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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of APPLICATION OF TEXAS UTILITIES GENERATING COMPANY, ET AL. FOR AN OPERATING LICENSE FOR COMANCHE PEAK STEAM ELECTRIC STATION UNITS #1 AND #2 (CPSES)	)	Docket Nos. 50-445 and 50-446

TESTIMONY OF CASE WITNESS
JACK DOYLE

Q: Mr. Doyle, have you read the CYGNA Report?

A: Yes, I have.

Q: What is your opinion of this document?

A: I have several objections to this document:

(1) It represents one of the simpler areas in the plant containing pipes and pipe supports, which is all that I am addressing in this testimony;

(2) It is not an independent assessment of the systems being reviewed;

(3) The section devoted to the pipe support criteria lacks a number of criteria which are critical to any assessment of supports;

(4) The document lacks the information required for a proper assessment of its accuracy;

(5) The bare minimum of information contained in this document is still sufficient to lead an independent reviewer to come

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1 to conclusions which are not reflected by this document.
2 In fact, the conclusions by CYGNA are the opposite of those
3 which should have been assessed.
4 Q: Taking these items in order, what do you mean by "one of the simpler
5 areas"?
6 A: To start with, the basic area is not cluttered as is the case
7 at, say, azimuth 270^{0} on elevation 808. Beyond that, the individual supports
8 are basically one=way supports as opposed to the more complex frames used
9 as one-, two-, three-, and even six-way restraints. There is practically
10 no friction conisderation for these supports. This may be noted from the
11 fact that of the 91 supports covered in the walk-down section of the report,
12 more than half are springs or snubbers. Of the remaining 43 or so, many are
13 struts. Therefore, this sample covers a far simpler segment than is the
14 norm for the plant. Beyond this, there were, to the best of my knowledge,
15 no A307 bolt problems, no instability problems, no local diaphram problems,
16 no cinched-up U-bolt problems, etc., present because of the nature of the
17 supports. Also, this area was a showcase area used to prove that the iterative
18 process was without problem.
19 Q: You say this is not an independent review. How do you arrive at
20 this conclusion?
21 A: Many factors lead to this conclusion. One example may be found in
22 note No. 1, attachment to PS-01, Appendix H, Pipe Support Check List. The
23 note effectively concurs with the vendors, the utility and Region IV NRC that
24 the stress contribution caused by the effects of seismic events on the structure
25 comprising the support is negligible. I don't recall anyone on either side

of the question claiming that the self-weight excitation segment of contribution was a major contributor to the stress of the support. All I have ever stated is that this loading element was one of the cumulative contributors which must be considered. So long as the engineer is permitted to design structures to the limits of the code allowables, the deletion of any customarily included stress contributor on the basis that, by itself, it induces a stress that is minor, is irrational. This premise is true because the closer the design stress is to the code allowable, the more critical minor contributors become. CYGNA is relying on item 3h of the SIT Report #50-445/82-26 and 50-446/82-14 as if it were the position of the Nuclear Regulatory Commission, rather than only one side of an argument which has yet to be adjudicated. Beyond this, the code is specific as to what "shall" be included in the design of supports. And this includes seismic for the support dead load. See NF 3111(e) and NF 3112.2 of ASME Section III, also NB, NC, and ND 3622.2, and 10 CFR Part 50, Appendix A, Criterion 2.

A second feature of this non-independent posture may be found in note 2 of the same source as note 1. In this case, CYGNA has not only deviated from fundamentals, they are deviating from their own criteria. See Appendix E "Pipe Support Design Review Criteria," page 4 of 11, 4.1.1. Stiffness, and page 1, Exhibit 4.1-1. CYGNA, which by its own admission, not only did not review the NRC conclusions in regard to the generic stiffness study, but the review report was not even available at the time of their review. Therefore, a rational man may only conclude that CYGNA deviated from their own criteria as a result of rumors that variations in the loads due to alterations in the support stiffness are negligible.

1 Having had access to this generic stiffness study, it is obvious that
2 200% increases in loads and in one case a 600% + change can hardly qualify
3 as negligible. Beyond this, the generic stiffness study did not include
4 all of the contributors to stiffness degradation such as effects of bolts,
5 hardware including U-bolts, local flexibilities, etc. It is obvious that
6 if the actual stiffness values from node point to hard point were used, the
7 increase in loads on the supports would fall somewhere between severe and
8 catastrophic. To inspect the supports as CYGNA did without reference to
9 stiffness because someone told them it was no problem is totally irrational
10 and indicates a total lack of independence. An independent assessment would
11 have, as a minimum, proceeded with the inspection to the criteria established
12 and as a caveat left the optimistic input for stiffness in the pipe stress
13 analysis as an open item pending the decision of the Board, which after
14 all in this instance will make the ruling.
15 A third factor which might lead some to believe that CYGNA was either
16 "somewhat knowledgeable" or not independent involves the problem of zero
17 inch gap on support No. SF-X-033-007; see WD03-01, Appendix F, "Observation
18 Record," 2.0 "Resolution." CYGNA identified a problem wherein a minimum
19 1/2" clearance required in the unrestrained direction was violated. Their
20 solution to the problem was to ask for an explanation from the utility.
21 Mr. Finneran explained that this problem was noted by CPSES and was recorded
22 on as-built reverification form 1267. Engineering solved this problem by
23 "accept as is," on 4/20/83.
24 Not only did this suffice to close out this item as far as CYGNA is
25 concerned, but they had to extend the following "independent" observation:

1 "This documentation indicates that the Comanche Peak as-built verification
2 is working effectively."
3 The problem, however, still exists. Nothing was accomplished which
4 would resolve the situation which obviously escaped detection by CPSES and
5 CYGNA. The purpose of the large gap requirement in the unrestrained direction
6 is to allow the pipe to move without restraint due to thermal expansion
7 or seismic event. Since seismic is either way or either direction, I will
8 only address this occurrence. If the pipe is free to move (unrestrained),
9 it will deflect first one way and then the other a number of times dependent
10 on the zero crossings for the specific event. In this case, however, it
11 is restrained in one direction. This restraint will therefore react a force
12 in lieu of displacement. In short, this is no longer a one-way restraint,
13 but is now a two-way restraint. Additionally, since it is free in one un-
14 restrained direction, the load is not simply the constraining effort in
15 one direction but now shock is present. Since this problem has been written
16 off, the magnitude of the shock load is unknown, but still will contribute
17 to the stress in the supports which, as a result of a lack of one element
18 inducing stress, is also unknown.
19 The issuance of "use-as-is" does not necessarily eliminate problems,
20 but as shown above may merely be burying them.
21 A fourth area of concern involves the checking of calculations. See
22 Appendix H, "Pipe Support Check List," sheet 1 of 4, PS-14, support No.
23 SI-1-073-0700-S32R. The reviewer made the following comment at item 1,
24 Comments, No. 3: "The design calculation includes a pipe bearing stress
25 calculation <u>although this is not required</u> for general pipe design." (Emphasis

added.) This reviewer would do well to look at the ASME Code, Section III, Sub-Sections, NB, NC, and ND 3645 which states: "Attachments" which require the design of external attachments to pipe in a way that will avoid a flattening of the pipe, excessive localized bending stresses or harmful gradients in the pipe wall.

A fifth example of non-independent disposition of problems involves support No. SF-X-003-003-F43K, a snubber which passes close to the clamp of another snubber, No. SF-X-007-014-F43K; see WD02-01, Appendix F, Observation Record. In this case, the minimum clearance between the snubber (extension) and the clamp is 1/4". This is not during plant operation nor utilization of the spent fuel pool; therefore, we must assume the pipes are at plant ambient.

While I lack sufficient information to pursue this problem, I find that the maximum relative seismic movement between these two points is only .0009 according to Texas Utilities. I have, by calculation on a number of snubbers and struts, found the displacement of the hardware itself to be beyond this value. For example, for a 2" diameter standard pipe 4' long and simply supported at each end, subjected to a 1 G seismic load, horizontal and perpendicular to the axis of the pipe, the seismic displacement would be $5wl^4/384EI$ where w = .304 lbs. per inch, l = 48 inches, E = 29,000,000, and I = .666 in.^{3}. or $5 \times .304 \times 48^4 \div 384EI = .0011$ in., which is 20% more than the total differential indicated by Texas Utilities. If the pipe were in a horizontal plane, and were twice as long, and subjected to 1 G vertical, the deflection would be .035 and the stress in the pipe would be 10% of the allowable, and this from dead load and seismic only. And this is without considering the

1 pipe node point movement or the differential movement of two run pipes which
2 may be seismically out of phase. Also, I must point out that after years
3 of operational cycling, the node point will not maintain the as-constructed
4 location.

5 Beyond this, it is amusing to note that the following note appears on
6 the page: "Texas Utilities has determined that the maximum relative move-
7 ment at these two points are as follows:" This would hardly seem to be an
8 independent assessment, when CYGNA finds a problem but Texas Utilities writes
9 it off.

10 Q: What do you mean by "the section devoted to design criteria lacks
11 a number of criteria"?

12 A: We must assume that the criteria was outlined prior to the review
13 and therefore the review team was unaware of the support configuration with
14 which they would be involved. If this was the case, the criteria must contain
15 a sufficient check list to review whatever type of support exists and flag
16 the items to be checked. In this case, the reviewer should be looking for
17 the following, which were not included in his check list except in such
18 broad terms that from the review it is not possible to decipher what features
19 were reviewed.

20 a. Instability;
21 b. Approved hardware (with load data sheets);
22 c. Prying action;
23 d. Summation of torsional effects to normal stress;
24 e. Local diaphram action;
25 f. Worst-case, additive signs for load input;

g. Massive hardware and structure included in calculations;

h. Weld transition for tubes (Beta angle);

i. Shear distribution for bolts in bearing;

j. Loads induced into piping;

k. Constraint to thermal growth of pipe;

l. Minimum weld and single pass requirements;

m. Thermal constraint of supports (wall-to-wall, etc.);

n. A-307 bolts used in friction connections;

o. Stress ratio based on sum of contributors;

p. Web crippling;

q. Shear lag (wide flanges loaded on single flange);

r. Flange rotation (wide flanges);

s. Web bending (wide flanges, channels, etc.);

t. Use of principal axis for unsemetrical bending;

u. Loading off shear center;

v. Bending allowable reductions for unbraced length;

w. Bending allowable reduction when compression ratio in bending members exceeds stress ratio of .15;

x. Differential spring rates (double struts of unequal length reacting single load, for example);

y. Friction or displacement equivalent load for all supports;

z. Effective length of intermittent welds;

aa. Support resisting seismic movement or dead load of buildings;

bb. Check for loading induced by supports which must be picked up by other up or down stream supports.

1 There are other features which require checking; however, this should
2 suffice to indicate the failure of the CYGNA check lists to adequately address
3 the review as required.
4 Q: What do you mean by "the document lacks the information required
5 for a proper assessment of its accuracy"?
6 A: For example, among the items not included:
7 a. The stress ratio;
8 b. The configuration of the support; and
9 c. The loads and deflection.
10 The report is written as if the infallibility of the reviewer was un-
11 contested and only those observations made by the reviewer are open to question.
12 There is really no way for one reading the report to assess the value of
13 the exercise except to analyze the write-off procedures utilized by the
14 reviewer.
15 Q: What do you mean by "in fact the conclusions by CYGNA are the
16 opposite of those which should have been assessed"?
17 A: Before getting into specifics, it is well to note two statements
18 made by CYGNA in Section 4 of their report. First, on page 4-10, 4.3.2.
19 "Pipe Supports Review," last paragraph: "In general the supports calculations
20 are well done." The second statement appears on 4-17 and 4-18 "Mechanical
21 Walkdown (Piping and Supports)":"The purpose of the walkdown was to verify
22 the as-built location of pertinent features of the piping system such as
23 valves, branch connections, elbows and supports and to <u>verify the as-built</u>
24 <u>condition of the supports</u>." (Emphasis added.)
25 "Except in the few places where any form of measurement (either accurate

or approximate) was not possible the location of all piping elements was verified to be in conformance with the relevant drawings." It is these two statements that I find I must challenge.

In reference to the first statement, the first point of consequence is to keep in mind that only 31 calculations were reviewed, and these as were stated above were among the simplest at CPSES.

Among those items noted by the reviewer in Appendix H that were written off are the following which also include drawing errors in addition to calculational errors:

a. PS-02 Super Hilti shown on drawing with 6½" embedment; required embedment is 8-1/8";

b. PS-03, embedment length for anchor bolt is shown on drawing as 3-1/2"; the required length is 5".

The above two were considered as drawing errors.

c. PS-05, weld length is actually 9" but 6" was used in the calculation. Strut allowable is 14,200 lbs.but calculations used allowable of 15,700 lbs. The actual load on the support is 7,974 lbs. Bolt locations used were incorrect.

d. PS-06, take out for hardware is 9"; 10" was used in calculation. Anchor bolt allowable was reduced, althought no space violation existed.

e. PS-07, moment X should be 52,824 lbs.; in the calculation moment X used was 28,858 lbs.

f. PS-09, seismic movement was not considered in spring design.

g. PS-11, forces used to qualify welds were incorrect.

h. A PUS U-bolt was used instead of a PUH U-bolt, but it was the PUH allowable which was used in the calculation.

The reviewer rechecked against the PUS allowable. The load on the bolt was 3915 lbs. and the allowable (per the reviewer) is 3,620 X 1.3 = 4706 lbs. (In reference to the stiffness importance, if the load on this support increases by less than 25%, the allowable for the U-bolt is exceeded. By Ed.)

i. PS-10, the pipe displacement supplied to support design was shown to be -.395 inches, whereas it should have been +.395 inches.

j. PS-25, stiffener ignored in base plate calculation (reviewer states that this is O.K. because it is conservative).

This caveat by the reviewer may or may not be true, but in any event, the reviewer obviously did not check the problem correctly. That is, the stiffener may be inadequate; it has not been qualified. Base plate analyzed by FUB II base plate calculator program with load centered on plate but actually the load is eccentric by one inch..

k. PS-30, SA193-B7 rods were used to replace normal Hilti bolts (bolt material made of SA4140 steel similar to the situation with A307 bolts made of SA36 steel).

Also, four calculations stated that "loads used were from a previous run which were higher than the new as-built loads." From this, one cannot tell if the calculation was checked to the loads used or written off because the new loads are lower.

In any event, checking the above citations, it does not take much of a brain to note that of the 31 drawings involved, at least two drawings had errors. This was about 7% of the drawings. Of the 31 calculations, at least

1 8 had one error (one had three errors). This is about 25% of the package.
2 Six of these errors, or about 20% of the package, were non-conservative errors.
3 If one out of 5 calculations contains a non-conservative error, the remainder
4 of the plant is in doubt. Beyond this, we might recall that the actual stiff-
5 ness and seismic acceleration of support steel was neglected. From the preceding,
6 therefore, I am hard put to understand the first quotation "well done."
7 In reference to the walk-down as-built assessment check list, the information
8 to be gleaned from the limited documentation is equally interesting.
9 To start with, at Section 4.0, page 4-19, first item (in reference to
10 the walkdown effort) states that four snubbers have been inverted 180° but
11 does not state whether an investigation had been made to determine if boots
12 were required (for the condition before or after). Also, there is no state-
13 ment which indicates if the mechanism has been converted into proximity
14 with a hot line or the other way around. All that is mentioned is that
15 CP-CPM 9.17 dated 5/31/83 permits this inversion without including the
16 document. Of more interest is the numbers game introduced in this section
17 and to determine the numbers of actual supports which were reviewed per
18 the CYGNA criteria "verify the as-built condition of the supports." We
19 must first eliminate those supports which were not verified other than visually
20 (which means that someone saw the support) or ground projection (which means
21 much the same as visual observation from a substantial distance). These sup-
22 ports were obviously out of range of a 12, 14, or 16 foot ladder or even
23 an extension ladder; therefore, visual observation has no meaning. Further,
24 I note that a transit has not been mentioned, although it would have proved
25 rather useful. The fact that some dimensions were taken on seven supports

1 also means that some dimensions were not taken. Therefore, of the 91 supports
2 that made up the review, only 48 were actually reviewed. Of this number,
3 4 contained drawing errors; they were WD-01 on page 9 of 11, branch dimension
4 is wrong; WD-02, page 4 of 10, drawing incorrectly shows square tube, filler
5 material shows a round tube, also this drawing has an incorrect centerline
6 dimension; WD-02, page 8 of 10, drawing shows wrong pipe centerline elevation;
7 WD-03, page 9 of 12, sway strut length is incorrect. From this we find that
8 about 1/12, or about 8%, of the drawings have errors. In summation, of the
9 31 calculations and 48 reviewed supports (79 total supports), 12 have drawing
10 errors and 8 have calculation errors. In addition, two others have post-
11 construction errors (1) clearance between two different supports and (1)
12 no clearance in the unrestrained direction. Thus, for 79 supports, there
13 are 22 discrepancies, or 25% of the supports have an error. And this is
14 for a system which was to showcase the iterative process and has been sub-
15 jected to more checks than Chase Manhattan Bank. If I were reviewing any
16 system and found that 25% of it contained errors, I would have to say that
17 if this system were even remotely indicative of the remainder of the plant,
18 then the plant is in trouble. There is no way that I could write off the
19 rest of the plant as being safe based on the findings as they exist in the
20 CYGNA Report. The fact that CYGNA could justify some of the errors on the
21 basis that the stress ratio was low enough to absorb the error is without
22 merit except on a case-by-case basis. Since it is probable that on another
23 support the stress ratio may be too close to the allowable limit to absorb
24 any increase in stress, whether such stress results from an error or an
25 increase in load due to use of the actual stiffness factor which is less

1 than the generic stiffness.

2 The following should point out the minor nature of problems which can
3 result in major failures:

4 1. The steam generator failure at Beaver Valley nuclear power station
5 resulted from a failure of the supports which were non-conservatively
6 designed for the original smaller generator.

7 2. The failure of a 3/4" air valve resulted in the chain of events
8 that we now call the accident at TMI.

9 3. The failure of a zirconium deflector resulted in the accident
10 at Fermi 1.

11 4. Browns Ferry suffered major damage and was fast approaching catastrophic
12 proportions as the result of a workman's candle igniting flammable
13 materials.

14 We have enough problems with the unforeseen without evading the fore-
15 seeable. It is not in the interest of public safety to await the onslaught
16 of a seismic event to highlight the errors in engineering, nor is the fact
17 that seismic loading is incorporated into the analysis enough to assume
18 that it will act as a safety factor for errors during the period of non-
19 seismic activity, as this would then reduce the probability of accident
20 to the cycle of seismic activity. Consider: with the existence of non-
21 conservative error in at least 20% of the sample reviewed, the probability
22 of the same percentage of non-conservative error in the 40,000 supports
23 for CPSES means that 7,742 random supports are at risk. And no one can
24 state offhand which of these can be dismissed as being capable of absorbing
25 an unknown error.

1 A final point to be made is in reference to the actual stiffness factors
2 of the supports. The generic stiffness study shows that in the particular
3 case studied, the loads increased by up to 200%. Compare this with the comment
4 at 2. of check list PS-10, Appendix H:

5 "Bolts noted as unacceptable on the calculations. The designer waited
for as-built loads for a final determination of acceptability as part
6 of the as-built program. The final load did decrease to acceptable
levels."
7

8 If changes in loads will qualify these supports which fail to meet the
9 stress criteria, changes can also act to disqualify a previously qualified
10 support.

11 Q: Do you believe you found all of the items which concern you in
12 regards to the CYGNA review?

13 A: No, I do not, because my critique is based on the contents of the
14 commentary supplied by CYGNA, and this is only in areas where they had made
15 an observation. If we had access to the items which did not trigger an
16 observation, it is possible that the number of conflicts would have been
17 higher. To carry this thought one step further, one has only to examine
18 the types of supports reviewed versus the requirements of ASME Section III
19 to determine if there is a doubt that all factors were covered by the CYGNA
20 review.

21 Subsection NF 4000 contains several interesting items which were
22 generically neglected at CPSES. For example, the Applicant and Region IV
23 went to great lengths to prove that their support base plate joints are
24 all of the bearing type (no friction joints). In this case, there are two
25 areas which I noted when I worked at CPSES which I did not find mentioned

1 in the CYGNA review, either as a criteria to be checked or mentioned in their
2 observations. These items are: The requirement to exclude bolt threads
3 from the load bearing shank of bolts loaded in shear (generically violated
4 in the NPSI Richmond/tube support configurations, in which case the full
5 length of the A307 bolt is threaded). This violation is covered by NF 4722(b).
6 A second area involves the fact that locking devices for all threaded fasteners
7 must be provided, and this is covered by NF 4725. From my observations of
8 the base plates at CPSES, I find it hard to believe that CYGNA found no
9 violations of the type mentioned above during their walk-down.
10 Q: What causes you to be so certain that the CYGNA report is not
11 independent beyond the criticism you have with their observations and the
12 manner in which they closed out the problems?
13 A: Independence is not achieved when one must proceed from a posture
14 of self-defense, nor is independence achieved by having such an open mind
15 that your brains have fallen out. This obviously is the position that CYGNA
16 or any other organization or individual who depends on the nuclear industry
17 finds itself in an effort to ensure the acquisition of future contracts
18 or employment (such contracts as CYGNA now enjoys at the Seabrook nuclear
19 facility supplying support engineers on a contract basis). As the Board
20 is well aware, due to the number of affidavits filed charging retaliation
21 for making waves in the industry, it is obvious that one must exercise caution
22 in the critique of a member of the nuclear family. As is well known, it
23 is the bottom line which counts.
24 Q: Do you have anything further to say?
25 A: No, not at this particular time.