design Procedure Review Checklist (DAP-CLC-P-001, Revision 1, dated March 14, 1986) for consistency and completeness with respect to the design criteria list (DAP-CP-P-001, Revision 0, dated October 25, 1985).

In both documents, a criterion number is assigned to each item or issue. The team randomly checked the description of items/issues corresponding to criteria, and identified several cases where the criterion number for the item/issue in the design criteria list did not correspond to that for the apparently same item/issue in the procedure review checklist (e.g., Numbers 206, 211, 212, 243, and 312). However, in general, the items in the design criteria list were consistent with the corresponding items in the procedure review checklist with respect to criteria numbers. Thus, the team concluded that the inconsistencies were isolated errors. TERA agreed to correct the inconsistencies and to evaluate the reasons for their occurrence in order to ensure that checklists in general reflect all appropriate criteria from design criteria lists.

DAP Response

The third party has reviewed the inspection team comments and confirmed that isolated errors in referencing the criterion number had occurred. The corrections were incorporated in a revision to the checklist. Additionally, a 100 percent check of the checklist references to criteria has been performed and any additional errors noted were also incorporated.

The reasons for omitting criteria from the checklist have been summarized. Most omissions occur for one of the following reasons:

(1) The criterion is related to fabrication and therefore not pertinent to CPPP-6 (Appendix E to this supplement) and CPPP-7 review.

(2) The criterion is covered more specifically in other criteria already included.

The second reason for omitting a criterion was particularly prevalent for ASME Code criteria, where the system of extracting criteria on a subparagraph basis led to entries that contained only the heading for the criteria contained in subsequent subparagraphs. Such entries had no technical content and were included for information only.

NRC Evaluation

The DAP response confirmed the errors in criteria numbers were isolated and adequately addresses the staff's concerns.

B.1.15 Open Item P-15 (Closed)

The inspection team found that approximately one-half (144 of 326) of the total number of criteria in the design criteria list were not listed in the procedure review checklist. Procedure DAP-4, "Preparation of Checklists" (Revision 3) allows the checklist preparer to select less than 100 percent of the applicable criteria provided the bases for such selection are documented as an attachment to the design review summary form. At the time of the inspecti , the bases for all excluded design criteria were being prepared and documented by the checklist preparer.

DAP Response

See response to Open Item P-14.

NRC Evaluation

The DAP re se to Open Item P-14 lists the reasons for omitting criteria from the klist a d adequately addresses the staff's concerns.

B.1.1 I m P sed)

The r ed the depth and level of detail provided by the check is ple, under the item/issue concerning Richmond insert design, were listed. However, based on the team review of the DIRs, th to be many more than seven technical concerns related ichmond inse ne transposition of the concerns identified in the DIRs into the seven attributes involved a grouping of the external source issues into general categories apparently related to the resolution of the generic technical issues as described in the SWEC "Generic Technical Issues Report."

DAP Response

A concern was raised by the inspection team that subissues raised by the intervenor and the ASLB had been omitted in the checklist for reviewing SWEC procedures. DIR concerns had been grouped in the checklist instead of addressed separately, and the inspection team questioned whether the process had captured the subissues.

To close the primary-issue DIRs, reference is made to the engineering evaluation that resolves the technical issue. The individual external source DIRs are closed after it is confirmed that the primary-issue DIR addresses the specific concern. Revision 4 of the Program Plan eliminated the requirements for evaluations pertaining to safety significance.

NRC Evaluation

The DAP response clarifies the process used to close out subissues raised by ASLB and the intervenor and adequately addresses the staff's concerns.

B.1.17 Open Item P-17 (Closed)

TERA's checklist for Revision 2 of CPPP-7 was not complete. The inspection team will review the technical adequacy of the third-party review of CPPP-7, Revision 2, when completed.

DAP Response

The review documentation is now available for the inspection team.

NRC Evaluation

The staff audited the adequacy of TENERA's (formerly TERA Corporation) review of CPPP-7 (Revision 2) during the followup audit held at TENERA's offices (Berkeley, California) on August 17-20, 1987. The staff's findings are provided in Section 4.2.1 of this supplement.

B.2 NRC INSPECTION REPORT 50-445/82-26;50-446/82-14

The following open and/or unresolved items were identified in the piping and pipe support disciplines by the special inspection team (SIT) in Inspection Report 50-445/82-26, 50-446/82-14. Resolution of these items was addressed in Affidavit of W. Paul Chen on Open Items Relating to Walsh/Doyle Concerns, dated October 14, 1983. The piping and pipe supports of concern are being reevaluated during the design validation of all ASME Code Section III, Class 2 and 3 piping and all ASME Section III, Class 1, 2, and 3 pipe supports. The design validation is being conducted under the TU Electric Corrective Action Program (CAP) for design. The staff's evaluation of actions to be taken under the CAP that pertain the the resolutions of the piping and pipe support open items in the above NRC inspection report follows.

B.2.1 Open Item 50-445/8226-4 and 50-446/8214-3 (Closed)

During the SIT inspection, the applicant had stated that unstable, non-rigid supports had been identified in the review process and corrective actions had been or were to be taken to modify these supports before completion of the design process. Modifications under consideration for unstable non-rigid box frame supports included 1) the use of a U-bolt fixed to the frame and cinched down to the pipe, 2) lugs welded to the pipe that were to be indexed to the frame, and 3) the addition of stablizing struts to the frame. Verification of the acceptability of modifications was to be accomplished during followup inspections as part of NRC staff construction inspections and was identified as an open item.

Evaluation

The need for such verification to ensure that modified supports would perform their intended safety functions no longer exists because all piping and pipe supports are being requalified by SWEC. The three modifications previously described for non-rigid box frame instability have been deleted or revised. The staff's evaluation of the resolutions to the instability of pipe supports is provided in Appendix A to this supplement (Section 4).

B.2.2 Open Item 50-4458226-5 (Closed)

Differential thermal expansion effects between the insulated main steam pipe and the uninsulated structural steel support structure were not included in the local stress evaluations for support MS-1-003-009-C72K.

Evaluation

The project status report for large bore piping and pipe supports (piping PSR) describes the resolution of the design- and hardware-related issues related to CPSES large bore piping and pipe supports. These issues include local stress in piping (Subappendix A2 to piping PSR). This issue concerns local stresses resulting from relative displacements between piping and pipe supports.

Resolution of this issue requires in part that the design verification for integral welded attachments include stresses in the pipe trunnions and support structures resulting from the restraint of radial thermal expansion of the pipe at supports with integral welded opposed trunnions. Design verification procedures for these stresses are defined in Paragraph 4.6.4 of SWEC Comanche Peak Project Procedure CPPP-7, "Design Criteria for Pipe Stress and Pipe Supports". Staff evaluations of the acceptability of the procedures of CPPP-7 to resolve this issue are documented in Appendix A (Section 2.?) of this supplement.

Accordingly, the staff finds that the procedures and criteria defined in CPPP-7, Paragraph 4.6.4.1, as part of the TU Electric CAP are acceptable to resolve the concerns of differential thermal expansion effects in pipe support MS-1-103-009-C72K. This item is closed.

B.2.3 Open Item 50-446/8214-4 (Closed)

The allowable displacement and local stresses in the 1/2-inch diameter pipe stub as shown in Component Modification Card No. 63568, Revision 3. for support CC-2-008-709-A43K were exceeded during the service level C loading condition.

Evaluation

The piping PSR in Appendix A describes the resolution of the design and hardware-related issues related to pipe supports. These issues include External Source Issues A5, "Pipe Support Generic Stiffness," and A21, "Local Stress in Pipe Support Members."

External Source Issue A5 concerns the adequacy of (1) the 1/16-inch deflection criterion for service level B loads and (2) the analyses for verification of compliance with this 1/16-inch criterion. Resolution of this issue requires replacement of the 1/16-inch deflection criterion by a minimum support stiffness criterion. In particular, SWEC Procedure CPPP-7, Paragraph 4.3.2.2.2 requires that the stiffness of all ASME Code Section III, Class 2 and 3 pipe supports be assessed against the minimum acceptable values, Km, specified in Tables 3.10.0-1 through 3.10.3 of CPPP-7. CPPP-7, Paragraph 3.10.8 requires that (1) if the calculated support stiffness is greater than the minimum acceptable values, Km, the generic support stiffness, Kg, is to be used in the pipe stress analysis and (2) if the calculated support stiffness is less than Km, the calculated stiffness is to be used. Moreover, Paragraph 3.10.8 contains provisions for the elimination of very soft supports. Guidelines for the evaluation of support stiffness are provided in Attachment 4-18, "Pipe Support Stiffness Assessment," to CPPP-7.

External Source Issue A21 concerns local stresses in pipe supports. Resolution of this issue as specified in CPPP-7, Paragraph 4 3.3.2, requires in part that local stresses in plates in ASME Code Section III, Class 1, 2, and 3 linear type pipe supports that are attached to the ends of closed sections (pipe or tube) that are subject to normal and moment loads be analyzed by the method specified in Attachment 4-15, "Design Procedure for Stiffened Trunnions and Load Carrying End Plates" to CPPP-7.

Staff evaluations of the acceptability of the procedures in CPPP-7 to resolve these issues are documented in Appendix A, Sections 5 and 20, respectively, of this supplement.

Accordingly, the staff finds that the procedures and criteria defined in CPPP-7, Paragraphs 4.3.2.2 and 4.3.3.2, are acceptable to resolve the concerns related to exceedance of the allowable displacement and local stresses in the 1/2-inch plate shown in CMC No. 63568, Revision 3, for support CC-2-008-709-A43K. This item is closed.

B.2.4 Unresolved Item 50-445/8226 and 50-446/8214-5 (Closed)

The applicant agreed to provide a study to demonstrate that supports designed in accordance with their overall deflection guideline of 1/16-inch maximum deflection under the service level B loading condition will result in supports with stiffnesses that adequately conform with the generic values used in the piping stress analysis.

Evaluation

The piping PSR, Appendix A, describes the resolution of the design and hardware-related issues related to CPSES large-bore piping and pipe supports, including External Source Issue A5, "Pipe Support Generic Stiffness." As documented in the preceding staff evaluation of Open Item 50-446/8214-4, the 1/16-inch deflection criterion was evaluated and replaced with the minimum support stiffness criterion as part of the resolution of External Source Issue A5.

Based on the staff evaluation of the acceptablity of the procedures of CPPP-7 to resolve External Source Issue A5 (see Open Item 50-445/8214-4), this item is closed.

B.2.5 Unresolved Item No. 445/8226-7 (Closed)

The applicant agreed to perform a piping stress analysis to assess the effects of the difference between the generic and actual stiffnesses of pipe support CC-1-107-008-E23R on the distribution of stresses in the supported piping and loads in the support system. The actual stiffness for the support was one-eighth the generic stiffness, typical for very soft supports.

Evaluation

The piping PSR, Appendix A, describes the resolution of the design and hardware-related issues related to CPSES large-bore piping and pipe supports. These issues include External Source Issue A5, "Pipe Support Generic Stiffness." As documented in the staff evaluation of Open Item 50-446/8214-4, CPPP-7 Paragraph 3.10.8 provides criteria for pipe support stiffness values to be used in piping system stress analyses as well as guidelines for the elimination of very soft supports. Accordingly, the staff finds the criteria and guidelines to be acceptable as discussed in Appendix A (Section 5.1) to this supplement.

Based on the staff evaluation of the acceptability of the procedures of CPPP-7 to resolve External Source Issue A5 (see Open Item 50-445/8214-4), this item is closed.

B.3 NRC INSPECTION REPORT 50-445/85-16; 50-446/85-13

B.3.1 Open Item 50-445/8516-0-03; 50-446/8513-0-03 (Closed)

In NRC Inspection Report 50-445/85-16, 50-446/85-13, an open item was identified concerning the status of IE Bulletin 79-14, "Seismic Analyses for As-Built Safety-Related Piping Systems." This bulletin had been evaluated by TU Electric in 1983 and was closed. In the above inspection report, the NRC inspector indicated that closure of IE Bulletin 79-14 was premature because under the CAP design validation many of the piping and pipe support designs were being reanalized and modified and, therefore, the status of IE Bulletin 79-14 was considered an open item.

Evaluation

IE Bulletin 79-14 identified several piping and pipe support attributes that were to be included in an as-built walkdown inspection to ensure the validity of the piping seismic analyses. The attributes were pipe run geometry; support and restraint design, locations, function and clearances (including floor and wall penetration); and embedments (excluding those covered in IE Bulletin 79-04). Revision 1 to IE Bulletin 79-14 clarified that the action items applied to all safety-related piping 2½ inches in diameter and greater and to seismic Category I piping, regardless of size, which was dynamically analyzed by computer.

Under TU Electric's Corrective Action Program (CAP) all the attributes included in IE Bulletin 79-14 are reinspected or reviewed except for valve/operator weights. Valve weights were previously verified in the CPSES Valve Weighting Program as described in a letter from R. Gary (TUGCO) to J. Collins (NRC) dated December 3, 1982 (TXX-3597).

The staff reviewed various CPSES documents applicable to the CAP to determine whether the attributes identified in IE Bulletin 79-14 are addressed. The staff review finds that all other IE Bulletin 79-14 attributes are reinspected or reviewed in conjunction with the Post-Construction Hardware Validation Program (PCHVP); Site Procedure CPSP-12 "As-Built Verification" (Revision 4); or design validation in accordance with CPPP-7, "Design Criteria for Pipe Stress and Pipe Supports." The above reviews and reinspections are applicable to all ASME Code Class 1, 2, and 3 piping systems; non-ASME Code high energy lines over 1 inch that were computer analyzed; and any designated piping regardless of size (up to and including the first anchor) that is included in ASME Code Class 1, 2, or 3 piping stress analysis packages and, thus, satisfies the intent of IE Bulletin 79-14.

Based on our review of the PCHVP attribute matrix and Procedures CPSP-12 and CPPP-7, the staff finds that the procedures provide an adequate program to ensure that the as-built verification of safety-related piping systems is in accordance with the requirements of IE Bulletin 79-14. Contingent on an acceptable completion of the program for CPSES Units 1 and 2, the staff concludes that the intent of IE Bulletin 79-14 has been achieved for CPSES Units 1 and 2 and the item is closed.

APPENDIX C

RESOLUTION OF OPEN ITEMS FROM SSER-13

C.3 DSAP IX - PIPING AND PIPE SUPPORTS

STAFF COMMENT C.3(1) (CLOSED)

It was not evident that a process existed for identifying discrepancies (or deviations) for external source issues by Stone & Webster Engineering Corporation (SWEC) in view of the fact that hardware modifications may be made to piping and supports by SWEC irrespective of the corrective actions required for safety-significant problems. A root-cause/generic implication evaluation should be performed for all hardware modifications in order to document the reasons for such modifications.

Staff Review and Evaluation

In Appendix B to the project status reports for large- and small-bore piping and pipe supports (Piping PSRs), the significant deficiency analysis reports (SDARs) and their resolutions are provided. The issues related to the SDARs were identified by SWEC during the piping design validation. Thus, the SDARs provide an adequate process for identifying deficiencies and ensuring their resolution.

In Table 5-4 of the piping PSR, the reasons for all pipe support modifications in Unit 1 and Common are documented. The support modifications have been categorized according to four primary reasons: (1) prudence, (2) recent industry practice, (3) adjustment, (and 4) cumulative effects. A description of the specific types of modifications and their categories are also tabulated in the piping PSR. Based on the information in the piping PSR tables, the staff finds that the reasons for the pipe support modifications have been documented and, thus, the staff comment in Supplement 13 is closed.

STAFF COMMENTS C.3(2) (Closed)

The self-initiated review of the auxiliary feedwater (AFW) system does not fully address the interface with the SWEC piping reanalysis program. The third-party review should include a portion of the AFW system in its review of the SWEC piping and pipe supports requalification effort.

Staff Review and Evaluation

As discussed in Section 3 of this supplement the third-party self-initiated reviews were obviated in Revision 4 to the CPRT Program Plan with the initiation of a complete design verification under the Corrective Action Program (CAP). The overview responsibilities of the CPRT third-party were transferred to the TU Electric Technical Audit Program. As a result, the staff comment in Supplement 13 is no longer appropriate and applicable to the CAP activities and is thus closed.

STAFF COMMENT C.3(3) (Closed)

There is a lack of information in the Comanche Peak Response Team (CPRT) Program Plan regarding explanation of the process used to ensure the adequacy of the as-built data used in the SWEC piping reanalysis effort. Provide a description of the process followed by the various activities in the Quality of Construction (QOC) Program and in the SWEC program for the evaluation of as-built discrepancies including the interfaces among QOC SWEC, and TUGCO projects and the applicable procedures used in the process.

Staff Review and Evaluation

Discipline-Specific Action Plan (DSAP) IX required a Design Adequacy Program overview of SWEC activities associated with the verification of as-built documentation to assess the adequacy and completeness of the as-built data used as input into the SWEC piping analysis and support design effort. When the SWEC piping analysis effort began, the results of the QOC Program were not available. Therefore, SWEC performed limited walkdowns in accordance with Comanche Peak Project Procedure CPPP-5, "Field Walkdown-Unit 1" to determine the accuracy of existing as-built data and establish a sufficient level of confidence to proceed with analyses with an acceptable level of risk. As a result of a meeting with the NRC staff on October 2 and 3, 1985, SWEC extended its activities to include an assessment of all programs related to as-built verification. This included the QOC Program and TU Electric inspection programs. SWEC issued its assessment on July 23, 1986 in a report entitled "Assessment of TUGCO As-Built Documentation of Piping and Pipe Supports."

The staff's review and evaluation of the SWEC report and the overall adequacy of the as-built data used in the piping design validation is provided in Section 4.1.2.1 of this supplement.

STAFF COMMENT C.3(4) (CLOSED)

The scope of the Class 5 piping systems includes only those Class 5 piping systems within the boundaries of ASME Code Class 2 and 3 piping stress problems. Justify excluding the remaining Class 5 piping and supports from the SWEC scope.

Staff Review and Evaluation

After Supplement 13 was issued, the scope of the design validation for large bore piping was expanded. The staff review of the piping PSRs, Section 3.0, finds that the scope of the design validation includes certain Category II piping and pipe supports important to safety (Class 5 piping) to ensure that during or after a seismic event, the Seismic Category II piping will not fall and damage nearby Seismic Category I systems, structures, and components. The scope also includes high-energy and moderate-energy piping that is computer analyzed to determine high-stress locations for postulating pipe breaks and pipe cracks. Based on the the scope of the CAP design validation described in Section 3.0 of the piping PSR, the staff finds its concerns have been adequately addressed.

APPENDIX D

CHRONOLOGY OF NRC STAFF MEETINGS AUDITS, AND INSPECTIONS RELATED TO PIPING AND PIPE SUPPORT DESIGN

Event No.	Date	Description
1.	August 29-30-1985	NRC staff audit at office of Stone & Webster Engineering Corporation(SWEC) (NY) to discuss the status of SWEC piping and pipe support requalification program.
2.	September 23-26, 1985	NRC staff audit at Comanche Peak Steam Electric Station (CPSES) of SWEC Comanche Peak Project Procedure CPPP-5 as-built walkdown results.
3.	October 25, 1985	NRC staff audit at SWEC office (NY) to review status of SWEC requalification program, CPPP-8 walkdown procedures, and small bore piping approach.
4.	Oct. 28-Nov. 1, 1985	NRC staff inspection at TERA Corporation office (Bethesda, MD) of scope validation process and review of checklist development (NRC Inspection Report 50-445/85-17, 50-446/85-14).
5.	Nov. 13-14, 1985	NRC staff audit at CPSES of the Quality of Construction and QA/QC Adequacy Program sample reinspection of piping and pipe support hardware.
6.	Nov. 20-22, 1985	NRC staff audit at CPSES of the CPPP-8 walkdownresults.
7.	Nov. 25, 1985	NRC staff audit at SWEC office (NY) of the seismic/non-seismic piping interface.
8.	Dec. 8, 1985	NRC staff audit at SWEC office (NY) of the status of activities related to the piping and pipe support requalification program.
9.	Jan. 27, 1986	NRC staff audit at SWEC office (NY) of the status of activities related to the piping and pipe support requalification program.
10.	Feb. 10, 1986	NRC staff audit at SWEC (Boston) of the piping fluid transient analysis.
11.	Feb. 11-12, 1986	NRC staff audit at SWEC (Cherry Hill) of the resolutions to piping generic technical issues.

Event No.	Date	Description
12.	Feb. 18-19, 1986	NRC staff audit at CPSES of as-built activities for piping and pipe supports.
13.	Feb. 24, 1986	NRC staff audit at SWEC (NY) of the status of activities related to the piping and pipe support requalification program.
14.	Feb. 24-26, 1986	NRC staff audit at SWEC (NY) of the implementation of the piping and pipe support requalification program.
15.	Mar. 11-12, 1986	NRC staff audit at CPSES of the piping penetration as-built data.
16.	Apr. 4, 1986	NRC staff audit at SWEC (Cherry Hill) of the status of activities related to the piping and pipe support requalification program.
17.	Apr. 14-15, 1986	NRC staff audit at SWEC (Cherry Hill) of the resolutions to piping generic technical issues.
18.	May 13, 1986	NRC staff audit at SWEC (Boston) of the resolutions to generic technical issues.
19.	May 21, 1986	NRC staff audit at SWEC (NY) of the status of activities related to the piping and pipe support requalification program.
20.	July 7-10, 1986	NRC staff inspection at TERA (Berkeley) of the CPRT Design Adequacy Program implementation. (NRC Inspection Report 50-445/ 86-19, 50-446/86-16).
21.	Aug. 28, 1986	Public meeting at NRC offices (Bethesda) on FSAR changes related to SWEC piping requalification program.
22.	Nov. 11, 1986	NRC staff audit at CPSES to discuss the hardware validation program for piping.
23.	Nov. 13-14, 1986	Public meeting at SWEC office (Cherry Hill, NJ) with CYGNA Energy Services to discuss resolution of CYGNA piping and pipe support issues.
24.	Dec. 15-16, 1986	Public meeting at CPSES between SWEC and CYGNA to discuss resolutions to CYGNA piping and pipe support issues.

Event No.	Date	Description
25.	Mar. 19-21, 1987	Public meeting at Dallas, TX between TU Electric and Citizens Association for Sound Energy/J. Doyle to discuss resolution of Walsh/Doyle issues.
26.	Apr. 20-21, 1987	Public meeting at CPSES between CYGNA and SWEC/Ebasco to discuss resolution of CYGNA open items.
27.	July 29-30, 1987	NRC staff audit at CPSES of the status of activities related to the piping Corrective Action Program (CAP) and third-party overview.
28.	Aug. 10-12, 1987	NRC staff audit at CPSES of the piping as-built verification activities.
29.	Aug. 17-20, 1987	NRC staff audit at TENERA office (Berkeley, CA) of the piping result report and engineering evaluations.
30.	Aug. 25, 1987	NRC public meeting at SWEC office (Cherry Hill, NJ) to discuss the FSAR changes related to the CAP piping design validation.
31.	Sept. 2, 1987	NRC public meeting at SWEC office (Cherry Hill, NJ) to discuss the status of the resolution piping generic technical issues.
32.	Sept. 2-4, 1987	NRC staff audit at SWEC office (Cherry Hill, NJ) of the implementation of the resolution of piping generic technical issue.
33.	Sept. 21-22, 1987	NRC staff audit at SWEC office (Boston, MA) of the piping fluid transient analysis.
34.	Sept. 22-24, 1987	NRC staff audit at SWEC office (Cherry Hill, NJ) of the implementation of the resolution of piping generic technical issues.
35.	Oct. 7-9, 1987	NRC staff audit at CPSES (Glen Rose, TX) of generic technical issue modifications and TU Electric Technical Audit Program activities.
36.	Oct. 28-30, 1987	NRC staff audit at SWEC office (Cherry Hill, NJ) of CPPP-7 design criteria and of the implementation of the resolution of piping generic technical issues.

Event No.	Date	Description
37.	Jan. 21-22, 1987	NRC staff audit at SWEC office (Cherry Hill, NJ) of FSAR Amendment 61 (NA-1140 Report), CPPP-7 design criteria, and other open and unresolved audit items.

APPENDIX E

LIST OF COMANCHE PEAK PROJECT PROCEDURES (CPPP'S) AND PROJECT MEMORANDA (PM'S)

Comanche Peak Project Procedures

Procedure No.	Title
CPPP-1	Management Plan for Project Quality (Piping System Qualification/Requalification)
CPPP-2	Project Organization Charts
CPPP-3	Document Control Procedure
CPPP-4	Project Records Management Procedure
CPPP-5	Field Walk Procedure - Unit No. 1
CPPP-6	Pipe Stress/Support Requalification Procedure - Unit No. 1
CPPP-7	Design Criteria for Pipe Stress and Pipe Supports
CPPP-8	Piping and Support System Engineering Walkdown Procedure
CPPP-9	Pipe Stress/Support As-Built Procedure - Unit No. 2
CPPP-10	Procedure for Review of Plant Operating Mode Conditions
CPPP-11	Administrative Control of Calculations
CPPP-12	Cost and Schedule Control Procedure
CPPP-14	Procedure for the Preparation and Control of Project Procedures
CPPP-15	Small Bore Stress/Support Requalification - Unit No. 1
CPPP-16	Procedure for Stress Reports for Class 1 Piping Supports
CPPP-18	Procedure for Evaluation of ERC Deviation Reports
CPPP-19	Procedure for Processing of Problem Reports and Initial Problem Reports

CPPPs (Continued)

Procedure No.	Title
CPPP-20	Pipe Break/Crack Postulation Analysis Procedure
CPPP-21	Procedure for the Preparation and Control of Site Procedures
CPPP-22	Clearance Walkdown Procedure
CPPP-23	Pipe Stress/Support Final Reconciliation Procedure
CPPP-24	Thermal Expansion Test Procedure - Unit 1
CPPP-25	Piping Vibration Test Procedure - Unit 1
CPPP-26	Thermal Expansion Test Procedure - Unit 2
CPPP-27	Piping Vibration Test Procedure - Unit 2
CPPP-28	Procedure for Identification & Evaluation of Interfaces Between Seismic & Non-Seismic Piping
CPPP-29	Moment Restraint Qualification Procedure and Design Criteria
CPPP-30	Validation of Seismic Category II Large-Bore Piping and Support Designs
CPPP-31	CPSES Safety-Related Piping and Pipe Supports Design-Basis Consolidation Program
CPPP-32	Request for Changes to Licensing Documents
CPPP-33	Engineering Activities Support SWEC Certification of ASME III Class 2 and 3 System N-5 Data Reports as Piping System Designer
CPPP-35	Piping & Pipe Support Qualification Procedure for Secondary Wall Displacements

Project Memoranda (PMs)

Procedure No.	Title
PM-001	Pipe Support Computer Program Usage
PM-003	Design Information Request Procedure
PM-016	Qualification of Two (2) Bolt Base Plates
PM-025	Gang Hanger and Terminal Anchor Procedure - Unit 2
PM-039	Administrative Procedure for Qualifying Wall-to-Wall, Floor-to-Floor, and Corner Pipe Supports
PM-050	Procedure to Adjust the Seismic Response Acceleration for Valve Qualification
PM-051	Integral Welded Attachment (IWA) Task Group
PM-053	CPPP-7, Rev. 2, Sec. 3.6.4 (Essential Systems)
PM-054	Project Engineering Assurance Engineer Responsibilities
PM-056	Simplified Method For Qualification of As-Built Small-Bore Piping
PM-060	Revised Pad Width Requirements for Attachment 4-6A of CPPP-7
PM-061	Mismatch SIFs
PM-062	Calculation of Support Loads for Non-Nuclear Safety Related Piping Attached to an ASME III Support
PM-063	Pipe Support Clearance Requirements
PM-075	Design Considerations for E-Systems and Western Piping Stiff Clamps Used on Main Steam and Feedwater Piping
PM-091	Problem Boundary Modifications
PM-097	Pipe Support Welded Tube Steel Joints
PM-103	Allowable Valve Accelerations
PM-106	Proposed Modification Reports
PM-115	Code Case N318-2 and N413 Usage
PM-119	Allowable Stress Range for Expansion Stresses S_A

PMs (Continued)

Procedure No.	Title
PM-121	Loads and Movements Required To Be Shown on Pipe Support Drawings
PM-126	SA, PM, and PSC - Memos
PM-127	Reflective-Type Insulation Removal for Frame-Type Pipe Support/Penetration
PM-128	10 CFR 50.55(e) Recommendation/Evaluation Procedures
PM-131	External Transmittals of Requalification Results
PM-133	Final Reconciliation Check List
PM-134	Transmittal of Small Bore Data - Unit No. 1
PM-135	Sections of CPPP-7. Rev. 3, Which Require Confirmation
PM-136	Intra-Project Transmittals
PM-137	Wall Thinning Criteria
PM-138	Dynamic Analyses of Fluid Transient Loading
PM-139	Procedure for Evaluating Pipe Local Stresses at Stiff Clamp Supports
PM-140	Flare Bevel Groove Welds
PM-141	Unequal Shear Loading Effect on Richmond Inserts and Threaded Rods Used in Conjunction with Tube Steel
PM-142	Errata to Project Procedure CPPP-7, Rev. 3
PM-143	SIFs for Non-Bonney Forge Fittings
PM-144	Design of Welds for ITT Grinnel Rear Brackets
PM-145	Pipe Support Modification Procedure Large Bore Effort - Unit 2
PM-146	The Use of Galvanized Nuts on CPSES
PM-147	Supplemental Requirements for Hilti Bolts Used With Interface Anchors
PM-148	Effect of Concrete Topping on Hilti Edge Distance

Procedure No.	Title
PM-149	Unit 1 - Gang Hanger and Terminal Anchor Procedure Impacting Small Bore Supports
PM-150	Minimum Weld Size for Non-ASME Welds
PM-151	PSAP RELAP 5, and REPIPE,SCAP, and ETA Computer Programs
PM-152	Natural Frequencies of Safety-Related Flexible Valves
PM-153	Unit 1 - Site Processing of Requalification Results
PM-154	Axial Restraints With Lugs
PM-155	SIF Evaluation of Branch Connections
PM-156	Nonsafety-Related Flexible Metal Hose Interface Loads
PM-157	Break/Crack Postulation, Pipe Stress Analysis, and Pipe Qualification Requirements for Class 5 High and Moderate Energy Lines - Units 1 and 2
PM-159	Local Stress Evaluation of Welded Bracket Connections
PM-160	Addition to Record Classification Code List (RCCL)
PM-161	Evaluation of Tornado Missile Effect on Piping System
PM-162	Circular Trunnion Attachments to Elbows
PM-163	CPPP-7 Piping and Pipe Supports Code Applicability Changes
PM-164	Overall Final Assessment Review of Piping Systems
PM-165	Screening Procedure - Fluid Transient Cutoff Loads
PM-166	Pipe Stress and Support System Review Checklist
PM-167	Use of Computer Program PITRIFE (ME-211)

PMs (Continued)

Procedure No.	Title
PM-168	4-Bolt Clamp Anchor Drawings
PM-169	Interface Anchor Control Procedure
PM-170	Revised Procedure for Qualification of Elbows With Branch Connections
PM-171	Analysis and Design Guidelines for Stiff Clamp Supports
PM-173	Design Requirement for Intermittent Welds
PM-175	Local Stress in Pipe Support Members
PM-176	Control Procedure for Nonseismic Piping Attached to Safety--Related Gang Supports
PM-177	Cancellation of Project Memoranda (PM)
PM-178	Resolution of TERA Fluid Transient Issues
PM-179	Pipe Support Stiffness Representation
PM-180	Interface Coordination Requirement for Fluid Transient Loads
PM-181	NPSI Load Capacity Data Sheet (LCDS) and Certified Design Report Summary (CDRS)
PM-182	Supplemental Guidelines for Evaluation of Seismic Cat. II Piping
PM-183	Incorporation of Localized Minimum Wall and Radial Shrinkage Violations in the Stress Analysis
PM-184	Effects of Component Self Weight Excitation on the Local Stress Evaluation at the Tube Steel/Rear Bracket Interface
PM-185	Integral Welded Attachment (IWA) Near Concentrated Weights
PM-186	Procedure Determine Branch Stiffness at the Branch/Run Connection
PM-187	Update Requirement for Pipe Stress and Pipe Support System Review Documentation (PSRD)

Procedure No.	Title
PM-188	Procedure for Evaluation of Welds Between Nonintegral Pads & Piping
PM-189	Minimum Required Pipe Wall Thickness
PM-190	Shear Lug Analysis
PM-191	Calculation Index
PM-192	Document Transmittal to TU Electric's Automatic Records Management System (ARMS)
PM-193	Valve Acceleration and Valve Nozzle Load Evaluation for 2-in. and Smaller Rockwell Valves (MS-20A.1)
PM-194	Controlled Index of Vendor-Supplied Parts From E-Systems, Western Piping and Pacific Scientific
PM-195	CPPP-11 Corrections
PM-196	Small Bore Nozzle Load Criteria for Westinghouse-Supplied Auxiliary Heat Exchangers
PM-197	PRDP/TMS Validation in Relation to System Validation by SWEC-CAP-Unit 1
PM-199	Small Bore Piping Nozzle Loads for Westinghouse-Supplied Auxiliary Pump
PM-200	Controlled Index of Vendor-Supplied Parts from ITT Grinnel Corporation
PM-201	Valve Operator Support Classification
PM-202	Clarification of CPPP-22, Rev. 0
PM-203	Clarification for CPPP-7, Attachment 4-10, Design Methods for Interface Anchors
PM-204	SIF for Inward Tapered Transition Joints
PM-205	Fillet Weld Size Equivalency, Attachment 4-2, CPPP-7
PM-206	Take-Out Dimension for F-Type Springs
PM-207	Revision to Table 1 of Attachment 4-21 of CPPP-7, Revision 3

Procedure No.	Title
PM-208	Location of Equipment Nozzle Load Allowables for Westinghouse Equipment
PM-209	Clarification of Westinghouse D-Specification G-679150
PM-211	Cross-Configuration Supports
PM-212	Moderate and High Energy Line Lists
PM-213	Revision to Section 4.1 of CPPP-15
PM-214	Clarification of Evaluations for CT and SI Systems Supports
PM-215	Penetration Sleeve Seals Analytical Modeling
PM-216	Local Pipe Stresses Due to Pipe Through Pipe, Pipe Through Tube Steel, or Pipe Through Plate Anchors
PM-217	Piping Classification G
PM-218	Limitation for the Use of Attachment 4-6A to CPPP-7
PM-219	SIF at Pipe Mismatch
PM-220	Calculation Submittal to TU Electric Interim Calculation File (TICF)
PM-221	Seismic Category II PSAS Evaluation
PM-222	Seismic Category II PSAS Evaluation
PM-223	Procedure for Evaluation of Local Pipe Stress Due to Dual Trunnion Anchors
PM-224	Final Embedment Depth for Drilled-In Expansion Type Concrete Anchors
PM-225	Procedure for Calculating Indices and Distribution
PM-226	Clarification to CPPP-7
PM-227	Options Review Committee (ORC)
PM-228	Criteria for Class 1 Small Bore Pipe Stress Analysis
PM-229	Butt Weld Piping Connection Distortion Criteria

APPENDIX F
CYGNA HEARING ISSUES RELATED TO PIPING AND PIPE SUPPORTS

During the February 20-24, 1984 Atomic Safety and Licensing Board (ASLB) hearing sessions, Board Exhibit No. 1, "Independent Assessment Program Final Report," Volumes 1 and 2, prepared by CYGNA Energy Services (CYGNA) was introduced. At the conclusion of the February 1984 hearings, a set of 30 written cross-examination questions were submitted to CYGNA by witnesses, J. Doyle and M. Walsh for the intervenor, Citizens Association for Sound Energy (CASE). CYGNA developed its responses and adopted those responses as its prefiled testimony entitled "Testimony of Nancy H. Williams in Response to CASE Questions of February 22, 1984 to CYGNA Energy Services," dated April 12, 1984 (Testimony of N. H. Williams). CYGNA's Independent Assessment Program and its prefiled testimony on the 30 CASE questions were used as the subject matter for litigation during the April 24-27, 1984 and May 1-3, 1984 hearing sessions.

The staff evaluation included in this appendix addresses those 23 questions that concern piping and pipe support design. The remaining seven questions relate to cable tray and cable tray support design and will be addressed in a separate safety evaluation report.

The 23 questions addressed herein have been categorized into the issues discussed below.

A description of CASE's question, CYGNA's response from its prefiled testimony, the relevant discussions from the hearings, and the staff evaluation of the issue with respect to the SWEC design validation are provided under each hearing issue.

(1) U-Bolt Cinching
(CASE Question: Doyle #1)*

The concern raised by CASE related to the adequacy of cinched-up U-bolts and their being

(a) not in compliance with Cygna criteria
(b) not in compliance with NRC criteria
(c) stresses of unknown quality due to pre-stress, thermal, and design loads,
(d) effects on pipe not shown on calculations, and
(e) not in compliance with Board Notification BN-82-105A

CYGNA's prefiled testimony stated that Section 4.1.2 of its pipe support review criteria addressed the need for gaps to accommodate pipe radial expansion and construction tolerances. These criteria were not intended to apply to clamps

*The descriptor for CASE questions correspond to the numerical listing of the cross-examination questions provided by CASE (J. Doyle and M. Walsh) to CYGNA on February 22, 1984 (Attachment 1 to Testimony of N. H. Williams).

that contact the pipe but rather were intended to apply to pipe supports that do not require physical contact with the pipe. CYGNA further stated that loads due to cinching U-bolts were not assessed because the torquing requirements were not stated in installation specifications that were not included in CYGNA's scope of review.

During the February and April 1984 hearings, a substantial amount of testimony was presented regarding U-bolt cinching. (Tr-9768-9786; 12,324-12,366; 12,406; 12,411-12,423; 12,958-13,005; 13,033-13,039; 13,064-13,065; 13,073-13,077). In summation, CYGNA concluded that on the basis of its preliminary studies on the U-bolt cinching problem, there could be an overstress condition of the U-bolt at 5 foot-pounds torque and an overstress condition of the pipe (8-inch schedule 40) at 80 foot-pounds torque when the thermal stresses are added with the preload stress (Tr. 12,331-12,333). CYGNA concluded that further evaluation should be conducted. CYGNA did not believe that it was their charter to review installation procedures in their design review although those installation procedures contained information that affects design (Tr. 13,073).

Staff Evaluation

The concerns identified by CASE in this issue were associated with support SI-1-325-002-S32R. This support has been subsequently modified to a strut with a stiff pipe clamp. The stiff pipe clamp is a component standard support qualified by the vendor in accordance with ASME Code, Section III, Subsection NF requirements. The piping to which the stiff clamp is attached has been qualified by Stone and Webster Engineering Corporation (SWEC) using Project Memorandum PM-139 (see Appendix D to this supplement).

The staff evaluation of the generic concerns associated with U-bolt cinching at CPSES including its evaluation of PM-139 is provided in Appendix A (Section 11) to this supplement.

2) Local Stress In Tube Steel
(CASE Question: Doyle #2)

The concern regarding local effects on tube steel walls was raised with regard to:

(a) punching shear
(b) effect on welds and
(c) resultant effect due to wall flexibility on moments at tube welds.

CYGNA addressed the concern in its prefiled testimony by demonstrating that if the tube wall thickness is equal to or greater than the fillet weld size, punching shear stresses in the tube will be satisfactory.

For support RH-1-064-011-S22R, the tube thickness (1/2-inch) is twice the size of the attached fillet weld (1/4-inch) where a 3-inch long bracket is welded unto a 6-inch wide tube steel (Beta equal to 0.5).

During the April 1984 hearing, the discussion of this concern indicated that CYGNA did not believe that punching shear calculations were required. The discussion of the effects of wall flexibility on welds focused on certain design standard weldments shown in Design of Welded Structures, by O. W. Blodgett, James F. Lincoln ARC Welding Foundation (1966) (Tr. 12,487-12,501).

Staff Evaluation

American Welding Society (AWS) D1.1, Section 10.5 specifically addresses stepped tube connections and the evaluation of tube wall capacity for punching shear and wall crippling.

Reference 1 to the AWS D1.1, "Commentary on Structural Welding Code - Steel," is a paper by P. W. Marshall and A. S. Toprac entitled, "Basis for Tubular Joint Design," Welding Journal, Welding Research Supplement (May 1974). The purpose of the reference paper was to document the background data underlying the criteria in AWS D1.1, Section 10, and to enable potential designers of other classes of tubular structures (other than fixed offshore platforms) to evaluate the suitability of the criteria for their particular application. The paper states that, "for relatively stocky chord members - thickness greater than 7% of the diameter or 'gamma' less than 7 - the joints may be said to have a 100% punching shear efficiency, in the sense that the shear strength of the material is fully mobilized on the potential failure surface." Furthermore, it is evident in the paper that AWS Section 10.5 and, specifically, punching shear reduction capacity were developed primarily for tubular structures where the chord thinness ratio (R/t) or gamma is significantly greater than 8. The tube steel sizes used at CPSES are typically less than or equal to 8. Unless the tube steel gamma ratio is greater than 8, the staff concludes that reduced punching shear effects need not be considered. When the chord thinness ratio is equal to 8, there is a potential unconservatism of approximately 10 percent. The tube steel in the support evaluated by CYGNA and as it currently exists under the SWEC design validation has a gamma ratio equal to 6 and, thus, a punching shear reduction is not applicable.

The staff evaluation of the generic implications regarding punching shear in tube steel for the CPSES Units 1 and 2 is provided in Appendix A (Section 8.6) to this supplement.

(3) Dead Weight of Pipe Supports
(CASE Question: Doyle #3)

The concern raised by CASE was that dead weight of structures was not included in the support calculations. CYGNA's prefiled testimony indicated that the dead load of the pipe support itself is generally much smaller than piping loads for which the support is designed. In the April 1984 hearings, CYGNA clarified that for large structures the dead weight should be included in the calculation, but for small structures such as the pipe supports in the residual heat removal (RHR) system, it is reasonable to neglect it (Tr. 12,529). For two supports reviewed by Cygna, it was shown that the percentages of the total support weights to the design loads were 4 percent and 2 percent.

Staff Evaluation

The staff evaluation of the generic implications at CPSES regarding dead weight loads of pipe supports for the CPSES Units 1 and 2 is provided in Appendix A (Section 19.1) to this supplement.

(4) Pipe Support Mass Effects on Pipe Stress
(CASE Question: Doyle #4)

CASE raised a concern regarding the effect of pipe support masses on the piping stress analysis. CYGNA's prefiled testimony stated that standard industry practice is to not include support masses in the piping analysis. An analytical evaluation performed by CYGNA that included 16 supports modeled in a piping run showed that support masses had a negligible effect on piping stresses.

Staff Evaluation

The staff evaluation of the generic implications related to effect of the support mass effects on pipe stress for CPSES Units 1 and 2 is provided in Appendix A (Section 15.1) to this supplement.

(5) Stability of Pipe Supports
(CASE Question: Doyle #5)

CASE raised a question regarding the stability of column supports with pinned end connections. The prefiled testimony provided by CYNGA addressed the instability of various residual heat removal supports with respect to rigid body modes of instability, Euler column buckling, and beam-column effects.

During the April 1984 hearings, the concept of "instability" was discussed in a different context than that addressed in the CYGNA prefiled testimony. (Tr. 12,616-12,653). The concept of a "kick" load was identified by CASE as that load which is developed as a result of a skewed support. The skew is caused by the support angular installation tolerance of ±5° from the design drawings. For the particular support discussed (CASE Exhibit 928, ff.Tr. 12,903), a 19 kip load with a 3° offset from its analyzed position would result in approximately 1000 pounds which is not considered in the piping system analysis. This 1000-pound load was referred to as a "kick" load and it was alleged that the kick load can result in instability downstream (Tr. 12,621). CYGNA's response was that one must evaluate the system as a whole (Tr. 12,622). The Board questions the validity of neglecting the effects of a ±5° tolerance for pipe supports that CYGNA had accepted per their engineering judgement (Tr. 12,645). As a result, the Board identified an open concern and requested the staff to provide a basis for the 5° tolerance and, specifically, as applicable to the support in CASE Exhibit 928 (Tr. 12,651).

Staff Evaluation

The system instability resulting from kick loads is not explicitly covered by the ASME Code rules for piping systems but is generally reviewed by piping designers utilizing good engineering practice. ASME Code, Section III, does provide general design rules for the loading conditions to be taken in designing piping systems in Paragraphs NB/NC/ND-3111 and NB/NC/ND-3622; but the Code is not a handbook and the consideration of the overall stability of piping systems relies on the implementation of prudent engineering design practices in conjunction with the engineer's education, experience, and sound engineering judgment.

The response provided by CYGNA addressed the stability of the support configuration as required in ASME Code, Section III, Appendix XVII, and demonstrated that the Code requirements have been met. Kick loads for which there are no specific ASME Code requirements were not specifically addressed by CYGNA in its review criteria nor in its program results.

The staff concludes that the evaluation performed by CYGNA ensured compliance of the support to stability requirements as defined in Subsection NF of the ASME Code, although CYGNA did not explicitly address the effect of the support offset of approximately 3° in its report.

The specific support, SI-1-325-002-S32R, identified in the hearings has been subsequently modified to a strut with a stiff pipe clamp.

The staff's evaluation of the effect of kick loads and the generic implications regarding angular tolerances for skewed supports is discussed in Appendix A (Section 27.1) to this supplement. The staff evaluation of the acceptability of a 5° angular tolerance is provided in Appendix A (Section 27.2) to this supplement.

(6) Local Bearing Stress in Piping
(CASE Question: Doyle #6)

CASE raised a question regarding the bearing stresses that would result in piping in a box frame that is subjected to a 20,000-pound load. CYGNA's prefiled testimony did not address CASE's question by rather addressed the effect of radial pipe thermal expansion stresses developed in a box frame. The local thermal stresses in the pipe were found to be large when considered alone but were below ASME Code allowable values.

In the April 1984 hearing session, it was established that CYGNA did not perform a calculation to evaluate the local pipe bearing stresses caused by a 20-kip load (Tr. 12,666). CYGNA concluded that the concern should be evaluated further (Tr. 12,1668).

Staff Evaluation

The staff concludes that the concern identified by CASE was not adequately addressed by CYGNA in its Independent Assessment Program. The Staff believes the magnitude of the load (20 kips) could have resulted in an overstress condition of the pipe. The specific support, SI-1-325-002-S32R, related to this issue has been modified to a stiff clamp, and the issue of bearing stresses due to the box frame is no longer applicable to this support.

The generic implications regarding the local stresses in a pipe, specifically a pipe in a box frame, are addressed in Appendix A (Section 2.2) to this supplement.

(7) Use of Clip Angles/U-Bolts on Box Frames
(CASE Question: Doyle #7)

CASE raised a concern regarding the adequacy of the clip angles to maintain stability. The clip angles are welded onto the box frame and are used for attaching the cinched to the U-bolt/box frame. CYGNA's prefiled testimony stated that in the U-bolt-to-the-box-frame configuration, no credit was given for the U-bolt maintaining stability. The clamping mechanism was assumed by

CYGNA to be provided solely by the friction forces developed between the pipe and box frame. CYGNA further stated that a subsequent review of the installation instruction for the preloading of the U-bolts found that the clip angles would theoretically be overstressed.

In the April 1984 hearings, CYGNA clarified that the clip angle is incapable of supporting the preload torque of the U-bolts but stated that the U-bolt/box frame support would not necessarily lose its function because of the friction forces developed as a result of thermal expansion and the zero inch clearance between the pipe and box frame (Tr. 12,706). The ensuing discussion focused on whether there was a zero-inch clearance or whether there could be a small gap between the pipe and box frame in the installed condition. (Tr. 12,709-12,747). Cygna finally stated that if there were a gap between the pipe and box frame (and the overstressed clip angles would be required to maintain the clamping effectiveness), then further analyses would be required to determine the overall support adequacy (Tr. 12,747).

Staff Evaluation

The basic function of a pipe clamp is to attach piping component supports (e.g., hangers, struts, snubbers) to the piping. It is common industry practice to use pipe clamps in association with other component standard supports and hardware. The total component support is typically attached to structural (building) steel or to anchorages in the building walls and floors. Where component standard supports are not used, the piping is usually supported by the use of welded supplementary steel (e.g., I-beams, tube steel, angles, etc.).

The staff views the U-bolt/box frame as a substitute for a standard pipe clamp. The clip angles function as an attachment for the U-bolt to the box frame. The unusual feature in regards to this configuration is that the box frame is analyzed for the design basis loadings but when a gap between the pipe and box frame exists, there is a need for a clamping mechanism to ensure the support functionality. The clamping mechanism is provided by the U-bolt. Thus, the U-bolt function was not specifically designed to resist the design basis loading but was added for serviceability (i.e., to prevent undesirable rotation around the pipe axis). In essence, the dual function of the U-bolt/box frame is an unusual method for providing the same function as that of a standard pipe clamp but its effectiveness has not been adequately demonstrated.

If the clip angles on the U-bolt/box frame are overstressed to a degree where the clamping mechanism is lost, then the intended function of the U-bolt/box frame "clamp" is not ensured.

The U-bolt torquing and the clip angle evaluation are a necessary element to ensure the component support structural and functional design adequacy for the U-bolt/box frame configuration. However, the overall design is highly unusual.

In the TU Electric Corrective Action Program for piping and pipe supports, this type of pipe support design (i.e., box frame with U-bolt attached with clip angles) was totally eliminated; thus, the generic implication has been adequately addressed.

(8) Flare Bevel Welds
(CASE Question: Doyle #8)

The concern raised by CASE is related to the basis for CYGNA's acceptance that flare welds are stronger than fillet welds. CYGNA's prefiled testimony provided calculations that concluded that changing from a 1/4-inch fillet weld to a minimum flare bevel groove weld increased the weld capacity by 65 percent. During the April 1984 hearing, it was clarified that at the time of CYGNA's review, the weld was depicted as a fillet weld but was subsequently changed to a flare bevel groove weld. Although CYGNA did not address the weld change at the time of its review, they did address the weld change in its written testimony in response to CASE's question (Tr. 12,748-12,751).

Staff Evaluation

There was no apparent concern in this issue that opened from the hearings. The staff evaluation of the design of flare bevel welds at CPSES Units 1 and 2 is provided in Appendix A (Section 8.9) to this supplement.

(9) (CASE Question: Doyle #9)

This question was withdrawn. (Tr. 12,756)

10) (CASE Question: Doyle #10)

This question was deleted. (Tr. 12,758)

(11) Seismic Excitation of Pipe Supports
(CASE Question: Doyle #11)

CASE raised a concern regarding the effect of support self-weight excitation in the support off-direction and its effect on the pipe support loads. CYGNA's prefiled testimony stated that in its review of the residual heat removal piping system, the potential problem of neglecting support self-weight excitation was identified in Note 1 to Checklist PS-01. Cygna resolved this item by noting that this particular concern was addressed in the special inspection team (SIT) report and deferred to the staff evaluation.

In the April 1984 hearing session, it was revealed that when CYGNA performed an analysis to assess the effect of support mass on piping stress (see Doyle #4), CYGNA found a 24 percent increase in the safe-shutdown earthquake load on the support itself (TR. 12,751). CYGNA later clarified that, in the analysis, they "were focusing on one single item--the influence of support mass only... (CYGNA excluded all effects which would have reduced this value below its percent value" (Tr. 13,078). CYGNA's conclusions were that the 24 percent increase can be reduced by factoring in the effects of piping thermal and weight loads and the overall effect of support self-weight excitation does not have an effect on the residual heat removal system design adequacy (Tr. 13,079).

Staff Evaluation

The staff evaluation of the generic implications regarding seismic excitation of pipe supports at CPSES is provided in Appendix A (Section 19.2) to this supplement.

(12) Moment Restraining Effects of Dual Supports
(CASE Question: Doyle #12)

During the April 24-27, 1984 hearings on the CYGNA Independent Assessment Program, a substantial amount of discussion focuses on the subject of modeling used in piping stress analyses for dual restraints which act in the axial direction of the pipe. (See Tr. at 12,767-12,796, 12,851. 13,081-13,083, 13,105-13,107, and 13,124). The concern expressed during the hearing was that the support load was calculated on the basis of a piping stress analysis that modeled the dual axial restraints as a single axial restraint. The support load from the single axial restraint was assumed to have an equal (50/50) load distribution for the design of the dual restraints and each restraint was sized to half the load. The concern was that in addition to an axial load, there could be a moment in the piping system that could introduce a moment couple into the two axial restraints that was not considered and could result in higher restraint loads.

CYGNA evaluated the problem and concluded that the modeling used by Gibbs & Hill, which assumed a single axial restraint is an acceptable technique, and that a model assuming two restraints parallel to each other and connected to the pipe is an alternative technique - not necessarily better or more accurate (Tr. 12,772). CYGNA stated that when two restraints are modeled, they will provide some degree of rotational restraint and will result in a different distribution of loads on the two restraints. CYGNA had Gibbs & Hill rerun the piping analysis with the dual snubbers modeled as a single restraint (per the original analysis) and as a dual restraint for comparative purposes. CYGNA found that the support loads increased while the piping stress and equipment nozzle loads decreased (Tr. 12,789).

The support load increased from 1328 pounds to 3933 pounds. The rated load capacity for the snubber was 1500 pounds (Pacific Scientific PSA-1). The Board recommended that the staff advise it on the need for further reanalysis when the Staff provides its testimony (Tr. 13,107).

Staff Evaluation

The specific support discussed in the CYGNA hearings with respect to this issue was support RH-1-010-004-S22K. This support has subsequently been deleted and no longer exists at CPSES. Thus, the specific concerns identified with this support are not relevant to CPSES.

The staff evaluation of the generic implications regarding dual snubbers acting as moment restraints for CPSES Units 1 and 2 is provided in Appendix A (Section 12.1) to this supplement.

(13) Pipe Support Generic Stiffness
(CASE Question: Doyle #13)

CASE raised a concern regarding CYGNA's evaluation of the generic stiffness values used in piping analysis for the modeling of pipe supports. In its prefiled testimony, CYGNA explained that the use of generic stiffnesses was raised as a potential problem but was not pursued because the issue had been addressed in the SIT report. Accordingly, CYGNA recorded the potential deficiency on the appropriate checklist and deferred to the staff evaluation in the SIT report.

Staff Evaluation

The staff evaluation of the generic implications regarding pipe support generic stiffness values used in piping analysis for CPSES Units 1 and 2 is provided in Appendix A (Section 5.1) to this supplement.

(14) Local Flexibility of Pipe Support Members
(CASE Question: Doyle #14)

The question raised by CASE was related to CYGNA's review consideration of (a) the effect of support stiffness on the evaluation of self-weight excitation and (b) the flexibility of each element in the support load path. CYGNA's prefiled testimony addressed two considerations of the effect of support stiffness on self-weight excitation.

(1) the influence of the support stiffness relative to an approximate method used to estimate the natural frequency of the system

(2) the influence of support stiffness relative to the determination of support stresses and deflections

For the flexibility effects of each element in the support load path, CYGNA referred to its response in Doyle #13 which deferred to the SIT report for its evaluation of generic stiffnesses. Furthermore, CYGNA stated that current standard practice (state-of-the-art) is not to include baseplate stiffnesses in calculating the overall support stiffness and, thus, CYGNA did not consider it reasonable for it to be a requirement at CPSES. In the April 1984 hearing, CYGNA presented a detailed explanation of the effect of anchor bolts and baseplates on the overall support stiffness (Tr. 12,855-12,862).

Staff Evaluation

The staff finds that the technical discussion by CYGNA at the April 1984 hearing demonstrated that the effect of non-linear gaps and the flexibility of the support baseplate using Hilti anchor bolts did not significantly affect the overall stiffness of pipe supports.

The staff evaluation of the effect of generic stiffness, local flexibilities, and bolt hole gaps at CPSES Units 1 and 2 is provided in Appendix A (Sections 5.1, 5.2, and 13.1) to this supplement.

(15) Constraint of Pipe Thermal Expansion
(CASE Question: Doyle #15)

CASE raised a concern regarding the effect of anchors and supports constraining pipe radial growth due to thermal expansion of the pipe. CYGNA's response in its prefiled testimony addressed the constraint of pipe radial growth for three different types of support:

(a) box frame (zero inch clearance) support
(b) trunnion-type anchor
(c) stanchion with saddle anchor

During the April 1984 hearing, the testimony focused on the box frame support with zero-inch clearance (Tr. 12,666). CYGNA concluded that the high localized stresses in the pipe due to the constraint of radial expansion should be evaluated further to determine the acceptability of the total piping stress when the pressure and bending stresses are included (Tr. 12,669).

Staff Evaluation

The ASME Code in Paragraphs NC/ND-3645 and NC/ND-3613.3 provides two broad design rules that can hold local stresses in ASME Code Class 2 and 3 piping at a safety level consistent with experience. However, experience has shown that when structural steel is used to frame the piping in a box-type arrangement, it is good engineering practice to provide a small (typically 1/16 inch in the "hot" position) gap between the pipe and box frame to allow the pipe to expand freely in a radial direction when thermal loading exists in the pipe. One major reason for providing the gap is to prevent large frictional forces from developing that could prevent the pipe from moving axially through the box frame. It should be noted that common practice for box frame supports dictates that the auxiliary steel used in pipe supports is welded together forming a rigid self-supporting structure. At CPSES, the box frame tube steel support was commonly attached to component standard supports (i.e., struts) using pinned connections. The staff is not aware of this practice having been used at previously designed facilities. Consequently, the usual design concern of binding the pipe axially is eliminated, but is replaced by a new design concern of constraining the radial growth of the pipe due to thermal expansion loadings. Although the ASME Code recognizes that "highly localized and secondary bending stresses may exist" in certain Class 2 and 3 components, the staff found that the thermal binding of the pipe radial growth in box frames where a zero-inch clearance was specified had been adequately considered at CPSES by the designers. However, this zero gapped box frame design has subsequently been eliminated at CPSES and the issue no longer is relevant.

The staff does find that the trunnion-type anchor and the stanchion anchor are still used at CPSES and also are commonly used in other nuclear facilities. Previous experience does provide assurance that these types of anchors are an acceptable design provided the applicable code provisions are satisfied.

The staff evaluation of the generic implications regarding trunnion-type anchors and stanchion-with-saddle anchors is discussed in Appendix A (Section 20.2) to this supplement.

(16) Oversize Bolt Hole Effects on Anchor Bolts
(CASE Question: Doyle #16)

CASE raised a concern regarding the acceptability of assuming that all bolts in a baseplate equally sharing the shear loading when the bolts are acting as bearing-type connections. CYGNA's prefiled testimony provided a calculation that demonstrated that for the worst case (a 1-inch diameter bolt with a bolt hole of 1 1/8 inch) at CPSES, the factor of safety in shear for a four-bolt baseplate is reduced by only 4 percent. CYGNA concluded that for bolts composed of a sufficiently ductile material, the ultimate shear capacity of the four bolts in the baseplate will be achieved. During the April 1984 hearing session, CYGNA explained the loading for anchor bolts in baseplates (Tr. 12,856-12,876) in response to CASE's cross-examination on CASE Question: Doyle #14 and again on CASE Question: Doyle #16 (Tr. 12,885-12,888). CASE concluded that its concern regarding oversized bolt holes was eliminated (Tr. 12,888). CYGNA later clarified the calculation for the four-bolt-baseplate pattern that demonstrated the load sharing capability of the bolts in shear. (Tr. 13,622-13,628).

Staff Evaluation

It is apparent to the staff that the calculation performed by CYGNA assumed that the four bolts were acting as a bearing connection. The 1-inch bolt diameter with a 1/8-inch oversized hole was the only size identified by CYGNA that was not in compliance with the 1974 ASME Code. The deviation from the Code was 1/16 inch. CYGNA's calculation provided a technical justification for the 1/16-inch deviation by demonstrating that the safety factor of 5 for bolt shear, previously used by applicants for concrete expansion anchor bolts in piping support design, was reduced by only 4 percent. Thus, the factor of safety for bolt shear was still greater than the factor of safety of 4 required per IE Bulletin 79-02). CYGNA's calculation used the test data for a 1-inch diameter Hilt anchor bolt embedded in 4000 psi concrete.

The staff evaluation of the generic implications regarding oversized bolt holes for CPSES Units 1 and 2 is discussed in Appendix A (Sections 13.1 and 26.1) to this supplement.

(17) Effect of Two-Inch Topping
(CASE Question: Doyle #17)

CASE raised a question regarding the 2-inch topping that is provided for anchor bolts on several pipe supports. CYGNA's prefiled testimony stated that the installation procedures to determine the effective anchor bolt length did not take credit for the 2-inch topping as structural concrete. CASE did not appear to have any further concerns regarding this issue at the April 1984 hearing session (Tr. 12,888).

Staff Evaluation

The staff finds the treatment of the 2-inch topping was adequately evaluated in the CYGNA review. The generic implications of this issue is further addressed in the Corrective Action Program for civil/structural C/S design (see C/S project status report - Subappendix A11).

(18) Effect of Baseplate Stiffness
(CASE Question: Doyle #18)

CASE raised a question regarding the effect of baseplate stiffeners on the anchor bolt loads. CYGNA's prefiled testimony stated that it is a conservative approach to neglect the effect of baseplate stiffeners on the anchor bolt or baseplate design. CYGNA performed calculations for two support baseplates that demonstrated that the maximum bolt forces in an unstiffened baseplate are larger than in a stiffened baseplate. Similarly, CYGNA calculations showed that the maximum plate stress without stiffeners is greater than with stiffeners (Tr. 12,891).

Staff Evaluation

The calculations performed by CYGNA provided a reasonable technical basis for concluding that the effect of baseplate stiffeners can be neglected for the evaluation of the baseplate stresses and anchor bolt loads. The staff finds CYGNA's review in this area to be adequate.

(19) A500 Grade B Tube Steel
(CASE Question: Walsh #1)

CASE raised a question regarding the yield strength used for A500 Grade B tube steel. CYGNA's prefiled testimony stated that at CPSES, a yield strength of 42 ksi was used per ASME Code Case N-71-9. Subsequently, Code Case N-71-10 was issued, which reduced the yield strength to 36 ksi. CYGNA reviewed the pipe support calculations for the 20 supports in its scope or work and in each case the tube steel stresses were within the 36 ksi allowable stress.

Staff Evaluation

The Staff finds that on the basis of satisfying the provisions of the ASME Code in Paragraph NA-1140, the use of ASME Code Case N-71-9 is acceptable. The staff evaluation of the generic implications regarding the yielding strength for A500 Grade B tube steel is provided in Appendix A (Section 9.1) to this supplement.

(20) Interaction of Adjacent Concrete Anchorages
(CASE Question: Walsh #2)

The question raised by CASE was whether CYGNA had reviewed the shear cone interaction of adjacent concrete expansion anchor bolts. In its prefiled testimony, CYGNA stated that it had verified shear cone interaction and that the applicants had properly considered these effects using the anchor spacing provided in the Hilti catalog. There was no further concern expressed by CASE on this issue at the May 1984 hearings.

Staff Evaluation

CYGNA adequately addressed the consideration of shear cone interaction of Hilti expansion anchor bolts by the applicant in its scope of review. No open issue remained from the hearings. The staff finds CYGNA's review to be adequate in this area. The staff evaluation of the generic implications for CPSES Unit 1 and 2 related to interaction of adjacent concrete anchorages will be addressed by the staff in a separate safety evaluation on the civil/structural CAP.

(21) Pipe Wall Thickness
(CASE Question: Walsh #3)

CASE raised a concern that no detailed computer analysis was performed to evaluate the effect of an incorrect pipe wall thickness on piping stress. The assumption used by CYGNA in its resolution of Observation PI-01-02 was based on a linearly proportional stress increase whereas CASE's concern was that in the seismic analysis, the increase will not be linearly proportional. In CYGNA's prefiled testimony and in the May 1984 hearing, a substantial amount of testimony focused on the technical bases for CYGNA's simplified assumption of a linearly proportional stress increase (Tr. 13,386-13,440).

Staff Evaluation

The piping analysis error associated with this issue is no longer relevant because the SWEC design validation of all ASME Code Class 2 and 3 piping systems at CPSES has caused this Gibbs & Hill piping analysis to be superseded.

(22) (CASE Question: Walsh #4)

The concern was only a typographical error that was subsequently corrected by CYGNA.

(23) Support Angularity
(CASE Question: Walsh #11)

CASE raised a question regarding CYGNA's basis for assuming that support angular orientations that deviated from the construction tolerance were acceptable. CYGNA's prefiled testimony stated that the exceedances of the 5.0° construction tolerance were only 3.6° and 2.5° respectively, for the two supports evaluated. To verify the adequacy of its judgment, CYGNA requested Gibbs & Hill to reanalyze the piping subsystem. In the reanalysis, three supports were remodeled to their as-built configuration and the dual snubber axial restraint was remodeled as two parallel restraints (See Doyle #12). The reanalysis resulted in a decrease in equipment nozzle loads, a small increase in maximum piping stress, and an increase in pipe support loads. In the May 1984 hearing, CASE raised a question of whether the appropriate piping stress allowable value was used. An apparent conflict arose between the allowable value used in the CYGNA prefiled testimony and the allowable value stated in the CYGNA Independent Assessment Report under Appendix H checklist Item PI-02 (Tr. 13,504). CYGNA resolved this issue in later testimony (Tr. 13,679-13,684) by clarifying that in the piping system model, two different piping materials are specified for different portions of the piping system. The portion of the system addressed in PI-02 was composed of a different material than the portion of the system (addressed in Walsh #11) where the maximum piping stress occurred.

Staff Evaluation

On the basis of its review of the piping analysis results, the staff finds that CYGNA's conclusion that the effects of the skewed angle deviations were negligible is correct. The staff evaluation of the generic implications for CPSES Units 1 and 2 related to support angularity is discussed in Appendix A (Section 27.1) of this supplement.

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Docket Nos. 50-445 and 50-446

13. ABSTRACT (200 words or less)

Supplement 14 to the Safety Evaluation Report related to the operation of the Comanche Peak Steam Electric Station (CPSES), Units 1 and 2 (NUREG-0797), has been prepared by the Office of Special Projects of the U.S. Nuclear Regulatory Commission (NRC). The facility is located in Somerville County, Texas, approximately 40 miles southwest of Fort Worth, Texas. This supplement presents the staff's evaluation of the applicants' Corrective Action Program (CAP) related to large and small bore piping and pipe supports which was developed to resolve various design issues raised by the Atomic Safety and Licensing Board (ASLB), the intervenor Citizens Association for Sound Energy (CASE), the Comanche Peak Response Team (CPRT), Cygna Energy Services (Cygna), and the NRC Staff.

The NRC staff concludes that the CAP establishes a comprehensive program for resolving the technical concerns identified by the ASLB, CASE, CPRT, Cygna, and the NRC staff and its implementation ensures that the design of large and small bore piping and pipe supports at CPSES satisfies the applicable requirements of 10 CFR Part 50.

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