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Re: Texas Utilities Electric Company, et al
(Comanche Peak Steam Electric Station,
Units 1 & 2); Docket Nos. 50-445 and 50-446

Dear Administrative Judges:

Applicants have this date delivered to Mr. Vincent S. Noonan Revision 1 of Appendix D, entitled "CPRT Sampling Approach, Applications, and Guidelines," developed by the Comanche Peak Response Team.

As a part of our continuing effort to keep the Board apprised of matters which relate to the licensing of Comanche Peak, we are enclosing four copies of such revision. This revision is not being offered into evidence at this time, and is provided for information only.

Respectively,

Robert A. Wooldridge

RAW/klw
Enclosures

cc: Service List

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TXX-4685
File No. 10068

TEXAS UTILITIES GENERATING COMPANY

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January 31, 1986

WILLIAM G. COUNSIL
EXECUTIVE VICE PRESIDENT

CPRT-219

Mr. Vincent S. Noonan
Director, Comanche Peak Project
Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20599

SUBJECT: Comanche Peak Steam Electric Station
Submittal of Appendix D of the
Comanche Peak Response Team (CPRT)
Program Plan

Dear Mr. Noonan:

Transmitted herewith is Revision 1 of Appendix D "CPRT Sampling Approach, Applications and Guidelines" of the CPRT Program Plan. Recipients are asked to insert this Appendix after the tab "Appendix D Sampling" which was included in our submittal of Revision 3 of the Program Plan on January 27, 1986.

We still intend to submit Appendix E during the week of February 3 and the testing issue-specific action plans by March 1. Should you have any questions please do not hesitate to call either John Beck or myself.

Yours very truly,

W. G. Counsil

WGC:tj

Enclosures

APPENDIX D

CPRT SAMPLING POLICY, APPLICATIONS AND GUIDELINES

1.0 POLICY STATEMENT

The Senior Review Team (SRT) has determined that, in general, it is unnecessary to examine an entire population of items or quantity of material in order to determine whether programmatic problems exist. By sampling a portion, inferences can be made regarding the entire population. The basis for CPRT decisions on design, construction, testing and QA/QC adequacy will be supported by sound engineering evaluation techniques, which often may include principles of sampling. Sampling and resulting inferences can be used as a powerful tool in identifying programmatic safety-significant deficiencies in programs and processes. Although the process of drawing inferences from sampling is not the sole means of reaching reasonable assurance that the plant design and construction are adequate, sampling may be a significant contributor to that evaluation.

It is also recognized that, for sampling to result in meaningful information about a process or program, the items in the population to be sampled must be similar (i.e., homogeneous) in the significant traits or attributes associated with that process or program. Some populations will be homogeneous by virtue of the work process by which they were made (e.g., ASME pipe support welding), others will be similar by virtue of the design activity that created them (e.g., containment isolation valve closure time), and so forth. Since sampling is utilized for a variety of purposes in the CPRT program it is essential that, when sampling is used, the population to be sampled is homogeneous and the objectives of the sampling are clearly tied to those of the action plan under consideration.

There are two basic ways to sample: one is to use judgment to select from a population those items that are likely to be the most critical, the other is to randomly select items from the general population (e.g., random selection of welds in a support structure). In the first method, called "biased sampling," the validity of one's inferences depend to a considerable extent on the validity of the investigator's prejudgment. In the second method, the samples are drawn randomly; and the resulting inferences depend on little or no bias from human prejudgment. Within the scope of the CPRT, both of these approaches are used to investigate various areas of interest and are justified within the context of their applications. In many cases, both approaches are used in the investigation of a single area of interest

APPENDIX D
(Cont'd)

2.0 APPLICATIONS

The purpose of this appendix is to:

- Delineate the various applications of sampling within the CPRT program.
- Set forth consistent guidelines for the mechanics of selecting samples wherever random sampling techniques are used in ISAPs and DSAPs (including the TRT issues, the Design Adequacy Program and Quality of Construction Program).

2.1 Quality of Construction (QOC)

The construction process produces hardware by execution of a number of relatively uniform construction activities. Therefore, the construction process is inherently susceptible to isolated hardware discrepancies. The overall frequency of deficiencies relative to the total number of opportunities is typically low, unless a programmatic problem exists.

To obtain a consistent sampling approach in the QOC Reinspection/Document Review (Issue-Specific Action Plan VII.c), described as the self-initiated investigation in Appendix B, the SRT believed that an initial sample screen should be based on a specific standard. The SRT has concluded that a 95/5 sample plan, when used in the context of homogeneous populations of attributes, would provide a reasonable screen to detect programmatic or systematic deficiencies*. Such a screen would ensure a sufficient initial sample size to evaluate the adequacy of the safety-significant attributes associated with each of the homogeneous work activities (HWAs) in the VII.c investigation. Accordingly, an initial random sample of at least 60 items is required for each homogeneous population (see Attachment 1, Table 1).

2.2 Other ISAPs

Many of the other ISAPs (i.e., TRT issues) utilize sampling techniques to investigate specific areas of concern. In general, the SRT requires that the sample sizes in each of these cases be consistent, at a minimum, with that required by the use of a minimum 95/5 sample screen. Any exceptions to this general principal are approved by the SRT, based on a case-specific review, and are reflected in the associated ISAP.

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* A deficiency rate as low as 5% in a population will be detected by a 95/5 sampling plan with a probability or confidence level of 0.95.

APPENDIX D
(Cont'd)

2.0 APPLICATIONS (Cont'd)

2.3 Design Adequacy Program (DAP)

The focus of the Design Adequacy Program (DAP) is on the verification of the end products of the engineering and design process (i.e., designs represented by drawings, evaluations, or design specifications). In contrast to the construction process, where relatively few HWAs apply to large numbers of individual hardware items, the engineering and design process is characterized by a large number of homogeneous design activities (HDAs) with comparatively few design outputs being covered by each one.

The important aspect of the HDAs is that they include items for which a high degree of correlation exists in the design criteria, methodology, and procedures. Accordingly, evaluation of the adequacy of each HDA can be based on evaluating a representative selection of items within each HDA. The number of selected items will be sufficient to justify inferences and extrapolations that are appropriate for all items within each HDA. Attachment 4 of Appendix A to the CPRT Program Plan presents further details on the establishment of HDAs and the criteria for selecting items for evaluation.

If, in the event the DAP uses statistically-based sampling in the verification of any HDA, the sampling will be conducted in accordance with the provisions of this appendix.

3.0 GUIDELINES FOR RANDOM SAMPLING

The purpose of the attached guidelines is to:

- Assist in the development of non-parametric sample screens for Issue-Specific Action Plans (ISAPs) or Discipline Specific Action Plans (DSAPs) where random sampling is used (Attachment 1),
- Outline the use of one-sided tolerance limits for evaluating special cases of parametric attributes (Attachment 2),
- Outline the basic methods to be used in generating random samples from a population of items or attributes (Attachment 3),
- Outline the methods to be used for expanding samples (Attachment 4).

APPENDIX D
(Cont'd)

3.0 GUIDELINES FOR RANDOM SAMPLING (Cont'd)

These guidelines apply to sampling screens for most ISAPs and DSAPs. If other types of sampling applications arise, they must be considered on a case-by-case basis.

APPENDIX D
(Cont'd)

ATTACHMENT 1

GUIDELINES FOR SAMPLE INSPECTION OR REVIEW OF ATTRIBUTES

Table 1 of this attachment is generally used by CPRT to determine the sample sizes and corresponding detection numbers which are consistent with a 95 percent confidence level (or 0.95 probability) on the 5, 2.5, and 1 percent upper bound population percentage screens. Unless otherwise justified and specifically approved by the SRT, the number of deficiencies allowed in the sample screen will be no more than one (see Attachment 4 for discussion of sample expansion where one deficiency is identified). These sampling plans are based on the assumption of an infinite population size and are conservative when compared to sampling plans based on finite populations.

The minimum sample size for a 95/5 screen is 60 with a detection number of zero (i.e., the critical region is one or more detected items). This means that out of a random sample of 60 items inspected, if no items are found to belong to the classification of interest (e.g., deficient), there is a 95 percent confidence (or 0.95 probability) that less than 5 percent of the population will be in this classification. If items belonging to the classification of interest are detected in a minimum sample (i.e., the number detected is in the critical region), the 95 percent upper-bound confidence limit (or 0.95 probability interval) will be greater than 5 percent. It is still possible that the population percentage is less than 5 percent, but based only on the initial sample evidence, the probability that this is so is less than 0.95.

A root cause evaluation of the deficiency is performed in order to isolate a potentially deficient stratum from the population. If such a stratum is identified, sample expansion into that stratum is used to verify that indeed the deficiency is associated with the identified stratum. Sample augmentation in the remaining population (minus the potentially deficient stratum) is used to verify that the deficiency is not associated with the remaining stratum. Sample expansion is further discussed in Attachment 4 to this appendix.

APPENDIX D
(Cont'd)

ATTACHMENT 1
(Cont'd)

TABLE 1

SAMPLING PLANS FOR DETECTING UPPER-BOUND POPULATION PERCENTAGES (p_u) AT 95 PERCENT CONFIDENCE LEVEL*

SAMPLE SIZE**			DETECTION	CRITICAL
p_u = 5.0%	p_u = 2.5%	p_u = 1.0%	NUMBER	REGION
60***	120	300	0	1 or more
95	190	474	1	2 or more
126	252	630	2	3 or more
155	310	775	3	4 or more
183	366	915	4	5 or more
210	421	1051	5	6 or more

* Or 0.95 probability level.

** Sample sizes are determined from A. H. Bowker, and G. J. Lieberman, Engineering Statistics, 2nd Edition, Prentice-Hall, 1972, page 538. Note that these same sample plans may also be derived from Bayes' theorem, and are therefore applicable for sample expansion, using Bayes' theorem (see A. Boissonnade "CPRT Sampling Plans-Addendum," Civil/Structural/Mechanical CPRT File No. 11.1-005, or Box and Tiao, Bayesian Inference in Statistical Analysis, Addison-Wesley, 1973).

*** For populations of 100 or fewer items, the minimum sample size may be reduced to 45, with a detection number of zero. This is based on the hypergeometric distribution. Reference: Lieberman, and Owen, Tables of the Hypergeometric Probability Distribution, Standard University Press, 1961.

APPENDIX D
(Cont'd)

ATTACHMENT 2

SAMPLING GUIDELINES FOR ONE-SIDED TOLERANCE LIMITS

In some special cases ISAPs or DSAPs (or an evaluation of an adverse trend) may require the determination of a parametric tolerance limit of a particular attribute associated with items of a population. The acceptable quality of a population of items or quantity of material is often specified by setting a lower (upper) bound value based on the criterion that a certain percentage of the population fall above (below) this value (e.g., the concrete code specifies that at least 90 percent of the 28-day cylinder strengths fall above the required design strength). A lower (upper) bound population percentage is then inferred from a sample, compared with criterion value and the population either accepted as is, or corrective action taken. When a lower (upper) bound population percentage is specified in statistical terms, it is called a tolerance limit. A one-sided tolerance limit has the property that a certain percentage of the population of values (e.g., 90 percent) may be expected to fall above or below this bound with some level of confidence (e.g., 95 percent confidence).

A one-sided tolerance limit is defined as $X - KS$ ($X + KS$), where X is the sample average, and S is the sample standard deviation. The tolerance factor, K, is dependent upon the sample size, the specified population percentage above (below) the limit, and the desired level of confidence (e.g., the 95 percent confidence level). Once the confidence level has been selected and the population percentage specified, the sample size is only a function of the tolerance factor K. To lower the tolerance factor, it is necessary to increase the sample size. The relationship for several population percentages is listed in Table 2.

For ISAPs or DSAPs requiring the use of one-sided tolerance limits, sampling plans are developed by first determining, through engineering, materials, or other types of evaluations, that the underlying population distribution is either normal or log-normal*. Then, as a minimum, a sample size of 50 is obtained. The actual sample size selected, however, takes into account the difficulty in obtaining the sample and how sensitive the resulting conclusions are to the actual tolerance limit.

There is no unique sample size to be used for any particular tolerance limit problem. However, it is obvious from Table 2 that it becomes increasingly difficult to lower the tolerance factor as the sample size increases. From a practical point of view, sample sizes between 50 and 100 provide reasonable tolerance factors for the sampling effort.

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* A goodness-of-fit test should be used to aid in evaluating the reasonableness of the assumed underlying distributions. Any tolerance limit applications for which the underlying population distribution cannot be reasonably assumed to be normal or log-normal will be handled on a case-by-case basis.

APPENDIX D
(Cont'd)

ATTACHMENT 2
(Cont'd)

TABLE 2

ONE-SIDED TOLERANCE LIMIT
FACTORS, K, FOR 95 PERCENT CONFIDENCE LEVEL

Sample Size	First* (ninety-ninth) Percentile	Fifth* (ninety-fifth) Percentile	Tenth* (ninetieth) Percentile	Fiftieth** Percentile
5	5.75	4.21	3.41	0.90
10	3.98	2.91	2.36	0.56
15	3.52	2.91	2.36	0.45
20	3.30	2.40	1.93	0.38
25	3.16	2.29	1.84	0.34
30	3.06	2.22	1.78	0.31
35	2.99	2.17	1.73	0.28
40	2.94	2.13	1.70	0.26
50	2.86	2.07	1.65	0.24
70	2.77	1.99	1.58	0.20
100	2.68	1.93	1.53	0.17
300	2.52	1.80	1.42	0.10

* Reference: D. B. Owen, Handbook of Statistical Tables, Addison Wesley, 1962, page 126. Note that the first percentile means that 99 percent of the population falls above, one percent falls below.

** Reference: F. A. Webster, "Developing Sampling Plans for TRT Issues", Civil/Structural/Mechanical CPRT, File No. 11.1-001, 3/12/85.

APPENDIX D
(Cont'd)

ATTACHMENT 3

GUIDELINES FOR GENERATING RANDOM SAMPLES

The procedure for generating a random sample begins by first defining the unit to be sampled (e.g., truckloads of concrete, conduit runs, conductor terminations, etc.), then determining the total number of these units or items in the population. Note that the population, so defined, may actually be a subpopulation which has certain specified engineering attributes (i.e., a stratum). Each unit in the population (or stratum) must be assigned a unique sequential number 1 through N, where N is the total number of units. A table of random digits or a random number generator is then used to develop a random sequence of units from the population. Table 3 outlines the complete procedure.

APPENDIX D
(Cont'd)

ATTACHMENT 3
(Cont'd)

TABLE 3

PROCEDURE FOR GENERATING A RANDOM SAMPLE FROM A POPULATION

1. Determine population size, N, and number each item sequentially, 1, 2, ...N.

2. Start at a random position in a table of random digits or use a random seed in a random number generator and perform the following steps for each random five digit decimal fraction in sequence, until desired sample size is obtained.

3. If using a table of random digits, place a decimal point in front of each set of five digits* and multiply by the population size. If using a random number generator which produces five digit decimal fractions*, simply multiply by the population size.

4. Retain only the integer part of the above product and add 1. This will define the i^{th} item to be included in the random sample.

5. It is usually a good idea to generate a longer list of randomly selected items in case a particular item is inaccessible in the field, or in case the same item is selected more than once.

Example: Generate a sample of 300 items from a population of size 3791.

RN1	=	.04146**	x	3791	=	157.17486	==	157	+	1	=	158
RN2	=	.23432	x	3791	=	888.30712	==	888	+	1	=	889
RN3	=	.74381	x	3791	=	2,819.78371	==	2,819	+	1	=	2,820
.		.		.		.		.				.
.		.		.		.		.				.
.		.		.		.		.				.
RN300	=	.59221	x	3791	=	2,245.06810	==	2,245	+	1	=	2,246

---

* A five digit random decimal fraction is only useful on populations of 10,000 items or less. Additional random digits must be used in the decimal fraction if larger populations are sampled.

** Reference: The Rand Corporation, A Million Random Digits, Free Press, 1955, p. 355.

APPENDIX D
(Cont'd)

ATTACHMENT 4

GUIDELINES ON SAMPLE EXPANSION

The primary reason for continuing a sampling investigation is to determine if detected deficiencies are systematic or random, and aid in their evaluation. It may also be used as an aid in evaluating adverse trends and their root cause(s).

If the 95 percent upper-bound confidence limit (or probability interval) calculated from the sample is greater than 5 percent, the population of items is said to have failed the screen and further investigation is necessary. If one deficiency is detected in the initial minimum sample of items (or one or more different attributes in the case of VII.c) and no root cause can be identified, sample expansion in the entire population, including all attributes, will continue until it is determined that either the deficiency is a random occurrence of very low frequency, or a trend or programmatic deficiency is identified in the population (i.e., a potentially deficient stratum*). If a deficiency is detected in the initial sample and a root cause that implicates only a subset of attributes is identified, a reduced set of attributes will be considered in the sample expansion. If a sample is found to contain deficiencies or an adverse trend associated with items possessing a certain characteristic and not with items that do not possess this characteristic, a subset of items possessing these certain characteristics will be considered in the sample expansion. If deficiencies continue to be detected in the expanded sample, or two or more deficiencies of the same type are detected in the initial minimum sample, and they cannot be associated with a specific stratum, 100 percent of the population will be inspected or reviewed.

Sample expansion into a stratum will be required when it has been determined or hypothesized that the stratum contains and bounds the adverse trends or deficiencies of the type detected in the initial sample. Such a stratum may be identified by an adverse trend in the initial sample or by a root cause evaluation originating inside or outside the population of items being inspected or reviewed. Sample expansion into a stratum proceeds in one of the following ways:

- The stratum is identified completely, separated from the general population, items numbered sequentially from one to the total number and then randomly selected, or

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* As used in the CPRT program, stratum will refer to either
1) a subset of items in the population,
2) a set of attributes of items in the population,
or 3) a set of attributes for a subset of items in the population.

APPENDIX D
(Cont'd)

ATTACHMENT 4
(Cont'd)

- The stratum is left within the general population and random sampling is continued in the general population until the required sample size is obtained in the stratum.

If there is no identified root cause for the initial deficiency or adverse trend, sample expansion in the general population is required to verify that the deficiency detected in the initial sample was a random occurrence of low frequency. When sample expansion is performed only for a stratum, the sample in the general population (minus the identified stratum) will be augmented with additional items to bring the general population sample back to the minimum 95/5 sample size.

For example, if one deficiency is found in an initial sample using the minimum 95/5 sample screen, and no stratum can be identified, then an additional 35 randomly selected items is needed (note: this is based on Bayes' theorem). If a deficiency is found in an initial minimum 95/5 sample, and a stratum is identified and removed for separate investigation, enough additional items must be randomly selected from the general population minus the identified stratum to bring the total sample back up to the minimum 95/5 sample size. In addition, the sample size in the stratum must total 95. Any items that were selected from the stratum in the initial sample are included as part of the sample expansion in the stratum. If no more deficiencies are detected, then the sample will pass the 95/5 screen and the conclusion will be made that the deficiencies are random and of very low frequency in the population (i.e., there was no programmatic breakdown).

Generating an expanded sample in the general population follows the same rules for generating the initial random sample. The sampling will start where the initial sample ended (see Table 3 of Attachment 3). Table 1 in Attachment 1 should be used as a guide for sample expansion in those cases where ISAP sample plans deviate from the general minimum 95/5 sample screen.