TU ELECTRIC

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February 7, 1992

William J. Cahill, Jr.
Group Vice President

U. S. Nuclear Regulatory Commission
Attn: Document Control Desk
Washington, D. C. 20555

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES) - UNIT 1
DOCKET NO. 50-445
FINAL RESPONSE FOR UNIT 1 TO NRC BULLETIN 88-08:
THERMAL STRESSES IN PIPING CONNECTED TO REACTOR
COOLANT SYSTEMS

REF: 1) TU Electric letter logged TXX-88766, from W. G. Counsil to NRC, dated October 31, 1988

2) TU Electric letter logged TXX-89805, from W. J. Cahill, Jr. to NRC, dated November 17, 1989

3) TU Electric letter logged TXX-90113, from W. J. Cahill, Jr. to NRC, dated March 27, 1990

Gentlemen:

Reference 1) provided TU Electric's response to Reporting Requirement 1 of NRC Bulletin 88-08 for Units 1 and 2. The TU Electric response identified sections of unisolable piping that are potentially susceptible to the conditions described in the bulletin. Reference 2) provided an interim response for Unit 1 to Reporting Requirement 2 of the bulletin. TU Electric's final response to Reporting Requirement 2 for Unit 1 was provided in Reference 3. The purpose of this letter is to update our response for Action 3 of Reporting Requirement 2. For clarity, Reporting Requirement 2 and associated Action 3 have been restated. The attachment provides the required affidavit, in accordance with the requirement of NRC Bulletin 88-08; that responses be submitted under oath or affirmation under the provisions of Section 182a, Atomic Energy Act of 1954, as amended.

<u>Reporting Requirement 2</u>

Those addressees who determine that there are unisolable sections of piping that can be subjected to stresses from temperature oscillations that could be induced by leaking valves and that were not evaluated in the design analysis of the piping shall submit a letter within 30 days of completion of Actions 2 and 3. This letter should confirm that Actions 2 and 3 have been completed and describe the actions taken.

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Action 3

Plan and implement a program to provide continuing assurance that unisolable sections of all piping connected to the RCS will not be subjected to combined cyclic and static thermal and other stresses that could cause fatigue failure during the remaining life of the unit. This assurance may be provided by 1) redesigning and modifying these sections of piping to withstand combined stresses caused by various loads including temporal and spatial distributions of temperature resulting from leakage across valve seats, 2) instrumenting this piping to detect adverse temperature distributions, or 3) providing means for ensuring that pressure upstream from block valves which might leak is monitored and does not exceed RCS pressure.

TU Electric Response to Action 3

TU Electric has implemented a program utilizing the second option described by Action 3 above. Resistance Temperature Detectors (RTDs) have been installed on the unisolable piping section described in reference 1. The RTDs sense pipe temperatures at selected locations on the piping. The output of these RTDs is fed to a data acquisition system. Temperature data is collected by Operations personnel at procedurally specified intervals and is used to develop temperature profiles for evaluation by engineering personnel. Other plant parameters, such as RCS pressures and temperatures, and system flow rates are also recorded.

Limits on temperatures and differential temperatures are specified in procedures. If these limits are exceeded, further engineering evaluations will be conducted and appropriate actions will be taken. The above program is based on monitoring guidelines developed by Westinghouse. Installation of the RTDs, Data Acquisition System, and interconnecting wiring were completed. Data Acquisition System testing and checkout was performed and the system was declared operational on March 10, 1990. Documentation of these activities is available for review by NRC inspectors.

As a result of the analysis performed by Westinghouse and summarized in the enclosure, further collection of data is not necessary. Therefore, we request that the requirement to record data be suspended.

Sincerely,

William J Cahill

William J. Cahill, Jr.

CEJ/vld
Attachment
Enclosure
c - Mr. R. D. Martin, Region IV
Resident Inspectors, CPSES (2)

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of	)	
	)	
Texas Utilities Electric Company	)	Docket No. 50-445
	)	
(Comanche Peak Steam Electric Station, Unit 1)	)	

AFFIDAVIT

William J. Cahill, Jr. being duly sworn, hereby deposes and says that he is Group Vice President, Nuclear of TU Electric, the licensee herein; that he is duly authorized to sign and file with the Nuclear Regulatory Commission this response to NRC Bulletin 88-08; for the captioned facility; that he is familiar with the content thereof; and that the matters set forth therein are true and correct to the best of his knowledge, information and belief.

William J. Cahill, Jr.
William J. Cahill, Jr.
Group Vice President, Nuclear

STATE OF TEXAS)
)
COUNTY OF Somervell)

Subscribed and sworn to before me, on this 7TH day of February, 1991.

CAROLYN S. WILLIAMS
NOTARY PUBLIC
STATE OF TEXAS
EXPIRES
3-22-96

Carol S. Williams
Notary Public

TXX-92010
ENCLOSURE

CHARGING, ALTERNATE CHARGING, AUXILIARY SPRAY AND COLD LEG SAFETY INJECTION LINES SUMMARY REPORT

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1.0 INTRODUCTION

Following the discovery of pipe cracks in the auxiliary lines of several commercial nuclear power plants, the United States Nuclear Regulatory Commission issued Bulletin 88-08 (Reference 1). Action Item 1 of the bulletin requested utilities to identify unisolable piping connected to the Reactor Coolant System (RCS) which are susceptible to adverse temperature distributions (not considered in the design of the piping) that could be induced by leakage through isolation valves into the RCS (inleakage). TU Electric identified the following lines for Comanche Peak (Reference 2):

1. Charging line downstream of valve 8146,
2. Alternate charging line downstream of valve 8147,
3. Auxiliary spray line downstream of valve 8145, and
4. Four centrifugal charging pump cold leg injection lines downstream of valves 8801A/8801B.

Action Item 2 of the bulletin requested that utilities nondestructively examine (NDE) the welds, heat-affected zones and high stress locations, including geometric discontinuities of the identified piping to ensure that there are no existing flaws. Comanche Peak Unit 1 was undergoing hot functional testing in the time frame that the bulletin was issued. Therefore, NDE was not warranted, since it was considered highly unlikely for cracks to initiate during testing (Reference 3).

Action Item 3 requested that a program be implemented to provide continuing assurance that unisolable sections of piping connected to the RCS will not be subjected to combined cyclic and static thermal and other stresses that could cause fatigue failure during the remaining life of the unit. Accordingly, TU Electric instrumented the susceptible piping at Comanche Peak Unit 1 with surface-mounted temperature sensors (Reference 4).

As a result of successful data collection for the first fuel cycle, a review has been conducted to determine if valve leakage is occurring. In addition, an evaluation has been performed to determine augmented inservice inspection intervals, based on fatigue usage and fatigue crack growth methodology, and assuming continuous stress cycling.

Augmented inservice inspection intervals based on conservative fatigue usage and fatigue crack growth analyses provide a strong technical justification to eliminate temperature monitoring of the charging, alternate charging, auxiliary spray and cold leg safety injection lines, while still satisfying the requirements of NRC Bulletin 88-08.

2.0 OVERALL EVALUATION APPROACH

Upon reviewing the monitoring results for the charging, alternate charging, auxiliary spray and cold leg safety injection lines for the period from March 15, 1990 to August 6, 1991, it was found that there was no evidence of valve leakage in the unisolable piping. For the purpose of analysis and Bulletin 88-08 requirements, however, it was postulated that stress cycles occur continuously in the unisolable piping during plant operation, resulting from postulated isolation valve leakage. (This valve leakage is considered herein as a postulated condition and should not be treated as a design condition).

The steps in the structural evaluation of the unisolable piping under the postulated valve leakage loadings are listed below:

- Definition of postulated valve leakage transients
- Calculation of stresses from the postulated transients
- Evaluation of fatigue usage factor
- Calculation of fatigue crack growth
- Determination of augmented inservice inspection intervals based on fatigue usage and fatigue crack growth calculations

Comanche Peak Unit 1 began commercial operation August 13, 1990. Given that the unit is new, and has experienced very few fatigue cycles, it is highly unlikely that cracks are present in the susceptible piping. In the fatigue crack growth calculations, however, initial crack sizes of 10% of the wall thickness are conservatively assumed. Additional conservatism is also introduced into the analysis by limiting the crack size to 60% of the wall thickness.

Based upon the time required to initiate and to propagate cracks to 60% of the wall thickness, augmented inservice inspection intervals will be determined for the critical locations of the susceptible piping.

3.0 EVALUATION OF CHARGING AND ALTERNATE CHARGING LINES

There are two charging paths provided in the Comanche Peak design. The first is the normal charging line to the cold leg of RCS Loop 4; the second is the alternate charging line connected to the cold leg of Loop 1. During normal plant operation, one of these lines will be in service, with the other line isolated. When the line is isolated, the postulated leakage can induce stress cycling.

The source of postulated leakage is the outlet of the regenerative heat exchanger, which is typically at 500°F. This leakage must transverse a distance of about 129 feet for the charging line, and 36 feet for the alternate charging line, before entering the unisolable piping (i.e., the piping between the RCS connection and the first check valve upstream from the RCS). Depending on leakage flowrate and insulation characteristics, it is possible for the leakage to cool significantly over this distance, resulting in high thermal stresses in the unisolable piping. From this standpoint, the normal charging line represents a bounding configuration, its distance to the unisolable piping being longer than the alternate charging line. However, calculations were performed for both lines.

Heat transfer calculations were carried out to determine the leakage temperature as it enters the unisolable piping, as a function of flowrate. As leak rate increases, the leakage enters the unisolable piping at higher temperatures (approaching the regenerative heat exchanger outlet temperature) and the potential for adverse thermal stress decreases. Temperature monitoring of the alternate charging line had indicated an unisolable piping temperature of about 470°F near the check valve outlet weld, while the line was isolated. (The normal charging line was operating during the monitoring period, therefore 470°F was assumed for the normal charging line since the two charging lines are geometrically similar in the unisolable sections). Given an unisolable piping temperature for the line not in service and the leakage temperature, a stratification temperature difference was determined, as a function of leakage flowrate.

Using an approach presented by Ven Te Chow (Reference 5), the stratification interface depth was determined. This depth is dependent on temperature difference, pipe size and leakage flowrate. For the purpose of this evaluation the stratification interface depth was assumed to be 10% of the pipe inside diameter, ie, leakage was assumed to fill the lower 10% of the pipe inside diameter. Corresponding leakrates and stratification temperature differences (and hence through-wall thermal gradient stresses) were then determined for the charging and alternate charging lines.

The critical location for the normal and alternate charging lines was determined to be the check valve outlet weld, since the stratification temperature difference and postulated stresses are expected to be most severe at this location. The unisolable piping will heat the leakage as it flows toward the RCS, and loop turbulence will promote mixing, thus reducing the stratification temperature difference at other locations in the unisolable piping.

A credible mechanism to initiate and terminate isolation valve leakage does not exist, therefore continuous leakage was postulated at the critical leakrate. Fatigue cycles are possible, however, due to variations in turbulent penetration, which periodically mix and re-establish the stratification. Fatigue usage calculation, based on a conservative cycling frequency of five minutes, determined that cracking is possible within the life of the unit. Crack initiation time based on this fatigue usage calculation for this line is 10 years of operation. Fatigue crack growth calculation, also based upon a five minute cyclic frequency, resulted in 1.2 years of power operation for the normal charging line and twenty years of power operation for the alternate charging line. It should be noted that periods when the line is in service should not be included in the determination of time at power operation, since only isolated piping is of concern. Critical location can be found in a table in section 6.0.

4.0 EVALUATION OF AUXILIARY SPRAY LINE

The auxiliary spray line provides a flow path from the regenerative heat exchanger to the main spray line, and is isolated during normal plant operation. The connection to the main spray piping is essentially a 15'-6" riser, which branches into the bottom of the horizontal main spray line.

The source of potential leakage is the outlet of the regenerative heat exchanger, which is typically at 500°F during normal plant operation. The distance from the leakage source to the unisolable piping is about 215 feet, therefore the temperature of the leakage flow as it enters the unisolable piping may be substantially less than the source temperature, depending on leakage flowrate and insulation characteristics.

Since the unisolable piping is essentially a long vertical riser which extends down from the main spray line, it is expected that the inlet to the unisolable piping (the check valve outlet weld) will be at containment ambient temperature without isolation valve leakage. Such a condition is commonly termed "cold trap". The temperature in other regions of the unisolable piping are determined by conduction from the main spray line temperature.

Should isolation valve leakage occur in the auxiliary spray line, it would enter the unisolable piping in the "cold trapped" region, and gradually heat up and disperse into the bulk fluid as it flowed upward toward the main spray connection. Stratification, in the general sense, does not occur in vertical pipes, therefore it is expected that the thermal loadings would be axisymmetric and relatively small. As for the charging and alternate charging lines, no credible mechanism exists to initiate and terminate auxiliary spray line isolation valve leakage. Fatigue cycles are possible, however, during main spray operation, which creates turbulent penetration into the auxiliary spray line. (Typically, the main spray line is operated with a bypass flow rate of 1 to 5 gpm, in order to prevent thermal shock to the pressurizer spray nozzle during spray actuation. This reduced flowrate results in essentially no turbulent penetration into the auxiliary spray line.) Fatigue usage calculation, based on an assumed two minute temperature ramp from main spray line temperature to containment ambient temperature resulted in a umulative usage factor less than 1.0 for the plant life. This evaluation was performed at the critical location which is, the 6" x 2" sock-o-let which connects the auxiliary spray line to the main spray line. Fatigue crack growth evaluation was not performed, based on the fatigue usage results which resulted in a cumulative usage facto- of 0.7 for 40 year design life.

5.0 EVALUATION OF COLD LEG SAFETY INJECTION LINES

The 1-1/2 inch cold leg safety injection lines connect to the cold legs of each of the four RCS loops. During normal plant operation, these lines are isolated from centrifugal charging pump pressure. Under postulated isolation valve leakage, the potential for stress cycling exists in the unisolable piping sections.

In order to evaluate the effect of isolation valve leakage on the safety injection lines, plant monitoring data was reviewed for a plant which is known to have had valve leakage (Reference 6). A leakage transient was then developed based upon the most severe loading observed in that data.

Fatigue cycles were postulated to result from variations in turbulent penetration, which periodically mix and re-establish the thermal loading at the critical location, which was determined to be the check valve outlet weld. Fatigue usage calculation showed that cracking is possible under a conservatively postulated cyclic frequency of five minutes. Crack initiation time based on this fatigue usage calculation for this line is 7 years of operation. Fatigue crack growth evaluation resulted in 7 years of continuous cycling at power operation to propagate a crack to 60% of the wall thickness. Critical location or locations can be found in a table in section 6.0.

6.0 SUMMARY AND CONCLUSIONS

A detailed evaluation has been completed for the Comanche Peak Unit 1 normal charging, alternate charging, auxiliary spray and cold leg safety injection lines in response to concerns raised in NRC Bulletin 88-08.

The monitored data from the above lines was reviewed, and it was determined that no NRC Bulletin 88-08 type of valve leakage was occurring during the monitoring period. However, conservative assumptions were made to develop isolation valve leakage transients. Subsequent calculation of stress, fatigue usage and fatigue crack growth were performed, in order to determine the time for cracks to initiate and the time required for cracks to propagate.

Results of this evaluation indicate that the following critical locations require a minimum of the time for crack to initiate and to propagate cracks to 60% of the wall thickness.

Line	Critical Location	Initiation Time	Propagation Time
Charging	Check Valve Outlet	10 years	1.2 years**
Alternate Charging	Check Valve Outlet	10 years	20 years**
Auxiliary Spray	6" x 2" Sock-o-let	>40 years	*
Cold Leg Safety Injection	Check Valve Outlet;	10 years	7 years
	3" x 1 1/2" Reducer	7 years	>40 years

* Fatigue usage calculation resulted in CUF < 1.0 for design life.

** Time at power operation while line is isolated.

Augmented inservice inspection intervals at the critical locations should be developed based on these results. All other welds in these lines should be inspected in accordance with standard ASME Section XI criteria.

With augmented inservice inspections at the critical locations, based upon the results of conservative fatigue usage and fracture mechanics evaluations, it is justified that the temporary monitoring devices be removed from the Unit 1 piping.

7.0 REFERENCES

1. United States NRC Bulletin 88-08, "Thermal Stresses in Piping Connected to Reactor Coolant Systems," 6/22/88; Supplement 1, 6/24/89 and Supplement 2, 8/4/88.

2. TU Electric letter TXX-88766, "Comanche Peak Steam Electric Station (CPSES) Docket Nos. 50-445 and 50-446, NRC Bulletin 88-08: Thermal Stresses in Piping Connected to Reactor Coolant Systems," 10/31/88.

3. TU Electric Letter TXX-89805, "Comanche Peak Steam Electric Station (CPSES) Docket Nos. 50-445 and 50-446, NRC Bulletin 88-08: Interim Response to Thermal Stresses in Piping Connected to Reactor Coolant Systems," 11/17/89.

4. TU Electric Letter TXX-90113, "Comanche Peak Steam Electric Station (CPSES) Docket Nos. 50-445 and 50-446, Final Response for Unit 1 to NRC Bulletin 88-08: Thermal Stresses in Piping Connected to Reactor Coolant Systems," 3/27/90.

5. Ven Te Chow, Open-Channel Hydraulics, McGraw-Hill, 1959.

6. WCAP-12499, "Evaluation of Trojan Nuclear Power Plant Monitoring Data for NRC Bulletin 88-08," January 1990, Westinghouse Proprietary Class 2.