ATTACHMENT 2

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

APPLICANTS' STATEMENT OF MATERIAL FACTS
AS TO WHICH THERE IS NO GENUINE ISSUE
REGARDING CONSIDERATION OF CINCHING U-BOLTS

1. Relaxation is a characteristic of certain materials which when stressed to certain levels will not maintain that level, but will "relax" to a lower stress level. The total strain remains fixed, but a part of the elastic strain is replaced with inelastic strain. It should be noted that stress relaxation stops after a material reaches a certain level of stress, e.g., for material such as SA-36 this level is approximately 1/2 of the yield stress. Affidavit of Robert C. Iotti and John C. Finneran, Jr. Regarding Cinching Down of U-Bolts at 6.

2. The U-bolt/cross piece connection is not a friction type connection, and is not intended to be loaded in shear. While it could be loaded in shear under U-bolt lateral or axial loads, in this instance it is inconsequential whether it acts as a friction

or a bearing connection. Accordingly, Note 1 of ASME Table XII-2461.1-1 is not relevant to the U-bolt "clamp" configuration used at Comanche Peak. Id. at 6-7.

3. To determine the range of torques which exists in the field, Applicants inspected the torques of a representative sample of cinched down U-bolt supports. This data was used to determine the range of torques to be applied to test specimens. From the data, Applicants established preload test values. Id. at 10.

4. The effective torque in the plant for all pipe sizes will be the lesser of the value corresponding to a U-bolt stress of half-yield or the value achieved by a man with a torque wrench or impact wrench. Therefore, it is unlikely that there might be considerably higher torques applied to U-bolts in the plant than those which were measured by random sampling noted above. Id. at 11-12.

5. Applicants' testing program to respond to concerns regarding cinching down U-bolts consisted of seven distinct tests. The objectives and results of the seven tests are summarized below:

a. Torque versus Preload Test (Id. at 12-14.)

The objectives of this test were two fold, viz., (1) to establish the relationship between torque applied to a U-bolt nut and the resulting tension in the U-bolt as a function of pipe size, and (2) to determine the strain in a pipe as a function of preload on the associated U-bolt.

The results of the torque versus preload test indicate that for the range of values of concern, a linear relationship of t = KTD exists between the torque imparted to a U-bolt nut and the tension developed in the U-bolt, where t is the applied torque, D is the bolt diameter, T is the tension in the bolt and K is a constant that varies between 0.25 and 0.35. Also, the test reflected that maximum pipe strains (and stresses) caused by preload of the U-bolt are generally found in the circumferential direction, are compressive in nature, and occur generally below the cross piece.

b. Friction Test (*Id.* at 14-18.)

The objective of this test was to determine the force on a U-bolt which is needed to cause slippage between the U-bolt/cross piece assembly and the pipe.

The friction test produced two results, *viz.*, (1) the force required to cause slippage between the U-bolt support assembly and the pipe in the plane of the U-bolt (*i.e.*, the force that produces rotation about the pipe axis), and (2) the coefficient of friction which exists for the U-bolt/cross piece assembly.

c. Load Distribution/Strain Measurement Test (*Id.* at 18-21.)

The objective of this test was to determine the stiffness of the U-bolt assembly, and accordingly, whether thermal expansion and mechanical loads are directly additive to the preload. Applicants had maintained that while expansion loads are additive to preload, total mechanical loads are not directly additive. The results of this test reflect that the mechanical external loads are not directly additive to preload.

d. Thermal Cycling/Thermal Gradient Test (*Id*. at 21-25.)

The objectives of this test were twofold, *viz.*, (1) to determine the additional load (and resulting stresses) on a support and pipe caused by differential thermal expansion of the pipe with respect to the U-bolt, and (2) to assess the relaxation of the U-bolt preload caused by long-term temperature cycling in order to determine whether material relaxation effects would reduce the preload to the extent that slipping of the U-bolt/cross piece can occur.

This test provided the thermal load data for use in the finite element analyses. Further, the results of the test reflect that (1) the maximum relaxation of each specimen can be predicted with reasonable assurance, and (2) where there are stresses above approximately 1/2 yield, thermal relaxation will occur rapidly until the stress reaches about 1/2 yield (sufficient to retain an adequate clamping force) and then will stabilize.

e. Creep Test (*Id*. at 25-26.)

The objective of this test was to determine whether long-term temperature exposure could result in material relaxation so that preload would be decreased or lost. The results reflect that after the initial relaxation achieved during thermal cycling, no further relaxation occurs, i.e., that at these temperatures creep is not a problem.

f. Accelerated Vibration Test (Id. at 26-31.)

The objective of this test was to determine whether normal vibration levels in the plant could cause material relaxation, and consequently, loss of preload. In order to simulate 40 years of accumulative effects of piping vibration, this test was run as an accelerated vibration test utilizing vibratory forces varying in frequency from 5 to 200 Hz at an amplitude equal to the maximum expected OBE force for the pipe tested (4000 lbs.) as well as at lower forces (1000-1500 lbs.). The time duration of this test combined with the amplitude of the vibratory (sinusoidal) force resulted in an overall energy input into the test specimen exceeding by orders of magnitude the energy that would be induced by an earthquake (both operating basis and design basis earthquakes). This test simulates conditions far more severe than expected in the plant for normal vibration levels.

The results of the test reflect that after an initial repositioning of the assembly, which reduces the preload a relatively small amount, no further decrease in preload was observed, indicating that the vibration per se had no effect on relaxation.

g. Seismic Test (Id. at 31-34.)

The objective of this test (an auxiliary test to the accelerated vibration test, noted above) was to test the effect on the U-bolt assembly of the peak force for the safe shutdown earthquake, 7000 lbs. Although the test was not capable of being totally completed, the results of those portions completed supported determinations in previous tests.

6. Each U-bolt assembly tested was modeled with a finite element analysis utilizing MSC NASTRAN Version 63. Id. at 42. This computer code was chosen because it is universally recognized and accepted by industry as having the capability of providing analytical solutions that accurately characterize the local stress, gap, friction effects, and plastic material behavior (if any) that are important for assessing the pipe and U-bolt assembly stress, and the support stability. Id. at 42-43.

The objectives of the finite element analysis program were (1) to determine if the pipe would slip, creating an unstable support condition when the hanger support was subjected to the preload, thermal, pressure and mechanical loads that would be expected in the Comanche Peak hanger assemblies; and (2) to calculate pipe and pipe support stresses that could be expected to be experienced by the Comanche Peak U-bolt support assemblies and assess their significance. Id. at 44-45.

The results of the analyses reflect that (1) the U-bolt assemblies would behave stably at and even below the low preload values evaluated in the analyses (below those values generally expected in the field) (Id. at 45-46); (2) maximum stress in the U-bolt as a result of the worst case load combination evaluated compared favorably with test results and demonstrated that stresses in the U-bolts will not cause any adverse impact (Id. at 46-47); and (3) stresses in piping due to preload values expected in the field in conjunction with other loads imposed will not result in any adverse impact. Id. at 47-49.

7. From the testing and finite element analyses, the U-bolt/cross piece assembly can perform effectively as a clamp provided that sufficient preload is established in the U-bolt. Id. at 34 and 71-73. (It should be noted that a clamp also requires preloading.) Further, if the preload level was insufficient, but present in some amount, the U-bolt support would vibrate, but still be capable of supporting the necessary loads, thus behaving "stably." Id. at 34 and 74-75. The results of the finite element analyses support the conclusions of the test in this regard. Id. at 45-46 and 74-75.

8. To provide further assurance of acceptable preload values, Applicants have committed to an inspection program to assure that every cinched down U-bolt on a single strut or snubber (a total of 380) is torqued to a level at which the

assembly will be stable in the absolute truest sense, i.e., no rotation, and axial movement, if any, is toward the strut. Id. at 34 and 75.

9. The results of the tests conducted for vibration, seismic response, creep and thermal cycling confirm the capability to maintain over time and varying conditions the stability of the assembly when preloaded to observed values. Id. at 21-34.

10. From the results of tests, stresses produced in the U-bolts at CPSES would not adversely impact the U-bolts' capability to function. Id. at 36-42. High stresses in the U-bolts occur only if large preload values are applied (i.e., near the maximum used in the tests) to small diameter U-bolts. Id. Large preload values are generally not present in the plant supports, nor are they needed to assure stability of the supports under seismic excitation. Id. In those instances where high preload torques may be initially present, the characteristic relaxation behavior of the material employed (A-36) will reduce the preload value, and hence, the stresses in the U-bolt, to acceptable levels. Id. Moreover, tests have demonstrated that there is adequate margin between yield and failure of the U-bolts. Id. The finite element analyses in essence confirmed the results of testing. Id. at 46-47.

11. Testing reflects that the maximum torques to the U-bolt pipe assembiles can potentially result in high but acceptable local pipe stresses. Id. at 37-40. The finite element analyses

confirm that piping stresses resulting from U-bolt assemblies and associated loading will not adversely impact plant safety. Id. at 47-49.

12. While the ASME Code does not provide any direct quantitative guidance regarding local stresses induced by external attachments such as U-bolt clamp assemblies, the acceptance criteria established and met by Applicants in this regard conform with the intent of the ASME Code. Id. at 50-73.

13. A significant number of U-bolt supports at CPSES were always intended to be cinched down. On only a relatively small number (less than 15) was the initial design changed such that U-bolts were cinched down because of potential pipe support instability. There are other U-bolt supports at CPSES which are not cinched down, e.g., U-bolts on rigid frames used as one- or two-way supports. Id. at 5.