UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

March 17, 1988

Docket Nos. 50-445
and 50-446

APPLICANT: Texas Utilities Electric Company (TU Electric)

FACILITY: Comanche Peak Steam Electric Station (CPSES), Units 1 and 2

SUBJECT: SUMMARY OF MEETING ON FEBRUARY 5, 1988 - DEVELOPMENT AND ATTENUATION OF JETS FROM HIGH-ENERGY LINE BREAKS

On February 5, 1988 NRC staff met with representatives of TU Electric, lead applicant for the CPSES, in NRC's Rockville, MD offices to discuss NRC comments on the Ebasco Services, Incorporated (Ebasco) jet attenuation calculation, CPE-SI-CA-0000-645. The meeting notice (with NRC's comments as enclosure) and a list of attendees are provided as Enclosures 1 and 2, respectively, to this summary.

During the NRC inspection of Ebasco's Systems Interaction Program for CPSES, the team reviewed Ebasco calculation CPE-SI-CA-0000-645 Revision 0 for jet attenuation from high-energy line breaks. NRC Inspection Report 50-445/87-37; 50-446/87-28 dated February 8, 1988 raised several technical issues concerning misinterpretations of terms and limitations in the theory being used to calculate jet attenuation. For example, Ebasco uses a method which is applicable to gaseous jets and can be used for steam and water jets if the quality beyond the asymptotic plane is greater than 90%. However, Ebasco uses this method without any restriction on the quality of the jet fluid.

During the meeting, TU Electric committed to provide NRC with justification for the attenuation factors employed in the analysis of single-phase steam jets and two-phase flashing water jets. By letter dated February 18, 1988 (TXX-88227), TU Electric informed NRC that they are performing analyses to demonstrate that the attenuation factors being utilized for CPSES are conservative (Enclosure 3). The results of these analyses were expected to be available during the week of February 22, 1988 for NRC review. TU Electric subsequently revised this time frame to late March 1988. The staff has scheduled a follow-up meeting for March 21, 1988 to discuss the results of these analyses with TU Electric representatives.

Melinda Malloy

Melinda Malloy, Project Manager
Comanche Peak Project Division
Office of Special Projects

Enclosures:
1. Meeting Notice
2. List of Attendees
3. TXX-88227 dtd 2/18/88

cc: See next page

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ENCLOSURE 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

January 27, 1988

Reissued on Feb. 2, 1988 with NRC comments on jet attenuation calculation (CPE-SI-CA-0000-645) to be addressed during the meeting

Docket Nos. 50-445
and 50-446

MEMORANDUM FOR: Christopher I. Grimes, Director
Comanche Peak Project Division
Office of Special Projects

THRU: James H. Wilson, Assistant Director
for Projects
Comanche Peak Project Division
Office of Special Projects

FROM: Melinda Malloy, Project Manager
Comanche Peak Project Division
Office of Special Projects

SUBJECT: FORTHCOMING MEETING WITH TU ELECTRIC

Date & Time: Friday, February 5, 1988
1:00 pm

Location: One White Flint North
11555 Rockville Pike
Room 1f-B-11
Rockville, MD 20852

Purpose: For Applicant to discuss development and attenuation of jets from high-energy line breaks

Participants*:

NRC	Applicant
D. Norkin	D. West
J. Lyons	R. Walker, et al.
P. T. Kuo	
J. Wilson	
M. Malloy	

Melinda Malloy, Project Manager
Comanche Peak Project Division
Office of Special Projects

Enclosure: NRC comments
on calculation

*Meetings between NRC technical staff and applicants for licenses are open for interested members of the public, petitioners, intervenors, or other parties to attend as observers pursuant to "Open Meetings and Statement of NRC Staff Policy," 43 Federal Register 28058, 6/28/78.

CONTACTS: Melinda Malloy (301)492-0738 or James H. Wilson (301)492-3306

cc: See next page

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ENCLOSURE

COMMENTS ON CALCULATION CPE-SI-CA-0000-645

The procedure for evaluating the attenuation of jets resulting from high energy line ruptures given in the subject document has been reviewed. Our comments are as follows:

1. The document under review claims (Pg. 2) that Ref. 1 does not address the attenuation of the jet. We believe that Reference 1 does address the attenuation of the jet; although it does not appear as an explicit coefficient. Any attempt to develop an additional attenuation coefficient is inappropriate.

2. The procedure uses a method recommended by Reference 1 based on jet axial velocity, pressure and temperature profiles developed in Reference 2 instead of using Eq. D-2 and D-3 as prescribed in Reference 1. However, this method is applicable to gaseous jets and can be used for steam water mixture jets, if the quality beyond the asymptotic plane is greater than 90%. The subject document, however, uses this approach without any restriction on the quality of the jet fluid. Actually, the lower quality mixture behaves very differently from perfect gas, and because of the relatively higher density of the two phase fluid, the jet will attenuate at a significantly slower rate compared to the gaseous jets. This suggests that the method used in the document is not conservative for low-quality jets. In most cases of flashing water jets (both for primary and secondary coolant systems), the quality of the jet fluid is significantly lower than 90%. The assumption that water substantially separates out before the asymptotic plane resulting in a high quality steam beyond that plane cannot be justified.

3. The postulation (on page 13) that the force that the jet can impart to a target is proportional to $p + \rho v^2/2$ is not correct. The impingement force should be proportional to $(P - p)$.

   Where P is the local stagnation pressure and p is the local static pressure and they are related by the following expression:

$$P = p \left\{ 1 + \frac{\gamma - 1}{2} M^2 \right\}^{\frac{\gamma}{\gamma - 1}}$$

   Where M is the local Mach number.

   It is to be noted that beyond the asymptotic plane, local static pressure (p) remains constant and is equal to the pressure surrounding the jet.

4. In a free jet the total momentum of the jet beyond asymptotic plane remains constant along the axis of the jet. As the jet entrains more and more of the ambient fluid, its velocity and temperature profiles become flatter. But if the target is large enough to intercept the entire jet, the impingement force does not drop even though the stagnation pressure at the jet axis has decayed substantially.

The document under review interprets Figure D.7 in Reference 1 as a plot of variation of local static pressure with distance. It is actually a plot of $(P - p)/p_e$ vs. distance, where p_e is the exit plane pressure of the jet. This figure is the same as Figure 5 of Reference 2. It is to be noted that $(P - p)$ is measured at the jet centerline. The incorrect use of this figure in the document under review has led to the conclusion that there is an additional attenuation factor. It is suggested that Ref. 2 be consulted in case further clarification is needed.

The work done by the jet fluid on the surrounding and the exchange of molecular kinetic energy do not result in any reduction of momentum of the entire jet including the entrained fluid, and any attenuation effect resulting from the work done by the jet and energy exchange cannot be justified.

5. Figure 6 of Reference 2 represents the decay of temperature difference ratio ($\Delta Tm/\Delta Te$). The subject document uses this figure inappropriately as temperature ratio (T*) on Page 11. The error due to this might be significant for the range of temperature of interest.

6. The document determines the attenuation factor "α" in somewhat arbitrary fashion. First, it claims that this factor should follow the decay of P*, and then, since the decay of P* is excessive, it considers the decay of V* as the acceptable attenuation. Since this factor has been applied to the impingement force on a target using Reference 1, the credit due to the attenuation of jet has been double-counted.

REFERENCES:

1. "Design Basis for Protection of Light Water Nuclear Power Plants Against Effects of Postulated Pipe Rupture," ANSI/ANS 58.2-1980.

2. Anderson, A. R. and Johns, F. R., "Characteristics of Free Supersonic Jets Exhausting into Quiescent Air," Jet Propulsion, January 1955.

ENCLOSURE 2

NRC/TU Electric Meeting on Development
and Attenuation of Jets
February 5, 1988

ATTENDEES

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J. H. Wilson	OSP/CPPD
J. E. Lyons	OSP/CPPD
D. A. West	TU Electric
R. G. eo	Ebasco
V. Thiagarajan	Ebasco
R. D. Walker	TU Electric
R. Dacko	TU Electric
D. Lowrie	TU Electric
K. K. Niyogi	NRC consultant (United Engineers & Constructors)
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G. Tuday	NRC Consultant (United Engineers & Constructors)
R. C. Iotti	Ebasco
J. Moore	OGC
S. Hou	NRR

ENCLOSURE 3

TU ELECTRIC

Log # TXX-88227
File # 10010
903.6
Ref # 10CFR50.30(a)

February 18, 1988

William G. Counsil
Executive Vice President

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

SUBJECT: COMANCHE PEAK STEAM ELECTRIC STATION (CPSES)
DOCKETS NOS. 50-445 AND 50-446
JET IMPINGEMENT ANALYSES

Gentlemen:

During the February 5, 1988 meeting with the NRC concerning CPSES jet impingement analyses, TU Electric committed to provide the NRC with justification for the attenuation factors employed in the analysis of single phase steam jets and two phase flashing water jets.

TU Electric is performing analyses to demonstrate that the attenuation factors presently being utilized at CPSES are conservative. These analyses are being performed as follows:

1. For single phase jets (i.e., jets with a quality greater than ninety percent) the attenuation factors contained in CPSES calculation CPE-SI-CA-0000-645 will be demonstrated to be conservative with respect to attenuation factors derived using the methodology presented in American National Standard ANSI/ANS 58.2, "Design Basis for Protection of Light Water Nuclear Power Plants Against Effects of Pipe Rupture".

2. For two phase flashing water jets, an analysis of CPSES specific lines will be performed to demonstrate that the attenuation factors contained in CPSES calculation CPE-SI-CA-0000-645 are conservative with respect to attenuation factors derived using the methodology presented in NUREG/CR-2913, "Two Phase Jet Loads"

Preliminary results of these analyses will be available during the week of February 22, for your review.

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We are confident that above analyses will demonstrate that the attenuation factors used at CPSES for single phase and two phase jets are justified.

Very truly yours,

W. G. Counsil

BSD/amb

c - Mr. R. D. Martin, Region IV
Resident Inspectors, CPSES (3)