UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

AFFIDAVIT OF ROBERT C. IOTTI AND
JOHN C. FINNERAN, JR. REGARDING
BOARD REQUEST FOR INFORMATION
CONCERNING A36 AND A307 STEEL

We, Robert C. Iotti and John C. Finneran, Jr., having first been duly sworn hereby depose and state, as follows:

(Iotti) I am Vice President of Advanced Technology for Ebasco Services, Inc. A statement of my educational and professional qualifications was transmitted with Applicants' letter of May 16, 1984, to the Licensing Board in this proceeding.

(Finneran) I am employed by Texas Utilities Generating Company as Project Pipe Support Engineer for Comanche Peak Steam Electric Station. A statement of my educational and professional qualifications is in evidence as Applicants' Exhibit 142B.

We previously submitted affidavits regarding cinching-down of U-bolts, U-bolts acting as two-way restraints, and Richmond Inserts, which were filed in support of Applicants' motions for summary disposition of these issues on June 29, May 23, and June 2, 1984, respectively.

Q. What is the purpose of your affidavit?

A. The purpose of this affidavit is to provide information in response to the Board's Memorandum (Information on Composition of A36 and A307 Steel), dated October 25, 1984.

Interchangeability of SA36 and SA307 Materials

Q. Are SA36 and SA307 steels the same material?

A. No. CASE incorrectly asserts that these materials are the same.[1] Although it is true that SA36 and SA307 materials are similar, there is a major difference in the specified mechanical requirements for SA36 and SA307 steels. As Applicants explained in our affidavit in support of Applicants' reply to CASE's answer to Applicants' motion for summary disposition regarding the effects of gaps (October 26, 1984) at 8-9, the material specification for SA36 requires both a test for ultimate tensile strength and a

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1 CASE's Answer to Applicants' Statement of Material Facts Relating to Richmond Inserts, Walsh Affidavit (September 10, 1984) at 10. The memorandum cited by CASE (CASE Exhibit 834) is not correct in referring to the tested materials as SA307. SA36 and SA307 rods are both used in some structural applications not involving pipe supports. The individual who prepared that memorandum (who commonly works with those other applications) apparently did not focus on the distinction when he prepared the memorandum.

test for minimum yield point, whereas the SA307 specification requires only a tensile test (ultimate tensile strength). Thus, unlike SA36, there is no established basis for determining certain characteristics, including relaxation, of components using SA307 material. In summary, it is not appropriate, therefore, to interchange the two steels as CASE has done. (See Memorandum at 1 ". . . variability in A36 (A307) steel . . .".)

Materials Employed in Applicants' Tests in Support of Motions for Summary Disposition

Q. Which tests performed in support of Applicants' motions for summary disposition employed SA36 or SA307 steels?

A. None of the tests employed SA307 material in the test specimens. Three tests utilized in Applicants' motions employed SA36 steel specimens, as follows:

1) The tests performed by Westinghouse on cinched-down U-bolt assemblies were undertaken to assess the adequacy of cinched-down U-bolts to function as clamps. In these tests the U-bolts were SA36 material (see Attachment 1 to Applicants' Affidavit on Cinched-Down U-Bolts).

2) The tests conducted by ITT-Grinnell to determine the ultimate capacity of U-bolts under different loading conditions, in support of Applicants' May 23, 1984, motion regarding U-bolts acting as two-way restraints, utilized SA36 test specimens. (see Attachment 1 to Applicants' Affidavit on U-bolts acting as two-way restraints.)

3) Tests conducted by TUGCO on Richmond inserts in March 1983 and May 1984 were used by Applicants in support of their motion for summary disposition on Richmond Inserts. (See Attachments A and F to the Affidavit supporting Applicants' motion on Richmond Inserts.)

None of the above tests employed SA307 material because, with one exception (see Affidavit accompanying Applicants' motion for summary disposition on Richmond Inserts at page 9). Applicants do not use SA307 material for any of the applications tested.

Representativeness of Materials Employed in Tests

Q. Are the properties of the materials employed in these tests representative of the steels employed in the plant?

A. Yes. Figure 1 (attached) shows the distribution curve of the yield strengths of the SA36 steels employed in the plant. The distribution curve for ultimate strength is similar, and is shown in Figure 2. Also shown on these figures are the yield strengths and ultimate strengths of the actual steels employed in the test specimens.

Q. How were the samples of materials employed in the plant selected?

A. For the data concerning U-bolts, the distribution curves have been assembled from a sample of certified material test reports for U-bolts actually installed in the plant. Specifically, the following data was used:

1) All available certified material test reports for the U-bolts acting as two-way restraints.

2) Randomly selected certified material test reports for U-bolts in the plant which are cinched-down on single struts and snubbers. This sample consisted of approximately one fifth of the U-bolts in this category.

With respect to the SA36 threaded rods employed in Richmond Inserts, a table has been prepared (Table 1) which is based on certified material test reports for a number of heats of materials. Because it would have been inordinately time consuming to do so, we did not trace back to individual threaded rods actually installed in the plant.[2] The material properties of the tested specimens are also provided in Table 1.

Q. Is there anything else you would like to add regarding the "representativeness" of the specimens chosen for testing?

A. Yes. The Board states in note 2 of its Memorandum that we have provided no explanation or description of variations in dimensions of components in the plant. The Board referred to a statement in note 8 on page 21 of our Affidavit on cinched-down U-bolts where we acknowledged small differences in dimensions between two finite element analyses in the model of a crosspiece in a support with cinched U-bolts.

By referring to the context in which note 8 was made, the Board will observe that Applicants were discussing a simple finite element model of a crosspiece which was

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2 The above samples of material properties are sufficiently large, although not statistically selected, to demonstrate the representativeness of the materials used in Applicants' testing. As we note above, it would have been extremely time consuming to trace material properties of a large sample of specific U-bolts or Richmond Inserts employed in particular applications in the plant. We did do so to the extent practicable for the U-bolts acting as two-way restraints because, as we will discuss later, the results of the tests on U-bolts used in that application were the only ones used to establish allowables.

performed to verify that the test configuration, e.g., strain gauge type and location, produced valid results. Applicants had noted after the completion of that finite element analysis that there were some discrepancies between the dimensions utilized in the simple finite element model (Attachment 2 to Affidavit) and the actual measurements.[3] The precise measurements were eventually used in the detailed finite element analysis in Attachment 3 to our Affidavit. Thus, these "differences" do not exist in the detailed finite element analysis in Attachment 3. The results of that analysis were used to determine acceptability of results as well as a guide for setting minimum torque values. They have nothing whatsoever to do with variations in dimensions in the plant.

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[3] Differences of .06 inches in the length of half the plate, 0.16 inches in the half width of the bracket, 0.37 inches between the center of the plate and U-bolt center, were observed (see sheet 1, Attachment 1 to our Affidavit). These variations result in a difference in the effective cantilever arm of 3.55 (actual, used in Attachment 3) and 3.25 (used in Attachment 2). The difference in the cantilever length produces a similar difference in stress, i.e., the simple finite element analysis predicted a stress of 16.4 ksi (see Affidavit at 21), whereas a stress of 17.91 ksi would have been computed if the precise dimensions were used. The stress observed in the test was 17.1 ksi. Given the uncertainties inherent in measuring the exact location of the effective strain gauge center the observed differences in dimensions are of no consequence with respect to the conclusions drawn from the analysis.

Establishment of Allowables and Margins of Safety

Q. Are allowables established as a result of any of the tests described above impacted by variations in material properties?

A. The only test for which this effect could be of concern is the test conducted by ITT-Grinnell on U-bolts acting as two-way restraints. However, that test was only used to establish allowables employed in the affidavit. The Board should note that those allowables were used only to evaluate the special cases addressed in our affidavit and are not the normal allowables used in the design process which are based on the minimum specified material properties.

The tests on cinched-up U-bolts employed U-bolts with yield strengths between 43550 to 45500 psi, which is above the minimum yield strengths specified by Code. However, in assessing the test results, comparison to allowable values or yield strengths were made utilizing minimum properties of the Code, i.e., Sy = 36,000 psi, and not actual material properties. Likewise, the finite element analyses utilized minimum properties specified by Code. Thus, no allowables predicated on test results have been used, and hence, the safety factors inherent in these applications are those inherent in the use of ASME Code allowables premised on minimum material properties.

Further, no allowables were set by the tests on SA36 rods. The purpose of the tests in March, 1983, on SA36 rods in Richmond Inserts were to confirm for the NRC that a factor of safety of 3 existed in allowables already established for SA36 rods when used with 1" washer plates. The purpose of the tests conducted in May 1984 (see Attachment F to Applicants' Affidavit on Richmond Inserts) was to demonstrate the adequacy of the design method in regard to consideration of bolt bending movement. The allowables for the threaded rod were the Code allowable values established utilizing minimum material properties. Again, neither test was used to establish allowables for SA36 rods.

Q. What is the impact of using actual material properties in the testing of U-bolts used as two-way restraints?

A. As we previously noted, those tests were the only tests performed by Applicants which were used to establish any kind of allowables, and then only for purposes of the evaluation performed in support of our motion. As we explain below, substitution of minimum specified material properties does not alter any of the conclusions in our affidavit on that topic. The allowable loads established by these tests are set forth in the Summary of Results of Attachment 1 to our Affidavit on U-Bolts Acting as Two-Way Restraints, under the column "NF-Rated Load". In accordance

with Code procedures (see ASME Code Section NF-3260) these values were derived using test loads and minimum specified code values for yield and ultimate strengths.

Because the actual properties of the materials employed for the test are higher than the minimum specified strengths of the Code, there is an identifiable probability that some specimens in the plant will have lower material properties than those used in the tests. For instance, for the 1/2-inch rods (actual Sy = 45.13 ksi) there is a 27.3% probability that U-bolts in the field will have lower yield strengths (i.e., integral under curve in Figure 1 up to 45,130 psi equals .273). Similarly, for the 1-inch rod (actual Sy = 51.6 ksi), there is an 86% probability that U-bolts in the field will have lower yield strengths (integral under the curve up to 51,600 psi equals 0.86). Thus, if the allowable loads predicated on test specimens (with material properties exceeding the minimum specified material strengths) are applied to field specimens with lesser strengths, the margin to yielding and failure would be less than predicted by the tests. However, as explained below, this variation in safety margin is not significant.

The allowable load rating computed by test assures that the stress in the material is less than 60 percent of the tested material's yield strength. However, if that load rating is applied to a material having minimum Code properties (instead of a material having properties equal to

those tested) the resulting stresses could, under certain loads, be higher than 60% of the minimum specified yield strength. For the U-bolts used by Applicants, the lowest possible margin to yield arises using the allowable established by tests on the 1-inch rod (Sy = 51.6 ksi). The maximum stress permitted by application of the rated load of this material is 31 ksi (.6 x 51.6). The minimum margin to yield, therefore, (which would exist for a material having the minimum specified material strength, i.e. 36 ksi) would be 1.16 or 36 ksi/31 ksi. The average margin to yield (material with average yield strength from Figure 1, i.e., 47.45 ksi) is 1.53. Similarly, the minimum margin to failure would be 1.87, and average margin to failure would be 2.21. Thus, reasonable margins to yield and failure would remain even for U-bolts with the minimum specified material strengths.

Q. Would the conclusions in Applicants' Motion on U-Bolts Acting As Two-Way Restraints change if specimens with minimum material properties had been used.

A. No. The conclusion that the U-bolts can act as two-way restraints was drawn in part from the acceptability of the values of the interaction ratios, reported on page 14 of our Affidavit. The conclusion was also predicated, in part, on the acceptability of pipe and nozzle stresses. However, the effect of the interaction ratios is all that is of interest here, because it is the only factor affected by the

allowable values obtained from test. To demonstrate the continued appropriateness of our conclusions premised on the interaction values we have scaled down the allowable values to correspond to test results which would have been obtained had specimens with minimum material properties been used. At 122°F the allowable normal load would be 6225 lbs. (instead of 6723) and the allowable side load would be 1353 (instead of 1697). Using these revised allowables in the interaction ratios for the four supports discussed on page 14 of the Affidavit produces ratios of 0.982, 0.936, 0.680 and 0.493, which are still acceptable. Similarly, the interaction formula bounding the remainder of the supports (see page 14 of our Affidavit regarding U-bolts used as two-way restraints) would have the following value:

$$\frac{500}{1015} + \frac{2260}{4668} = 0.977$$

Thus, the conclusions presented in our Affidavit remain valid even if one assumes minimum material properties.

Robert C. Iotti

John C. Finneran, Jr.

STATE OF TEXAS
COUNTY OF SOMERVELL

Subscribed and sworn to before me this 5th day of December, 1984.

Notary Public ETHEL S. GRUMBLES
My Comm. Expires 6/30/88

This is a telecopy facsimile. The original will be sent under separate cover.

FORM DHE-5

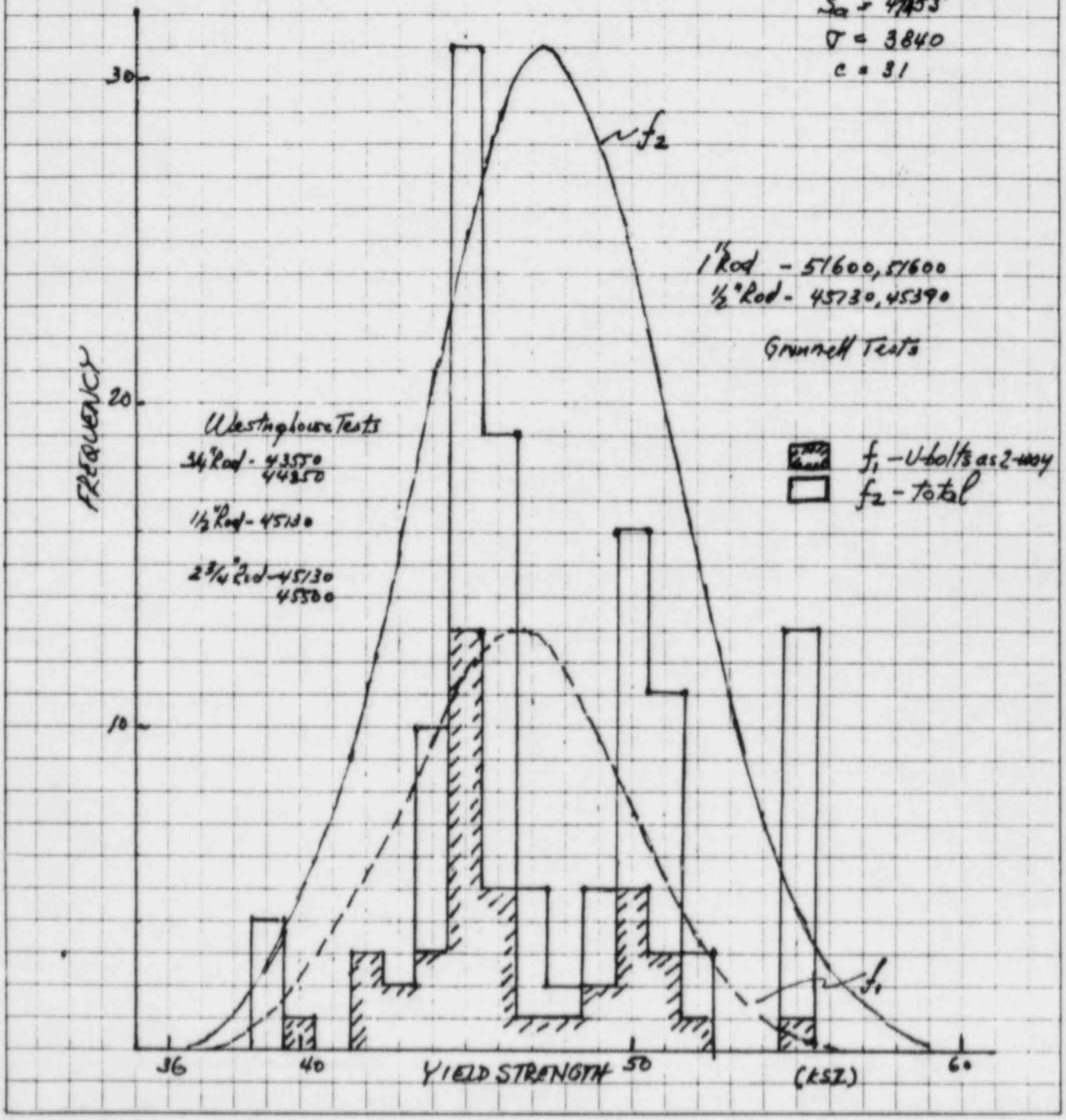
TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
DALLAS POWER & LIGHT COMPANY
TEXAS ELECTRIC SERVICE COMPANY
TEXAS POWER & LIGHT COMPANY

Date 11/13/84
Calc By LPIotti
Chk'd/Apprd. By
Filing Code
Sheet No. Of
G & H Job No.
Subject
Ref. Dwg./Spec. No.

Figure 1

$$f = Ce^{-[(S_a - S)/\sqrt{2}\sigma]^2}$$

$S_a = 47453$
$\sigma = 3840$
$C = 31$



FORM DHE-5

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

Date _____ Filing Code _____

Calc By _____ Sheet No. _____ Of _____

Chk'd/Apprd. By _____ C & H Job No. _____

Subject _____ Ref. Dwg./Spec. No. _____

Grinnell Tests

1" Rod - 73400
- 73400

1/2" Rod - 63080, 63590

Westinghouse Tests

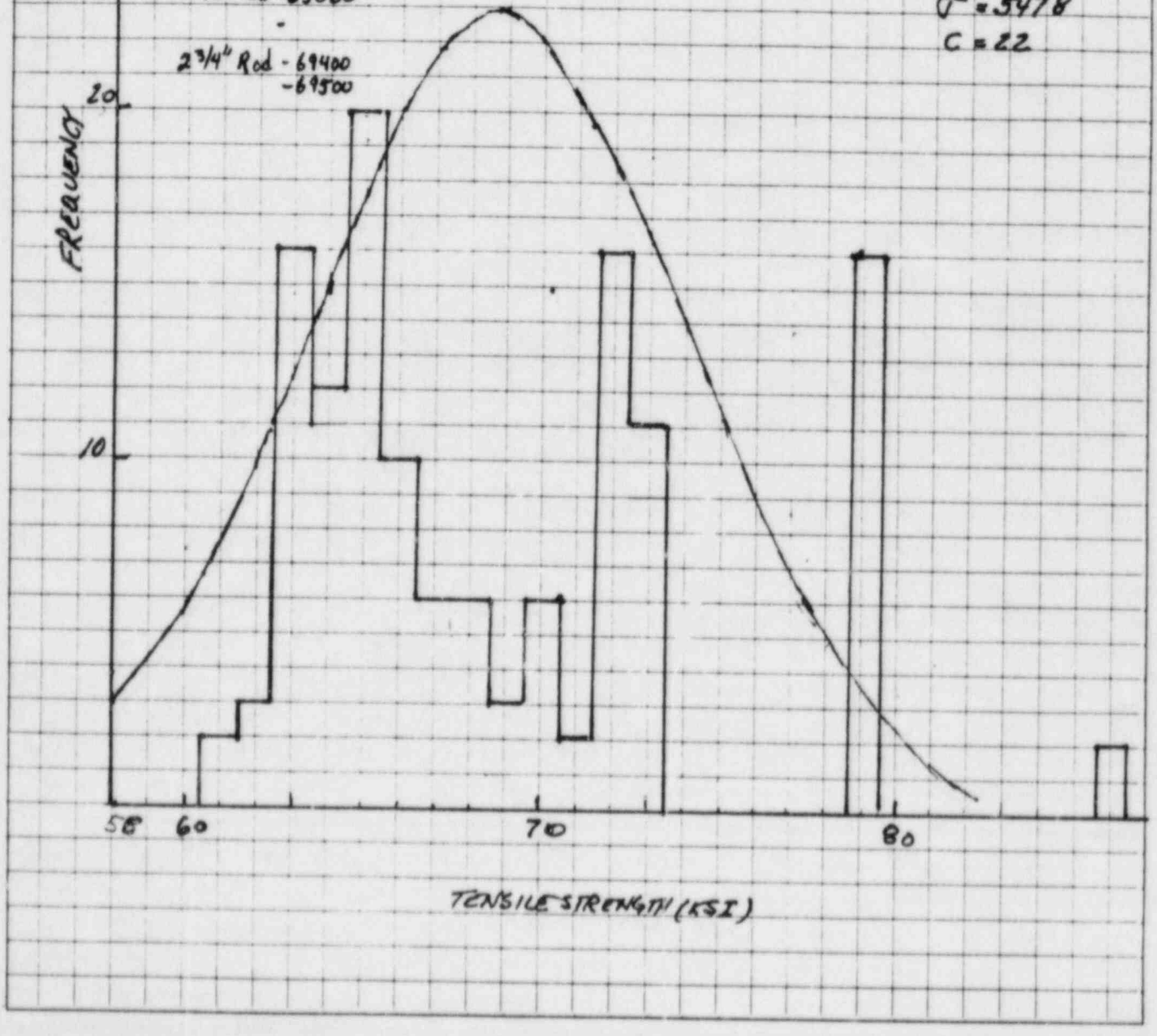
3/4" Rod - 65120
- 67535

1/2" Rod - 63080
-

2 3/4" Rod - 69400
- 69500

Figure 2

S_a = 68676
σ = 5478
C = 22



FORM DHE-5

TEXAS UTILITIES SERVICES INC.
COMANCHE PEAK S.E.S.
Agent For
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Date _____ Filing Code _____

Calc By _____ Sheet No. _____ Of _____

Chk'd/Apprd. By _____ G & H Job No. _____

Subject _____ Ref. Dwg./Spec. No. _____

TABLE 1

MATERIAL PROPERTIES FOR A-36 THREADED RODS

HT #	SIZE	S_y (KSI)	S_u (KSI)
H04431	1½"ϕ	45.1	69.2
H05509	¾"ϕ	52.1	72.8
H04253	1⅛"ϕ	52.0	78.0
H04230	1½"ϕ	57.1	78.5
N22020	1"ϕ	51.6	73.8
1-8926	1⅛"ϕ	46.5	71.7
B 20850	1"ϕ	49.3	72.0
March 83 Tests	1½"ϕ	45.7	69.7
		45.1	69.2
May 84 Tests	1½"ϕ	49.4	73.0

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COMPANY, et al.	)	
	)	(Application for
(Comanche Peak Steam Electric	)	Operating Licenses)
Station, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "Applicants' Response to Board Memorandum (Information on Composition of A36 and A307 Steel)", in the above-captioned matter was served upon the following persons by express delivery (*), or deposit in the United States mail, first class, postage prepaid, this 5th day of December, 1984, or by hand delivery (**) on the 6th day of December, 1984.

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