910

C A S E

(CITIZENS ASSN. FOR SOUND ENERGY)

1426 S. Polk
Dallas, Texas 75224

214/946-9446

84 SEP 17 P3:15

September 12, 1984

Administrative Judge Peter B. Bloch
U. S. Nuclear Regulatory Commission
4350 East/West Highway, 4th Floor
Bethesda, Maryland 20014

Dr. Walter H. Jordan
881 W. Outer Drive
Oak Ridge, Tennessee 37830

Dr. Kenneth A. McCollom, Dean
Division of Engineering, Architecture
and Technology
Oklahoma State University
Stillwater, Oklahoma 74074

Gentlemen:

SUBJECT: 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 O L

Affidavit of CASE Witness Mark Walsh,
and Attachment D to CASE's Answer to
Applicants' Motion for Summary Disposition
Relating to Richmond Inserts

We are attaching a copy of the signed and notarized signature page for the Affidavit of CASE Witness Mark Walsh, which constitutes and was attached to CASE's Answer to subject Motion. Also attached are revised pages 38, 43, 44, 46, 50, 51, and 52, on which Mr. Walsh has made changes; please replace the original pages with these revised pages.

Also attached is CASE's Attachment D to subject Answer (as discussed in our 9/10/84 letter to the Board).

In addition, attached is a corrected and revised Certificate of Service for our 9/10/84 letter to the Board and Answer to subject Motion. (We were misdirected to the Federal Express office near the copy place where we had copies made, so we hand-delivered copies of our Answer to the hotels of Messrs. Reynolds and Mizuno at about 11:30 P.M. on 9/10/84. Since it was too late to get the remaining copies postmarked on the 10th, they actually went out on the 11th. I called Dr. McCollom's secretary to inquire if we needed to try to get his copy to him via same-day delivery on the 11th, and she checked with him and advised that he was about to go out of town and did not intend to take our Answer with him and that we should send it first class, which we did.)

Respectfully submitted,

Juanita Ellis

(Mrs.) Juanita Ellis, CASE President

cc: Service List

Attachments

DS03

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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

CERTIFICATE OF SERVICE

By my signature below, I hereby certify that true and correct copies of CASE's 9/12/84 letter to ASLB; copy of signed and notarized signature page for Affidavit of CASE Witness Mark Walsh attached to CASE's Answer to Applicants' Motion for Summary Disposition on Richmond inserts, revised pages 38, 43, 44, 46, 50, 51, and 52, and CASE's Attachment D to that Answer have been sent to the names listed below this 12th day of September, 1984, by: Express Mail where indicated by * and First Class Mail elsewhere.

Administrative Judge Peter B. Bloch
U. S. Nuclear Regulatory Commission
4350 East/West Highway, 4th Floor
Bethesda, Maryland 20814

Ms. Ellen Ginsberg, Law Clerk
U. S. Nuclear Regulatory Commission
4350 East/West Highway, 4th Floor
Bethesda, Maryland 20814

* Dr. Kenneth A. McCollom, Dean
Division of Engineering,
Architecture and Technology
Oklahoma State University
Stillwater, Oklahoma 74074

Dr. Walter H. Jordan
881 W. Outer Drive
Oak Ridge, Tennessee 37830

Mr. Wm. A. Horin
* ~~Nicholas S. Reynolds~~, Esq.
Bishop, Liberman, Cook, Purcell
& Reynolds
1200 - 17th St., N. W.
Washington, D.C. 20036

* Geary S. Mizuno, Esq. (to Hotel in Ft. Worth)
Office of Executive Legal
Director
U. S. Nuclear Regulatory
Commission
Maryland National Bank Bldg.
- Room 10105
7735 Old Georgetown Road
Bethesda, Maryland 20814

Chairman, Atomic Safety and Licensing
Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

* Nicholas S. Reynolds, Esq.
c/o hotel in Fort Worth

Chairman
Atomic Safety and Licensing Appeal
Board Panel
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

John Collins
Regional Administrator, Region IV
U. S. Nuclear Regulatory Commission
611 Ryan Plaza Dr., Suite 1000
Arlington, Texas 76011

Lanny A. Sinkin
114 W. 7th, Suite 220
Austin, Texas 78701

Dr. David H. Boltz
2012 S. Polk
Dallas, Texas 75224

Michael D. Spence, President
Texas Utilities Generating Company
Skyway Tower
400 North Olive St., L.B. 81
Dallas, Texas 75201

Docketing and Service Section
(3 copies)
Office of the Secretary
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Renea Hicks, Esq.
Assistant Attorney General
Environmental Protection Division
Supreme Court Building
Austin, Texas 78711

Juanita Ellis

(Mrs.) Juanita Ellis, President
CASE (Citizens Association for Sound Energy)
1426 S. Polk
Dallas, Texas 75224
214/946-9446

Applicants admit above that, according to their own STARDYNE finite element analysis, the "~~forumlas~~ formulas used by Applicants to calculate axial torsion resulted in a calculated force that was low for all but six supports by as much as 18 percent (in six specific supports it was low by 33%)" (emphasis in the original). When one combines this fact with the fact that Applicants were also using assumptions for the amount of rebar and the strength of concrete which were fatally flawed, Applicants' statement that "because of conservatism in the methodology and process used, in all cases allowables would not have been exceeded" is unsupported, undocumented, and without technical merit. Applicants' "conservatism" is in fact unconservative, and misleading as shown in answer ~~19~~ 18 following. (See Footnote 2, page 14, herein.)

The Applicants utilize an unusual design configuration, as has been stated before in the record, and none of the Applicants' witnesses or CASE's witnesses had seen this type of support configuration (see CASE's Proposed Findings, pages VII - 1 through -3). The Applicants have not shown proof why they decided to use this unique design generically throughout the plant. The Applicants have attempted to utilize a finite element analysis to demonstrate that their position was correct. The results of the finite element analysis are summarized on pages 22 and 23 of Applicants' Affidavit. The results of the analysis were provided with only a summary and a math model, but no calculations or assumptions utilized in those calculations were provided.

will be shown later in answer 18, the combined effect of the Richmond insert/A307 bolt/tube steel connection ~~exceeds~~ reduces the factor of safety to less than the Applicants' prophesied factor of safety as well as exceeding the assumed deflection criteria of the supported connection by an amount equal to infinity. The consequences of the results due to the tests were not discussed within this portion of Applicants' Affidavit, but I shall discuss them later.

On page 23 of their Affidavit, Applicants allege that "As discussed below, this will result in no adverse effect on the safety of the plant." (Emphasis in the original.) However, it should be noted, first of all, that Applicants do not state that they included all supports in Table 1. They use two caviats when they use the terms "may be primarily loaded". This would appear to mean that they are not sure that they considered all supports and that they did not discuss those supports which were loaded previously with 49% in shear or torsion. In addition, the Applicants state that instances where item f) above exists are few, but they admit that 18 out of 102 supports exhibited the extreme case, which is 18%. The Applicants did not state what percentage of the supports were in between the extreme case of item f) above and the cases where the bolt was on the centerline of the tube. I asked for (on discovery) the calculations and drawings for 20 supports out of the alleged 182 supports which were the basis of Applicants' analysis regarding A500 Steel; these 20 supports were to meet the following criteria: large bore; large loads (both in magnitude and % of allowable); with Richmond inserts where there are two or more spans; and members that are in bending. It should be

noted that none of those supports were included in Applicants' Table 1. (see CASE Attachments L, N, O, P, Q)

Included in those 20 supports were 5 supports which had Richmond Inserts where Richmonds were called out on the drawing (some had Richmonds which were attached to other supports, but I did not include those). On those 5 supports there were 23 Richmond inserts. On drawing AF-1-001-035-Y33R (CASE Attachment L hereto) there are 3 Richmonds shown but the location with respect to the centerline of the tube is not indicated. In regards to the remaining 20 Richmonds, 14 of the Richmonds -- or 70% -- were located off the centerline of the tube. This calls into question Applicants' statement on page 23 of their Affidavit where they state that "the preponderant number of supports (90%) have tube steel connected to Richmond inserts at the centerline of the tube steel (zero offset) or with small eccentricities". It is not reasonable to believe that the the small random sample which I looked at in regards to a completely different Motion for Summary Disposition would have 70% of the known Richmond inserts located off the centerline of the tube if Applicants' statement were true. Not only are the Richmonds shown to be off the centerline of the tube, on drawing CC-1-028-024-S33R, the Richmond is at an angle (as shown in Sections E-E and B-B) which was not considered by the Applicants in their Motion. Also, on this same drawing, one will note that there is no washer between the tube steel member and the face of the concrete. This condition was not considered by the Applicants in their Motion.

On page 24 of Applicants' Affidavit, they state that ". . . the maximum possible underestimation of the tension resulting in the bolt

require closer scrutiny; they claim this this screening criterion was "based on a very conservative analysis." I disagree with this representation. The Applicants are attempting to justify a criterion which allows bolt bending to exceed the interaction ratio of 1 and go as high as 1.75. The two bases for their decision are as follows:

(1) The Applicants claim the FE method predicted the stress to be 33% lower than using standard manual calculations. Although what they stated in this regard is true, it is based on an inadequate number of elements /8/. In Attachment E-3 to their Affidavit, the Applicants state that the average stress for node point 311 is based on averaging the results of elements 287, 297, 307, and 317. Figure E-3(i) contains a portion of the math model for this analysis. The averaging of these four particular elements to determine the stress at node 311 is improper. Going for the center of the bolt node 281 to node 311, there is only one node point in between; i.e., node 291. The Applicants' method of modelling a small number of large elements resulted in the lower stresses. To demonstrate that the position the Applicants took was in error, consider the following:

Figure 1 (see CASE Attachment M hereto) is of a plate 1 inch wide and 4 inches long. To determine the moment of inertia, one can use the standard equation $1/12\ bh^3$ or can use a more basic approach which is to use the definition of the moment of inertia, and that is the summation of each element's area times the distance squared from the center of gravity of each area to the axis under consideration, commonly the neutral axis (NA). For Figure 1, the

/8/ As shown in my resume, I do have knowledge in the finite element method of analysis. (See ~~footnote 2, page 14, of this pleading,~~) CASE Exhibit 841, Revision to Resume of Mark Walsh, accepted into evidence at Tr. 7278.

Deformation.) Nowhere in Applicants' tests in Attachment F or Attachments A and B do the Applicants demonstrate that the connection behaves in an elastic manner.

Therefore, Applicants have not properly evaluated the test results and have not proved by the tests that the connection will behave in an elastic condition when the load exceeds the design capacity.

19. Applicants state:

"The results of the evaluation of the conservative criterion, coupled with subsequent testing, reflected that with regard to this bending moment in the bolts, there is no safety concern with these connections. Id at 27-30."

Applicants' statement is misleading, and their reference to a "conservative criterion" is incorrect, as discussed in answer 18 preceding. On page 30 of Applicants' Affidavit, they state that this condition is not covered by the Code. However, on page 5-206 of the AISC Code (to which Applicants are committed in Specification MS-46A), the commentary to the specification for high strength bolts states, in part:

> "Because bolts in friction-type connections do not depend upon bearing against the sides of their holes, those provisions of the general design specifications intended to guard against high bearing stresses, and bending of the bolt due to bearing, are waived." (First emphasis in the original; second emphasis added.)

See also CASE's Answers to Applicants' Motions for Summary Disposition on Generic Stiffnesses and on Gaps. mc

On page 27 of Applicants' Affidavit, they use what they call the "bolt interaction equation." This is a brand new invented formula which the Applicants have dreamed up. The AISC Code, at Section 1.6.3, lists the proper interaction formula for an A307 bolt, and that equation is

$Ft = 28 - 1.6\ fv \leq 20.0$

where Ft is the maximum allowable stress and

fv is the applied shear stress produced by the same forces and not to exceed the allowable shear stress given in Section 1.5.2 of the AISC Code.

Consider the following comparison using an external applied tensile load of 10 kips, an external shear load of 5 kips and a bending moment of 4 kip-in. on a 1-1/2" diameter A307 bolt. The area of the bolt for tension of 1.4053 in.; the area of the bolt for shear is 1.7621 in., and the section modulus for bending is .098175 d = .098175 (1.338)3 = .235 $in.^3$.

Utilizing the AISC equation (and not considering the requirements listed in answer 7 preceding), the shear stress is 5/1.7621 = 2.837 ksi < Fv of 1.5.2 which leads to Ft = 28 - 1.6 (2.837) = 23 ksi > 20 ksi; therefore, the allowable tensile strength is 20 ksi. The tension stress applied to the bolt is due to the tensile load and is 10/1.4053 = 7.116 ksi. The tension stress due to the applied moment is 3/.235 = 17.02 ksi. The total tension stress in the bolt is 7.116 + 17.02 = 24.136 ksi. The interaction ratio is 24.136/20 = 1.21. This interaction ratio exceeds 1; therefore, the bolt is overstressed.

Now we shall look at the Appliants' method (which is not mentioned in any Code): The applied shear over allowable shear is 5/17.67 = .283. Applied tensile load over allowable tension load is 10/28 = .357. The allowable bending moment, according to the Applicants, is (.75)(36)(.235) = 6.345. The applied moment over the allowable moment

is 4/6.345 = .630. Using the Applicants' invented "bolt interaction equation," the interaction ratio is $.283^2 + .357^2 + .63 = .080 + .127 + .63 = .84$. This value of .84 would be an acceptable value for the Applicants, because they believe (as discussed before) that the interaction ratio should be less than 1.75 instead of less than 1.

This simple example demonstrates that when the Applicants are utilizing an invented equation, they have concluded that there is no safety concern.

The ratio of the Applicants' equation to the AISC equation can be an approximation (based on the above example) of the values for the bolt interations that are in error. The ratio is .84/1.21 = .69. This value of .69 corresponds to the Applicants' bolt interaction value of 1. Of the 155 supports listed in Table 1 attached to Applicants' Affidavit, 51 supports have a bolt interaction value greater than .69. This represents 33% which have exceeded AISC Code allowables, based on this one simple example. It should be remembered that the values used were only for 70 degrees F. and did not include the recommended values from ASME as discussed in answer 7 preceding.

Although the interaction equation is as unique as Applicants' support configurations under consideration, some additional comments can be made. It would appear that prior to the introduction of the bending moment of the bolt, the Applicants used the following equation:

$$(T/TA)^2 + (S/SA)^2 = 1$$

This equation is the equation for a circle, where the radius of the circle is 1, and 1 squared is 1. As long as the bolt interaction formula had no additional components, it was similar to the combined

The preceding CASE's Answer to Applicants' Statement of Material Facts As To Which There Is No Genuine Issue was prepared under the personal direction of the undersigned, CASE Witness Mark Walsh. I can be contacted through CASE President, Mrs. Juanita Ellis, 1426 S. Polk, Dallas, Texas 75224, 214/946-9446.

My qualifications and background are already a part of the record in these proceedings. (See CASE Exhibit 841, Revision to Resume of Mark Walsh, accepted into evidence at Tr. 7278; see also Board's 12/28/83 Memorandum and Order (Quality Assurance for Design), pages 14-16.)

I have read the statements therein, and they are true and correct to the best of my knowledge and belief. I do not consider that Applicants have, in their Motion for Summary Disposition, adequately responded to the issues raised by CASE Witness Jack Doyle and me; however, I have attempted to comply with the Licensing Board's directive to answer only the specific statements made by Applicants.

/ Mark Walsh
(Signed) Mark Walsh

STATE OF TEXAS

On this, the 11 day of Sept, 1984, personally appeared Mark Walsh, known to me to be the person whose name is subscribed to the foregoing instrument, and acknowledged to me that he executed the same for the purposes therein expressed.

Subscribed and sworn before me on the 11 day of Sept, 1984.

Samuel W. Nestor
Notary Public in and for the
State of Texas

My Commission Expires: _____

SAMUEL W. NESTOR
My Commission Expires
1-31-85

CASE ATTACHMENT D

SUMMARY OF SELECTED DOCUMENTS REGARDING CONCRETE POURS AT COMANCHE PEAK

This is a brief summary of selected documents regarding concrete pours at Comanche Peak, as discussed in answer 8 of CASE's Answer to Applicants' Statement of Material Facts Relating To Richmond Inserts As To Which There Are No Material Issues. Some are attached to this pleading; others have already been admitted into evidence in accordance with the Board's 12/7/82 Order (Proposed Findings of Fact; CASE Exhibits), and were admitted into evidence in the May 1983 hearings -- these are marked with an *.

The following documents are summarized:

DDR No. C-219, 2/16/76 (copy attached)
DDR No. C-219, Rev. 1, 7/26/76 (copy attached)

DDR No. C-246, 3/23/76 (copy attached)

DDR No. C-239, 3/25/76 (copy attached)

DDR No. C-220, 2/17/76 (copy attached)

DDR No. C-449, 12/15/76 (CASE Exhibit 325, *in evidence)

DDR No. C-457, 12/28/76 (CASE Exhibit 328, *in evidence)

DDR No. C-499, 2/14/77 (CASE Exhibit 353, *in evidence)

DDR No. C-529, 3/11/77 (CASE Exhibit 365, *in evidence)

NCR C642,R1 and C642,R2, 5/24/77 (CASE Exhibits 529 and 530, * in evidence)

CAR (Corrective Action Request) S-8, 6/9/77 (CASE Exhibit 625, *in evidence)

For additional information, see:

NCR G589, 4/12/77 (CASE Exhibit 561, *in evidence); and CAR S-6, 5/24/77 (CASE Exhibit 624, *in evidence) -- regarding problems with the water meters used to measure amount of water which went into the concrete pours;

CASE's 10/18/82 Response to Board's Directive Regarding CASE Exhibits, page 25 (middle) through page 29, re: other concrete problems

DDR No. C-219, 2/16/76 (copy attached): (See also DDR C-239 following.)

"Deficiency: Field cure cylinders for concrete pour #201-5781-001 (Reactor #2 cavity wall) of 2/13/76 were found to be in curing box on 2/16/76. These cylinders should have been on the pour and being cured in the same manner. Also, field cure cylinders for SWI base mat pour (#035-2755-001) were not on the mat and being cured in the same manner. They were on the side of a road near the mat. This pour was made 2/11/76 and cylinders found misplaced 2/16/76." (Page 1, emphasis added.)

(See C-219, Rev. 1, following.)

DDR No. C-219, Rev. 1, 7/26/76 (copy attached): (See also DDR C-239 following)

(See C-219 preceding.)

BRV-1031, Brown & Root letter dated 11/3/75 from Peter L. Bussolini, Project Quality Assurance Manager, B&R, to A. J. Bray, R. W. Hunt Co. (the company which was, at that time, in charge of the concrete at Comanche Peak), stated, in part (page 4 of 13 of DDR C-219R1). It appears that this was the procedure which was supposed to be in effect at the time the DDR was written:

> "Please institute the following outlined procedures for the handling of field cured specimens at the Comanche Peak Site.
>
> "(1) Specimens are to be molded in accordance with the applicable procedures outlined in ASTM C-31-69.
>
> "(2) Initial curing procedures outlined in ASTM C-31-69, para. 7.2 shall be instituted for 24 hours after molding.
>
> "(3) At 24 hours after molding, strip the specimens and remove to the pour location represented. Field cure cylinders in the same manner and for the same period of time as the concrete represented. (7 days for regular mixes and 14 days for mass concrete mixes).
>
> "(4) At the end of this field curing period, place specimens in the wire-mesh enclosure in the auxiliary bldg. area until time of testing at 28 days. Test specimens in the moisture condition resulting from the above procedures."

DDR No. C-219, Rev. 1, 7/26/76 (continued):

It appears that following the writing of the DDR, Curing Report Form and Checklists were prepared on 2/25/76 and 3/1/76 for Concrete Pours 035-2755-001 and 201-5781-001, respectively (pages 5 through 11 of 13 of DDR C-219R1).

GHF-651, Gibbs & Hill Memo dated 5/28/76 from J. J. Moorhead, Resident Engineer, G&H - Jobsite, to C. H. Gatchell, TUSI - Jobsite, stated, in part (page 3 of 13):

> "We are in receipt of DDR C-219 which was forward to us for consideration.
>
> "The attached DDR was issued due to a deficiency discovered in the handling of field cured cylinders as outlined in BRV-1031.
>
> "The mishandling of field cured cylinders is unfortunate, however, once this has occurred an irretrievable situation exists. Due to this deficiency addressing the noncompliance with guidelines established by B&R Quality Assurance, no further review by the engineer is required." (Emphasis added.)

GHF-812, Gibbs & Hill Memo dated 8/4/76 from J. J. Moorhead, Resident Engineer, G&H, Jobsite, to C. H. Gatchell, TUSI, Jobsite, stated (page 2 of 13):

> "We have reviewed the curing records for the concrete represented by the subject DDR and have found them satisfactory. Past monitoring indicates adherence to the specification in regard to curing practices assure desired strengths.
>
> "The Engineer's position stated in GHF-651 remains unchanged, however, verification of proper curing is sufficient for evaluation of curing where an irretrievable situation exists. No further action is required." (page 2 of 13, emphases added.)

Two series of concrete rebound test hammer tests were made of concrete pour 035-2755-001 dated 7/22/76 (pages 12 and 13 of 13). They indicated a compressive strength-psi of 5,200 and 6,000. Although there was no statement as to the age of the concrete at the time of the tests, the date of the pour was 2/11/76 (page 1 of 13) and the concrete rebound test hammer tests were dated 7/22/76.

DDR No. C-219, Rev. 1, 7/26/76 (continued):

"Corrective Action: All field cure cylinders involved in the deficiency were placed on their respective pours on 2/17/76. However, since their representation of the cure of the placements had been impaired, the curing reports rather than the field cure cylinder strengths must be used to judge the adequacy of curing. Copies of these reports are attached. Attached also are copies of impact hammer tests performed on each of the affected concrete placements." (Page 1 of 13.)

(Emphasis added because there were no copies attached of impact hammer tests, and no indication that any were ever done, for concrete pour #201-5781-001 for the Reactor #2 cavity wall. It appears that concrete pour #201-5781-001 for the Reactor #2 Cavity Wall was never retested. See also DDR C-246 following.)

"Disposition: Use As Is. . . " (Page 1, emphasis added.)

DDR No. C-246, 3/23/76 (copy attached): (See also DDR C-219 preceding.)

"Deficiency: Field cured cylinder No. 6957 on R. W. Hunt Co. Report HCP 8744 failed to meet specification requirement of 85% of laboratory cured cylinders or at least 500 psi above design strength. This concerns Pour No. 201-5781-001 (Containment #2 cavity wall). . ."

(Emphasis added. This is one of the same concrete pours (the one which apparently was never retested) for which DDR C-219 was originally written up).

The following strength which is below 4000 psi-lbs. for field-tested concrete was shown as the result of Concrete Compression Tests, ASTM C-39 (Hunt E1001) dated 3/12/76:

Pour No.	Cylinder No.	psi-lbs.	page no.
201-5781-001	6957	3559	2 of 2

"Disposition: Other. This DDR has been cancelled since the field cured cylinders which are the subject of this DDR were not, in fact, representative of the cure of the concrete placed. (Reference DDR C-219, Rev. 1, closed 8-12-76)."

It appears that concrete pour 201-5781-001 for the Containment #2 cavity wall was still never retested and that it was used-as-is.

DDR No. C-239, 3/15/76 (copy attached): (See also DDR C-219 preceding.)

"Deficiency: 5 field cured cylinders of 14 tested for Pour No. 035-2755-001, dated 2-11-76, service water intake structure base mat, failed to meet specification requirement of 85% of laboratory cured cylinders or at least 500 psi above design stength. This involved Mix I.D. 204 only. . ."
(This is the same other pour for which DDR C-219 was written up.)

The following strengths which are below 4000 psi-lbs. were shown as the result of Concrete Compression Tests, ASTM C-39 (Hunt E!001):

Pour No.	Cylinder No.	psi-lbs.	page no.
035-2755-001	6264	3809	2 of 6
035-2755-001	6820	3904	5 of 6
035-2755-001	6834	3774	6 of 6

"Disposition: Other. This DDR has been cancelled since the field cured cylinders which are the subject of this DDR were not, in fact, representative of the cure of the concrete placed. (Reference DDR C-219, Rev. 1, closed 8-12-76)." (Emphasis added.)

DDR No. C-220, 2/17/76 (copy attached): (See also DDR C-219 preceding.)

"Deficiency: Field cured cylinders for auxiliary bldg. east wall and elevator shaft, Pour Nos. 002-5778-001 and 002-5778-004, placed 1-15-76, failed to be 85% of standard cured specimens or plus 500 psi over design strength. . . " (Page 1 of 19.)

Attached to the Deficiency and Disposition Report (DDR) were two Curing Report Form & Checklists dated 1/30/76, one each for concrete pour 002-5778-004 and 002-5778-001 (pages 14 and 15 of 19).

The temperature log which was attached (page 16 of 19) includes the following low temperatures which were freezing or below (in January):

31, 23, 21, 22, 32, 16, 10, 18, 30, 30, 30, 29, 32.

The following strengths which are below 4000 psi-lbs. for field-tested concrete were shown as the result of Concrete Compression Tests, ASTM C-39 (Hunt E1001) dated 2/12/76:

Pour No.	Cylinder No.	psi-lbs.	page no.
002-5778-001	5333	3695	9 of 19
	5334	3733	
002-5778-001	5348	3583	10 of 19
002-5778-001	5361	2987	11 of 19
002-5778-004	5355	3439	12 of 19

There are several memoranda and a letter to R. W. Hunt Co. on 2/18/76 and 2/19/76 to various people, emphasizing that all field cured cylinders are to be treated and cured with the same attention and protection that is given to in-place concrete, with statements such as: "This is a G&H specification requirement which is imposed in order to verify that proper curing is being done. Proper curing and protection, as is done to the in-place parent concrete, of the field cured cylinders will result in good strength results." (Pages 13, 17, 18, and 19 of 19.)

DDR No. C-220, 2/17/76 (continued):

On 2/26/76, in a Brown & Root Message from Jim Stancoff, B&R QA, to C. H. Gatchell, the request was made to "Please have G&H. Engr. review the attached copy of DDR C-220 and note their concurrence with the 'Use-As-Is" disposition on the reply portion of this memo. . ." (Page 4 of 19.)

GTT-158, telegram dated 5/5/76 to R. W. Caudle from R. E. Hersperger/E. J. Zigmond, Gibbs & Hill, N.Y., requested a change in the design engineer's comments to read: "Test data to confirm that represented concrete in the Auxiliary Building was not also subjected to adverse effects of freezing as needed. Swiss hammmer tests would fulfill this requirement." (Page 5 of 19, emphasis added.)

A TUSI Office Memorandum dated 5/7/76 from Robert W. Caudle to C. H. Gatchell stated (page 6 of 19):

> "Attached is an executed copy of Deviation Request, DRT-84, with status of Not Approved. Design Engineer's comments have been revised per telex GTT-158. Brown & Root should be directed to perform Swiss Hammer test to confirm that concrete in the Auxiliary Building as represented by the frozen field cured cylinders was not also subjected to freezing." (Emphasis added.)
>
> The Deviation Request, DRT-84 (with status of Not Approved), referenced in the preceding was not included with the DDR. "Aux bldg cast wall & elev. shaft 002-5778-001 002-5778-004" was hand-written on the copy of page 6 of 19 which CASE received.

Two series of concrete rebound test hammer tests of Concrete Pour No. 002-5778-004 (for auxiliary bldg. (electrical control) elevator shaft) dated 7/22/76 (pages 7 and 8 of 19) indicated compressive strength-psi of 6800 for the south wall and 7000 for the west wall. There is no statement on the forms as to the age of the concrete at the time of testing, but the concrete was placed on 1/15/76 (page 1 of 19) and the tests were on 7/22/76.

There is no indication that concrete pour 002-5778-001 for the auxiliary bldg. (electrical control) east wall was ever retested.

There was a Design Change/Design Deviation Request dated 7/23/76, prepared by D. A. Fellinger, Civil Engineer, and approved by the TUSI

DDR No. C-220, 2/17/76 (continued):

Resident Manager, to "Request Engineering Concurrence with the 'Use As Is' disposition of DDR No. C-220. Justification: See Corrective Action Disposition of Subject DDR. Results of Swiss Hammer Tests are Also Enclosed." This appears to have been approved by the Struc. Engr. on 8/3/76, the Independent Design Reviewer on 8/4/76, the Proj. Mgr. on 8/4/76, the Responsible Engineer on 8/6/76, the Project Engineer on 8/6/76, and by the Project Manager on 8/6/84. (Page 3 of 19.)

The original statement of "Corrective Action" was lined out on 8/19/76; it had stated:

> "The deficient test results on the field cured cylinders are attributable to freezing temperatures as shown by the attached daily temperature log, and improper curing and/or handling of these test cylinders. The laboratory cured test cylinders gave satisfactory test results and the attached two QC Curing Reports document that satisfactory curing was performed on the in place concrete." (Emphasis added.)

As an Attachment to DDR C-220 (page 2 of 19), the following was stated:

"Corrective Action

"The attached QC curing reports and concrete test hammer test reports document that satisfactory curing was achieved on the in-place concrete." (Emphasis in the original.)

"Disposition: Use As Is."

DDR No. C-449, 12/15/76, CASE Exhibit 325, *admitted into evidence:

"Deficiency: The attached compressive strength test reports representing concrete placements listed below indicate field cured cylinder compressive strengths that do not comply with the requirements of the cited document:" (Page 1 of 50.) (NOTE: Items marked with a check mark ✓ were retested using the rebound concrete hammer test; none of the other concrete pours were retested according to the documents attached to this DDR.)

"105-1806-001	002-4778-004 ✓
"111-1797-004	002-4790-004
"111-1794-008	002-4790-005
"111-1794-009	002-2790-005
"111-1797-007	201-2805-004
"002-5778-006 ✓	002-6778-011 ✓
"002-5778-007 ✓	105-4773-002 ✓
"105-4773-012	105-4773-013
"105-4773-029	105-4773-037
"111-1797-005	002-5778-014"✓ (This one tested at 4000 or more psi-lbs. initially.)

The following Field Cured (Job) strengths which are below 4000 psi-lbs. were shown as the result of Concrete Compression Tests, ASTM C-39 (Hunt E1001).

(NOTE: Pour numbers marked with a check mark ✓ were retested later using the concrete rebound hammer test; no other concrete pours were retested, according to the documents attached to this DDR.)

Pour No.	Cylinder No.	psi-lbs.	page no.
105-1806-001	14456	2802	5 of 50
	14457	2778	
	**14452	**3522	
	**14453	**3413	
002-4790-004	A2480	3949	6 of 50
002-5778-00. ✓	A-2752	3719	7 of 50

(continued on next page)

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

DDR No. C-449, 12/15/76 (continued):

Pour No. (continued)		Cylinder No.	psi-lbs.	page no.
111-1794-008	111-1797-004	A4061	2662	8 of 50
		A4062	2653	
		**A4057	**3739	
		**A4058	**3911	
111-1794-008	111-1797-004	A4103	2646	9 of 50
		**A4099	**3873	
201-2805-004		A4307	2975	11 of 50
002-5778-006 ✓		A4724	3272	16 of 50
111-1794-009		A4948	3440	17 of 50
		A4949	3468	
002-4778-004 ✓		A4964	3681	18 of 50
		A4965	3754	
111-1797-005		A4996	3782	21 of 50
		A4997	3877	
111-1797-007		A5233	2451	23 of 50
		A5234	2808	
		**A5229	**3862	
		**A5230	**3854	
✓ 105-4773-002-012 -013-029 -037		A5350	3618	24 of 50
		A5351	3845	
002-6778-011 ✓		A5405	3935	25 of 50
		A5406	3953	

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

DDR No. C-449, 12/15/76 (continued):

The following referenced Gibbs & Hill document was attached to both DDR C-449 and DDR C-457:

GTN-15645, 2/7/77 letter from R. E. Hersperger, Project Manager, Gibbs & Hill, New York, to H. C. Schmidt, Project Manager - Nuclear Plants, TUGCO, Dallas (pages 27 and 28 of 50) which stated, in part (referencing DDR-C 449 and DDR-C 457):

"The above reference documents address a series of compression test results in which field cured concrete cylinder strengths were less than that required by the specification and applicable ACI codes. Depending on the actual test strengths of laboratory cured cylinders, the comparion field cured cylinders are required to exhibit test strengths of at least 85 percent of the strength of the laboratory cured cylinders or 500 pounds per square inch greater than the minimum 28 day design compressive strength, f'_c.

"The actual field cured cylinder test failures addressed by the above DDR's can be divided into two categories. Category 1 cylinders are those whose strengths are less than 85 percent of laboratory cured cylinder strengths or less than 500 pounds per square inch greater than f'_c. Category 2 cylinders are those whose strengths are less than f'_c.

"For the concrete represented by Category 1 cylinder failures the concrete specification and ACI Codes require that the contractor implement improvements in his curing program for concrete placed in the structures. In addition, since there is some question concerning the degree to which the cylinders are representative of the respective concrete placements, steps should be taken to upgrade the treatment of the field cured cylinders to assure that they are as representative as practical.

"For the concrete represented by the Category 2 cylinder failures there is a need to establish if these cylinders are truly representative of the actual condition of the concrete in the structures. A test program should be established to answer this question. We recommend that a program using concrete hammer tests on a comparative basis be initiated. This program would compare tests results on questionable structural concrete with results on concrete of known strength and attempt to establish the relative soundness of the concrete in question. Such a program could be developed by the contractor subject to the design engineer's approval or it could be developed by G&H. Should the results of a concrete hammer test program prove to be inconclusive selective coring could be performed to establish actual concrete strengths.
. . .

"This matter is considered urgent by the field. We request your direction as to how you wish us to proceed in resolving these construction deficiencies." (Emphases added.)

DDR No. C-449, 12/15/76 (continued):

Several series of concrete rebound hammer tests (two of each pour) were made in April, May, and July 1977 (pages 29 through 50 of 50) to retest the following 6 concrete pours: 002-5778-007, 002-5778-006, 002-4778-004, 002-5778-014, 105-4773-002, and 002-6778-011 (using as comparisons two series of tests for the following concrete pours: 002-4778-011, 002-5778-015, 002-4778-006, 002-5790-002. and 002-4790-029).

Those concrete rebound tests were made when the age of the concrete varied from 159 to 256 days. These retests indicated compressive strength-psi of between 4800 and 7000.

There were no concrete rebound hammer test results attached for the other 14 concrete pours.

As indicated in the preceding by **, there were several instances where the standard (or laboratory) tested concrete cylinders indicated compressive strengths of less than 4000 psi-lbs. (In all such instances, the field-tested concrete cylinders indicated even less than the standard-tested ones.) And, based on the documents included in this DDR, in no instance were concrete rebound hammer tests done for the concrete pours where both the original field-tested cylinders and the original standard-tested cylinders indicated compressive strengths below 4000 psi-lbs.

The following referenced Gibbs & Hill document was attached to both DDR C-449 and DDR C-457:

GHF-2178, 11/1/77 Gibbs & Hill Memo from J. J. Moorhead, G&H-Jobsite, to J. T. Merritt, TUSI-Jobsite (pages 2 and 3 of 50), referencing DDR-C-457, DDR-C-449, NCR-C-642, and NCR-C-652, stated, in part:

> "We have completed our review of the attached results, forwarded by Brown & Root QA, for the referenced non-conformance reports and have determined that the in place concrete is satisfactory and no further review is required.
>
> "The results, as forwarded, complied with the evaluation program as established by GTN-15645. The results of the standard cured cylinders, field cured cylinders and swiss hammer comparative test results were evaluated for each individual placement under consideration. All standard cured cylinders representative of all placements far exceed design criteria. The associated field cured cylinders which had results below design criteria were reviewed for concern by comparing all associated strength information including comparative test information gathered by use of the Swiss Hammer.

DDR No. C-449, 12/15/76 (continued):

> "Based on the verification of proper curing technique by Brown & Root QA in their daily check it is felt that the technique for handling field cured cylinders attributed to the strength results obtained in that all questionable results occurred during cold weather which was not conducive to continued strength gain of the small cylinders after the curing period expired. Modification of handling field cured cylinders has been implemented at the direction of the Engineer which has alleviated this source of inaccuracy and we are presently not experiencing field cured cylinder results which indicate a concern in curing technique..."
>
> (Emphases added.)

"Disposition and Corrective Action: Use As Is. See Attachment. See GHF-2178 attached. See attached Concrete Hammer Test Reports HCP 26773, 26804, 26805, 26895." (Emphasis added.)

Shown as "ATTACHMENT TO DDR C-449 and C-457" and attached to both DDR's was information regarding "Corrective and Preventative Action" and "Test Program for In-Place Concrete Evaluation." It stated, in part (page 4 of DDR C-449):

> "Corrective and Preventative Action
>
> "A meeting was held on February 17, 1977 between G&H, TUSI, B&R Construction Engineering and B&R QC concerning the corrective and preventative action for DDR Nos. 449 and 457 as outlined in GTN-15645.
>
> "The following action has been implemented for Category 1 and 2 cylinder failures
>
> "Category 1 - (Concrete placements with field cured cylinders results equal to design strength or greater) . . . "
>
> (It should be noted that CASE is not addressing Category 1 cylinder failures in this summary.)
>
> "Category 2 - (Concrete placements with field cured cylinder results less than design strength)
>
> "Test Program for In-Place Concrete Evaluation

DDR No. C-449, 12/15/76 (continued):

"Purpose of Program: To establish a procedure for testing the soundness and strength of the in-place structural concrete in question represented by field cured cylinders with compressive strength results below the minimum design strength of 4000 psi by using a concrete test hammer.

"Step 1 - B&R Construction Engineering shall pick two test locations at random on each concrete placement with strengths below 4000 psi. . . "

(Emphases added.)

DDR No. C-457, 12/28/76, CASE Exhibit 328, *admitted into evidence:

"Deficiency: The attached compressive strength test reports representing concrete placements listed below indicate field cured cylinder compressive strengths that do not comply with the requirements of the cited document:" (Page 1 of 33.) (NOTE: Items marked with a check mark ✓ were retested using the rebound concrete hammer test; none of the other concrete pours were retested according to the documents attached to this DDR.)

"002-4790-027	105-4773-030
"111-1797-006	105-4773-035
"111-1797-008	105-4773-036
"111-1797-009	105-4773-039
"111-1797-010	101-5805-001
"035-1776-001	111-1794-010
"035-5755-003 ✓	111-1802-001
"105-4773-011	035-2782-001" ✓

The following Field Cured (Job) strengths which are below 4000 psi-lbs. were shown as the result of Concrete Compression Tests, ASTM C-39 (Hunt E1001) made in November and December of 1976; see pages 5 through 25 of 33.

(NOTE: Pour numbers marked with a check mark ✓ were retested later using the concrete rebound hammer test; no other concrete pours were retested, according to the documents attached to this DDR.)

Pour No.	Cylinder No.	psi-lbs.	page no.
035-1776-001	A5062	2716	8 of 33
	**A5058	**3465	
	**A5059	**3512	
111-1797-006	A5099	2561	9 of 33
	A5100	2585	
	**A5095	**3360	
	**A5096	**3457	
111-1797-006	A5109	2603	10 of 33
	**A5105	**3671	
	**A5106	**3637	
111-1797-008	A5571	3992	12 of 33

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

DDR No. C-457, 12/28/76 (continued):

Pour No. (continued)	Cylinder No.	psi-lbs.	page no.
035-5755-003 ✓	A6022	3983	17 of 33
035-5755-003 ✓	A6035	3774	18 of 33
111-1794-010	A6100	2725	20 of 33
	A6101	2631	
	**A6096	**3962	
	**A6097	**3883	
111-1802-001	A6431	2769	22 of 33
	A6432	2771	
	**A6427	**3498	
	**A6428	**3845	
035-2782-001 ✓	A6460	3909	25 of 33

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

The same referenced Gibbs & Hill document was attached to DDR C-457 as was attached to DDR C-449 (pages 30 and 31 of 33):

GTN-15645, 2/7/77 letter from R. E. Hersperger, Project Manager, Gibbs & Hill, New York, to H. C. Schmidt, Project Manager - Nuclear Plants, TUGCO, Dallas. (See DDR C-449, page 12 of this Summary.)

Several series of concrete rebound hammer tests (two of each pour) of two Concrete Pours, Nos. 035-5755-003 and 035-2782-001, were made in May 1977 (using as a comparison two series of tests for one concrete pour, 035-5755-001); see pages 26 through 29, and 32 and 33, of 33.

These concrete rebound hammer tests were made when the age of the concrete varied from 162 to 196 days. These retests indicated compressive strength-psi of between 4500 and 5700.

There were no concrete rebound hammer test results attached for the other 14 concrete pours.

DDR No. C-457, 12/28/76 (continued):

As indicated in the preceding by **, there were several instances where the standard (or laboratory) tested concrete cylinders indicated compressive strengths of less than 4000 psi-lbs. (In all such instances, the field-tested concrete cylinders indicated even less than the standard-tested ones.) And, based on the documents included in this DDR, in no instance were concrete rebound hammer tests done for the concrete pours where both the original field-tested cylinders and the original standard-tested cylinders indicated compressive strengths below 4000 psi-lbs.

The same referenced Gibbs & Hill document was attached to both DDR C-449 and DDR C-457:

GHF-2178, 11/1/77 Gibbs & Hill Memo from J. J. Moorhead, G&H-Jobsite, to J. T. Merritt, TUSI-Jobsite, referencing DDR-C-457, DDR-C-449, NCR-C-642, and NCR-C-652. See DDR C-449, pages 13 and 14 of this Summary.

"Disposition and Corrective Action: Use As Is. See Attachment. Also see HCP 26077 attached. See GHF-2178 attached." (Emphasis added.)

The same sheet was shown as "ATTACHMENT TO DDR C-449 and C-457" and attached to both DDR's, with information regarding "Corrective and Preventative Action" and "Test Program for In-Place Concrete Evaluation" (page 4 of 33). See DDR C-449, pages 14 and 15 of this Summary.

DDR No. C-499, 2/14/77, CASE Exhibit 353, *admitted into evidence:

"Deficiency: The attached strength test reports representing concrete placements listed below indicate field cured cylinders compressive strengths that do not comply with the requirements of the cited document:" (Page 1 of 33.) (NOTE: Items marked with a check mark ✓ were retested using the rebound conocrete hammer test; none of the other concrete pours were retested according to the documents attached to this DDR.)

"002-4790-037 ✓	101-2808-001 ✓
"002-4790-039	035-5755-007
"002-4790-040	035-5755-008
"002-4790-041	002-4778-013 ✓
"002-4790-042	002-4792-001 ✓
"002-4790-043	111-1797-011
"002-4790-046 ✓	002-4790-015 ✓ ****
"002-5790-008	105-4773-011
"002-4792-009 ✓	105-4773-030
"105-4773-035	002-5790-003 ✓
"105-4773-036	002-5790-015
"105-4773-039	111-1794-010
"002-6778-014 ✓	105-1806-004
"002-4792-008 ✓	002-9791-001
"035-5782-001 ✓	002-5778-017
"035-5782-002	002-4778-001 ✓
"002-4778-010 ✓	105-9773-002 ✓
"105-1800-002	002-4790-038 ✓
"002-5790-002 ✓ ***	002-5778-016 ✓ *****
"002-4790-026"	

*** = This pour tested at 4000 or more psi-lbs. initially. It was used for comparison purposes in retests, where it tested at 6000 and 6500 psi-lbs. at an age of the concrete of 158 days.

**** = This pour tested at 4000 or more psi-lbs. initially. It was used for comparison purposes in 4 series of retests, where it tested at 5500, 6510, 6150, and 6350 psi-lbs. at an age of the concrete of 171 days.

***** = This pour tested at 4000 or more psi-lbs. initially. It was apparently used for comparison purposes in retests, where it tested at 6600 and 6800 psi-lbs. at an age of the concrete of 252 days. These retests were horizontal.

DDR No. C-499, 2/14/77, CASE Exhibit 353, *admitted into evidence:

"Deficiency: The attached strength test reports representing concrete placements listed below indicate field cured cylinders compressive strengths that do not comply with the requirements of the cited document:" (Page 1 of 33.) (NOTE: Items marked with a check mark ✓ were retested using the rebound conocrete hammer test; none of the other concrete pours were retested according to the documents attached to this DDR.)

"002-4790-037 ✓	101-2808-001 ✓
"002-4790-039	035-5755-007
"002-4790-040	035-5755-008
"002-4790-041	002-4778-013 ✓
"002-4790-042	002-4792-001 ✓
"002-4790-043	111-1797-011
"002-4790-046 ✓	002-4790-015 ✓ ****
"002-5790-008	105-4773-011
"002-4792-009 ✓	105-4773-030
"105-4773-035	002-5790-003 ✓
"105-4773-036	002-5790-015
"105-4773-039	111-1794-010
"002-6778-014 ✓	105-1806-004
"002-4792-008 ✓	002-9791-001
"035-5782-001 ✓	002-5778-017
"035-5782-002	002-4778-001 ✓
"002-4778-010 ✓	105-9773-002 ✓
"105-1800-002	002-4790-038 ✓
"002-5790-002 ✓ ***	002-5778-016 ✓ *****
"002-4790-026"	

*** = This pour tested at 4000 or more psi-lbs. initially. It was used for comparison purposes in retests, where it tested at 6000 and 6500 psi-lbs. at an age of the concrete of 158 days.

**** = This pour tested at 4000 or more psi-lbs. initially. It was used for comparison purposes in 4 series of retests, where it tested at 5500, 6510, 6150, and 6350 psi-lbs. at an age of the concrete of 171 days.

***** = This pour tested at 4000 or more psi-lbs. initially. It was apparently used for comparison purposes in retests, where it tested at 6600 and 6800 psi-lbs. at an age of the concrete of 252 days. These retests were horizontal.

DDR No. C-499, 2/14/77 (continued):

The following Field Cured (Job) strengths which are below 4000 psi-lbs. were shown as the result of Concrete Compression Tests, ASTM C-39 (Hunt E1001) made in December 1976 and January and February 1977 (on those on which the dates were readable; some dates were not readable); see pages 4 through 29 of 84, and 64 through 66 of 84.

(NOTE: Pour numbers marked with a check mark ✓ were retested later using the concrete rebound hammer test (and in one instance, as indicated in the preceding, a pour was retested again, making the third time it was tested); no other concrete pours were retested, according to the documents attached to this DDR.)

Pour No.	Cylinder No.	psi-lbs.	page no.
111-1797-011	A6707	2581	4 of 84
	A6708	2513	
	**A6703	**3378	
	**A6704	**3267	
111-1794-010	A6100	2725	5 of 84
	A6101	2631	
	**A6096	**3962	
	**A6097	**3883	
105-1806-004	A7423	2261	6 of 84
	A7424	2655	
	**A7419	**3540	
	**A7420	**3483	
105-1800-002	A7520	1820	7 of 84
	A7521	1935	
	**A7516	**3428	
	**A7517	**3412	
101-2808-001	A7940	3731	9 of 84
	A7941	3695	
101-2808-001 ✓	A7957	3622	10 of 84
101-2808-001	A7964	3947	11 of 84

↑(A vertical-down retest was done at an age of the concrete of 229 days; it indicated 5000 and 5600 psi-lbs.)

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

DDR No. C-499, 2/14/77 (continued):

Pour No. (continued)	Cylinder No.	psi-lbs.	page no.
105-9773-002 ✓	A7300	3534	12 of 84
	A7301	3867	
↑(A horizontal retest was done at an age of the concrete of 240 days; it showed 6600 and 6800 psi-lbs.)			
002-4790-038 ✓	A7250	3656	13 of 84
	A7251	3949	
002-5778-017 002-4788-001✓	A7280	3891	16 of 84
	A7281	3819	
002-4790-046✓002-5790-008	A8031	3303	18 of 84
	A8032	3306	
002-4792-001 ✓	A7213	3498	19 of 84
002-5790-003✓,015	A7369	3609	20 of 84
	A7370	3306	
035-5755-007,008	A7906	3450	21 of 84
	A7907	3801	
✓plus ✓a retest was done -- see discussion following			
002-4790-037✓,039,040,041, 042, 002-4790-043	A8085	3579	24 of 84
	A8086	3483	
002-4778-010 ✓	A7510	3915	25 of 84
002-4792-008 ✓	A7757	3156	26 of 84
	A7758	3167	
002-4792-009 ✓	A7971	3640	27 of 84
	A7972	3436	

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

DDR No. C-499, 2/14/77 (continued):

Pour No. (continued)	Cylinder No.	psi-lbs.	page no.
002-4778-013✓ 002-6778-014✓	A7767	3362	28 of 84
	A7768	3139	

↑(a retest was done on pour -013, where the compressive strength-psi indicated was 5200 and 4150 at an age of the concrete of 123 days (pages 46 and 47 of 84), which is still below the strength claimed by Applicants of 4500 to over 5000 psi.)

002-4790-026	A7831	3216	29 of 84
	A7832	3243	
035-5782-001,002✓	A7577	3866	65 of 84
035-5782-001,002	A7584	2639	66 of 84

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

Several series of concrete rebound hammer tests (two of each pour, unless stated otherwise) of Concrete Pour Nos. 002-4790-038, 002-5790-003, 002-4790-015 (which tested at 4000 psi-lbs. or above initially and was used for comparison purposes), 002-4778-010, 002-5790-002 (which tested at 4000 psi-lbs. or above initially and was used for comparison purposes), 002-4792-009, 002-4792-008, 002-4778-013, 002-6778-014, 002-4790-046, 002-4790-037, 002-4792-001, 002-4788-001, and 035-5782-001, using as a comparison Concrete Pours 002-4790-015 (for 4 series of hammer tests), 002-5790-002, 002-4792-009, 002-5790-006, and 002-4790-009.

These tests were made during April and May 1977, at an age for the concrete of 102 to 171 days. See pages 30 through 63 of 84. These retests indicated compressive strength-psi of between 4500 and 6500, with one exception -- one of the tests on pour 002-4778-013 indicated a compressive strength-psi of 4150 (under the 4500 to over 5000 psi claimed by Applicants); there was no indication that it was retested again later; see page 47 of 84.

In August 1977, concrete rebound hammer tests were made (two of each pour) of pours 002-5778-016, a horizontal test (this pour had tested at 4000 psi-lbs. or above initially), a horizontal test of 105-9773-002, and a vertical-down test of 101-2808-001, using horizontal tests of pour 105-4773-016 for comparison purposes. These retests were made at an age of the concrete of between 229 days and 267 days, and indicated a compressive strength-psi of between 5000 and 7600. See pages 67 through 74 of 84.

DDR No. C-499, 2/14/77 (continued):

GHF-2179, a November 2, 1977, Gibbs & Hill Memo to R. E. Holloway, G&H-New York, from J. J. Moorhead (signed by D. Fellinger for Mr. Moorhead), G&H-Jobsite (see pages 78 and 79 of 84), referencing GHF-2178, DDR-C-499, DDR-C-529, and NCR-C-586, submitted the two DDR's and NCR for G&H's evaluation:

". . . as we feel gathered results indicate the potential that curing techniques for specific placements may not have been entirely effective. Specific placements of concern are as follows:

"DDR-C-499

"Item 3a.) Pour #002-4690-037, 039, 040, 041, 041, & 043

"DDR-C-529

"Item 2a.) Pour #002-4792-003
"Item 3a.) Pour #002-4790-018
"Item 7a.) Pour #035-5755-002
"Item 9a.) Pour #002-4792-010

"NCR-C-586

"Item 6a.) 105-4785-001, 002-003

"We feel the test results for the remainder of the placements addressed by the subject non-conformance reports conclude that the in place concrete meets design strength. Your concurrence on this is requested in addition to your evaluation of the placements listed above.

"As stated in GHF-2178, we do feel that the handling method of **field cured cylinders** during cold weather contributed to many of the low strength results registered and, therefore, to assist in evaluation we are attaching applicable QA curing surveillience records. . .

"We ask that this review be accomplished in the most expedient manner to permit further information to be gathered, if required, and subsequent closing of the non-conformance reports."

(Emphasis added.)

DDR No. C-499, 2/14/77 (continued):

Also included in this DDR (pages 77 and 78 of 84) was a Memorandum, GHF-2179, dated November 21, 1977 (attached to a November 28, 1977, Gibbs & Hill Memo to J. J. Moorehead, G&H, Field, from R. E. Holloway, G&H, Dallas), from R. E. McGrane to R. E. Holloway (Gibbs & Hill, New York) and G. G. Mowinkel, referencing non-conformance reports C-499, C-529 and C-586, and which stated, in part:

> "We have reviewed the results of the swiss hammer comparative tests made on in-place concrete where the representative field cured cylinders did not meet acceptance standards. These tests show that at the time of testing most of the subject concrete had attained sufficient stength to meet design requirements.
>
> "For concrete placements 002-4792-018," (C-529 has been handwritten in above this on the copy provided CASE by Applicants) "105-4785, 001, 002 and 003" (C-586 has been handwritten in above this) "the in-place concrete had not attained the minimum needed design strength at the date of the swiss hammer testing, according to the tests results. Other placements, as noted in the above reference, had indicated strengths only marginally above the minimum used in design. However, the questionable concrete should have continued to gain strength after the tests. We suggest that these placements be retested to confirm this continued strength gain.
>
> "Because the swiss hammer tests were made long after the 28 day tests of the field cured cylinders were performed, a direct correlation between the two test types cannot be made. As a result, although the handling of the cylinders during cold weather may be suspected as a cause of field cured cylinder failures, the possibility that curing practices are deficient must be considered. We recommend these practices be re-evaluated to determine if improvements are needed."
>
> (Emphases added.)

Also included in this DDR (page 75 of 84) was a TUSI Office Memorandum dated 12/1/77, referencing GHF-2179 and DALM-213, which stated, in part:

> "To assist in the Engineer's evaluation of field cured cylinder results as indicated by DDR-C-499, DDR-C-529 and NCR-C-586, we request that the following listed placements be retested by the Swiss Hammer tests to confirm continued strength gain.
>
> "DDR-C-499
>
> "Item 3a.) Pour #002-4690-037, 039, 040, 041, 041, & 043

DDR No. C-499, 2/14/77 (continued):

"DDR-C-529

"Item 2a.) Pour #002-4792-003
"Item 3a.) Pour #002-4790-018
"Item 7a.) Pour #035-5755-002
"Item 9a.) Pour #002-4792-010

"NCR-C-586

"Item 6a.) 105-4785-001, 002-003

"These test results should be submitted in the format used previously. We request submittal of these results prior to 12-15-77."

On 12/12/77, series of horizontal concrete rebound hammer tests were performed as follow: 2 series of horizontal tests were made on Concrete Pour 002-5790-006, which was marked "Comparison Test for 002-4790-037, 105-4785-"(off the page), which indicated compressive strength-PSI of 6,600 and 6,800 psi at an age of the concrete of 308 days. 2 series of horizontal tests were made on Concrete Pour 002-4790-037, which indicated compressive strength-PSI of 6,800 psi and 6,800 psi at an age of the concrete of 340 days. There is no indication that there were any further retests performed. (It should also be noted that these tests were for 002-4790-037, not 002-4690-037 as indicated in the 11/2/77 and 12/1/77 memos; it is, of course, possible that this was a typographical error, but there is no notation in the file to substantiate that this was the case.)

There were no concrete rebound hammer test results attached for the other 22 concrete pours.

As indicated in the preceding by **, there were several instances where the standard (or laboratory) tested concrete cylinders indicated compressive strengths of less than 4000 psi-lbs. (In all such instances, the field-tested concrete cylinders indicated even less than the standard-tested ones.) And, based on the documents included in this DDR, in no instance were concrete rebound hammer tests done for the concrete pours where both the original field-tested cylinders and the original standard-tested cylinders indicated compressive strengths below 4000 psi-lbs.

"Disposition and Corrective Action: Use As Is. Test concrete placement cited in accordance with Engineer's approved Test Program. See attached Concrete Hammer Test Reports HCP 26803, 26896, 26802, 26801, 26894. See retest reports attached. See GHF-2344 attached." (Page 1 of 84, emphasis added.)

DDR No. C-529, 3/11/77, CASE Exhibit 365, *admitted into evidence:

"Deficiency: The attached compressive strength reports representing concrete placements listed below indicate field cured cylinder compressive strengths that do not comply with the requirements of the cited document:" (Page 1 of 89.) (NOTE: Items marked with a check mark ✓ were retested using the rebound concrete hammer test; none of the other concrete pours were retested according to the documents attached to this DDR.)

"101-2808-002 ✓	002-4792-012
"101-2808-004	002-4792-014 ✓
"002-4790-026 ✓	119-1805-001
"002-4792-010 ✓+ retest	018-1805-001
"002-4792-011 ✓	002-4792-015
"002-4792-018 ✓	002-4792-016
"002-4790-047 ✓	002-4790-048 ✓
"035-5755-011 ✓	002-9791-016
"035-5755-008 ✓	101-5805-003 ✓
"002-4792-003 ✓+ retest	035-5755-002 ✓+ retest
"002-4792-006	035-5755-004" ✓

The following Field Cured (Job) strengths which are below 4000 psi-lbs. were shown as the result of Concrete Compression Tests, ASTM C-39 (Hunt E1001):

(NOTE: Pour numbers marked with a check mark ✓ were retested later using the concrete rebound hammer test (and in three instances, in indicated in the preceding, a pour was retested again, making the third time it was tested); no other concrete pours were retested, according to the documents attached to this DDR.)

Pour No.	Cylinder No.	psi-lbs.	page no.
101-2808-002,004 ✓	A8058	3734	4 of 89
↑	A8059	3589	

(A concrete rebound hammer test was done on this Containment Building pour, at an age of 135 days, which indicated a compressive strength of 4350 and 4500 psi-lbs. Although 4350 is below the 4500 to 5000 psi-lbs. claimed by Applicants, there is no indication in the documents contained in this DDR that this concrete pour was ever tested again.)

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

DDR No. C-529, 3/11/77 (continued):

Pour No. (continued)	Cylinder No.	psi-lbs.	page no.
002-4790-026 ✓	A7831	3216	8 of 89
	A7832	3243	
002-4792-014,012 ✓	A8422	3587	10 of 89
	A8423	2970	
035-5755-008 ✓	A8432	3402	11 of 89
	A8433	3507	
035-5755-011 ✓	A8405	3871	12 of 89
	A8406	3507	
035-5755-011 ✓	A8442	3664	13 of 89
018-1805-001	A8544	2305	14 of 89
	A8545	2349	
	**A8540	**3231	
	**A8541	**3315	
119-1805-001	A8696	2547	15 of 89
	A8697	2281	
	**A8692	**3424	
	**A8693	**3299	
002-4790-048 ✓	A8716	3816	16 of 89
	A8717	3867	
002-4790-047 ✓	A8331	3477	17 of 89
	A8332	3597	
002-4792-018 ✓	A8311	3575	18 of 89
	A8312	3571	

(A series of 2 concrete rebound hammer tests were done at an age of the concrete of 105 days, which indicated compressive strengths of 4750 and 3950. Although 3950 is below the design strength of 4000 psi and below the 4500 to 5000 psi claimed by Applicants, there is no indication in the documents contained in this DDR that additional retests were ever done on this concrete pour.)

002-4792-011 ✓	A8361	3052	19 of 89
	A8362	2986	

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

DDR No. C-529, 3/11/77 (continued):

Pour No. (continued)	Cylinder No.	psi-lbs.	page no.
002-4792-010 ✓	A8351	3498	20 of 89
	A8352	3479	

(2 series of concrete rebound hammer tests were done on this pour at an age of the concrete of 105 days, which indicated a compressive strength of 4700 psi-lbs. and 4150 psi-lbs. An additional 2 series of concrete rebound hammer retests were done at an age of the concrete of 331 days, which indicated compressive strengths of 5700 and 4800 psi-lbs.; this was a horizontal test.)

035-5755-004 ✓	A8931	3886	22 of 89
035-5755-002	A9008	3154	23 of 89
035-5755-002 ✓	A8977	3478	24 of 89
035-5755-002	A8970	3634	25 of 89
035-5755-002	A8960	3378	26 of 89
	A8961	3710	

(2 series of concrete rebound hammer tests were done of this concrete pour at an age of the concrete of 87 days, which indicated compressive strengths of 4450 and 4800 psi-lbs. An additional 2 series of retests were done at an age of the concrete of 311 days, which indicated compressive strengths of 6100 and 6800 psi-lbs.; these last two series were horizontal tests.)

002-4792-003 ✓	A8277	3179	27 of 89
	A8278	3145	

(2 series of concrete rebound hammer tests were done of this concrete pour at an age of the concrete of 106 days, which indicated compressive strenghts of 4750 and 4300 psi-lbs. An additional 2 series of retests were done at an age of the concrete of 332 days, which indicated compressive strengths of 5900 and 6600 psi-lbs.; these last two series were horizontal tests.)

101-5805-003 ✓	A8625	3923	29 of 89
101-5805-003	A8608	3642	69 of 89

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

DDR No. C-529, 3/11/77 (continued):

Several series of concrete rebound hammer tests (two of each pour usually) were made of Concrete Pour Nos. 002-4790-026, 002-4792-003, 002-4792-018, 002-4790-048, 035-5755-004, 035-5755-008, 035-5755-002, 035-5755-011, 002-4792-010, 002-4790-047, 002-4792-011, 002-4792-014, 101-2802-002, and 101-5805-003, using as comparison Concrete Pours 002-4792-009, 002-4790-009, 035-5755-012, 035-5755-006, 002-5790-002, and 002-4790-015.

These tests indicated compressive strength-psi of between 4500 and 6500, with the exception of the following: one test of 002-4792-003 indicated 4300; one test of 002-4792-018 indicated 3950; one test of 035-5755-002 indicated 4450; one test of 002-4792-010 indicated 4150; and one test of 101-2802-002 indicated 4350 (one of which was below the design strength of 4000 psi-lbs. for the concrete, and all of which were below the 4500 to over 5000 psi-lbs. claimed by Applicants).

Additional series of concrete rebound hammer tests were made (two of each pour) of pours as indicated in the preceding listing of concrete pours. (It should be noted that, due to time restraints, less detail is included here regarding this DDR than in previous DDR's; for additional information, please refer to the DDR's themselves.)

There were no concrete rebound hammer tests made of the other 8 concrete pours.

Also included in this Exhibit (pages 73 and 74 of 89) was a Gibbs & Hill Memo dated November 2, 1977, from J. J. Moorhead, G&H-Jobsite, to R. E. Holloway, G&H-New York, referencing DDR-C-499, DDR-C-529, and NCR-C-586, which stated, in part:

> "The attached GHF-2178 provides a summary of our review of questionable Field Cured Cylinder Results excluding the ones identified by the above referenced non-conformance reports. We are submitting DDR-C-499, DDR-C-529 and NCR-C-586 for your evaluation, as we feel gathered results indicate the potential that curing techniques for specific placements may not have been entirely effective. Specific placements of concern are as follows:
>
> "DDR-C-499
>
> "Item 3a.) Pour #002-4690-037, 039, 040, 041, 042, & 043

DDR No. C-529, 3/11/77 (continued):

"DDR-C-529

"Item 2a.) Pour #002-4792-003
"Item 3a.) Pour #002-4790-018
"Item 7a.) Pour #035-5755-002
"Item 9a.) Pour #002-4792-010

"NCR-C-586

"Item 6a.) 105-4785-001, 002, 003

"We feel the test results for the remainder of the placements addressed by the subject non-conformance reports conclude that the in place concrete meets design strength. Your concurrence on this is requested in addition to your evaluation of the placements listed above.

"As stated in GHF-2178, we do feel that the handling method of field cured cylinders during cold weather contributed to many of the low strength results registered and, therefore, to assist in evaluation we are attaching applicable QA curing surveillience records.

"Please contact Mike McBay or Dean Fellinger if additional clarification or information is needed in regard to concrete curing practices.

"We ask that this review be accomplished in the most expedient manner to permit further information to be gathered, if required, and subsequent closing of the non-conformance reports."

(Emphasis added.)

Also included in this Exhibit (pages 72 and 73 of 89) was the same Memorandum dated November 21, 1977, from R. E. McGrane to R. E. Holloway (Gibbs & Hill, New York) and G. G. Mowinkel, referencing non-conformance reports C-499, C-529 and C-586 (see quoted portions under DDR No. C-499 preceding).

Also included in this Exhibit (page 2 of 84) was the same 1/16/78 Gibbs & Hill Memo from J. J. Moorhead, G&H-Jobsite, to J. T. Merritt, TUSI-Jobsite, referencing DDR-C-499, DDR-C-529, and NCR-C-586 (see quoted portions under DDR No. C-499 preceding).

DDR No. C-529, 3/11/77 (continued):

"Disposition and Corrective Action: Use As Is. Test concrete placement cited in accordance with Engineer's approved Test Program. See attached Concrete Hammer Test Reports HCP 26803, 26806, 26802, 26801. See retest reports attached. See GHF-2344 attached." (Page 1 of 89, emphasis added.)

NCR C642,R1 and C642,R2, 5/24/77, CASE Exhibits 529 and 530, *admitted into evidence:

(It should be noted that on Rev. 1 of this NCR, the following was stated: "Orig. of C-642R0 not avail. for file." It also contained another note: "Rev. 1 issued to delete CAR 8 requirement. See FRIC C-1238." Rev. 2 contained the notation: "Rev. 2 issued for CAR 8 requirement.")

"Nonconforming Condition: . . . The attached compressive strength test reports representing concrete placements listed indicate field cured cylinder compressive strengths that do not comply with the requirements of the cited document." (Page 1 of 77.) (NOTE: Items marked with a check mark ✓ were retested using the rebound concrete hammer test; none of the other concrete pours were retested according to the documents attached to this NCR.)

"002-7807-002	105-7790-006
"002-5807-002 ✓	105-2810-001 ✓
"002-4790-027 ✓	105-7801-001 ✓
"002-6807-004	105-7790-002 ✓
"002-7810-002 ✓	105-7785-001
"101-2812-001	105-6810-009
"101-6808-001	105-4790-008 ✓
"003-9805-018	003-2785-001,002✓
"003-9805-017	003-1805-005,004
"003-1801-001	035-9780-001"

(NOTE: Concrete pour 101-2812-001 is the pour in which the crack in the Unit 1 base mat occurred, according to the wording of NCR C-650, regarding which hearings were held in June 1982; see CASE Exhibit 38, Brown & Root NCR Log, admitted into evidence June 1982.)

The following Field Cured (Job) strengths which are below 4000 psi-lbs. were shown as the result of Concrete Compression Tests, ASTM C-39 (Hunt E1001).

(NOTE: Pour numbers marked with a check mark ✓ were retested later using the concrete rebound hammer test; no other concrete pours were retested, according to the documents attached to this NCR.)

NCR C642,R1 and C642,R2, 5/24/77 (continued):

Pour No.		Cylinder No.	psi-lbs.	page no.
002-5807-002	✓	C0802	3922	9 of 77
002-5807-002	✓	C0809	3962	10 of 77
002-5807-002	✓	C0793	2477	11 of 77
002-4790-027	✓	C0390	3922	13 of 77
		C0391	3505	
002-7810-002	✓	C1654	3891	16 of 77
105-2810-001		C1026	3884	24 of 77
		C1027	3923	
105-2810-001		C1066	3860	25 of 77
105-2810-001		C1105	3856	27 of 77
105-2810-001	✓	C1112	3789	28 of 77
105-2810-001	✓	C1133	3629	29 of 77
105-2810-001	✓	C1140	3923	30 of 77
105-2810-001	✓	C1147	3583	31 of 77
105-7801-001	✓	C1445	3407	32 of 77
105-7790-002	✓	C0924	3956	33 of 77
105-4790-008	✓	C1779	3726	36 of 77

(A series of two concrete rebound test hammer tests were done at an age of the concrete of 76 days, indicating compressive strengths of 4350 and 4800 psi-lbs. Although 4350 psi-lbs. is below the 4500 to over 5000 psi-lbs. claimed by Applicants, there is no indication in the documents attached to this NCR that this pour was ever retested again.)

003-9805-018	C1081	2110	37 of 77
	C1082	2044	
	**C1077	**3588	
	**C1078	**3740	

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

NCR C642,R1 and C642,R2, 5/24/77 (continued):

Pour No. (continued)	Cylinder No.	psi-lbs.	page no.
003-9805-018	C1098	1902	38 of 77
	**C1095	**3834	
003-2785-002 ✓	C0977	3931	42 of 77
003-2785-002 ✓	C0984	3771	43 of 77
003-2785-002 ✓	C0991	3848	44 of 77
003-9805-017	C0746	2726	45 of 77
	C0747	2701	
003-9805-017	C0756	2420	46 of 77
003-9805-017	C0763	2219	47 of 77
	**C759	**3509	
	**C0760	**3523	
003-1805-005	C0626	2718	48 of 77
	C0627	2847	
003-1801-001,003-1805-004	C0326	2208	49 of 77
	C0327	2209	
	**C0322	**3277	
	**C0323	**3320	
035-9780-001	C0421	2465	50 of 77
	C0422	2389	
	**C0417	**3625	
	**C0418	**3619	

** Items marked with ** indicate standard (laboratory-tested) psi-lbs. results; those not marked are field-tested results.

Several series of concrete rebound hammer tests (two of each pour) of Concrete Pour Nos. 002-4790-027, 002-5807-002, 105-2810-001, 105-4790-008, 003-2785-002, 105-7801-001, 105-7790-002, and 002-7810-002, indicated compressive strength-psi of between 4500 and 5800, with the exception of the following: one test of 002-4792-007 indicated 4100; and one test of 105-4790-008 indicated 4350.

There were no concrete rebound hammer tests attached for the other 12 concrete pours, including 101-2812-001.

NCR C642,R1 and C642,R2, 5/24/77 (continued):

Also included in this Exhibit (pages 2 and 3 of 77) was the same Gibbs & Hill Memo, GHF-2178, dated November 1, 1977, from J. J. Moorhead, G&H-Jobsite, to J. T. Merritt, TUSI-Jobsite, referencing DDR-C-457, DDR-C-449, and NCR-C-652 (see quoted portions under DDR C-457 preceding).

"Disposition: Use As Is. . . Field cured compressive strength results less than the minimum design strength for the placements cited have been tested in accordance with the Engineer's approved test program and attached Test Hammer Reports indicate acceptable results. See GHF-2178 attached." (Page 1 of 77, emphasis added.)

CAR S-8 (Corrective Action Request), 6/9/77, CASE Exhibit 625,
*admitted into evidence

"Condition Description: Compressive strength test reports representing concrete placements indicate field cured cylinder compressive strengths that do not comply with requirements of referenced document and as noted on NCR C-642, R2. An evaluation of the method used for storing field cured cylinders after the curing period is completed, is requested." (Page 1 of 5, emphasis added.)

Attached to this CAR is a May 17, 1977, Brown & Root letter, BRQ-0545, from Peter L. Bussolini, Project Quality Assurance Manager, to C. H. Gatchell, Resident Manager, TUSI, under subject of "Field Cured Cylinder Program History," which states, in part:

"The following is the requested Fiedl Cured Cylinder Program History for your information and use.

"Concrete curing methods implements at CPSES on all structural placements are as follows:

"1. Normal and hot weather; wet curing by one or a combination of the following:

"a. Ponding or continuous sprinkling
"b. Application of absorbent mats kept wet

"2. Normal and cold weather:

"a. Same as a & b above and in conjunction with shelters and heaters when required.
"b. Use of impervious sheeting in conjunction with insulation pads annd/or shelters and heaters when required.

"Field cured cylinders are always placed on or as near as practical to the structural placements they represent and received insofar as possible the same cure as their parent structure for the duration of the curing period (7 or 14 days). At the end of the curing period they are transported to a location outside R. W. Hunt Company's lab and stored exposed to the elements until they are tested at 28 days. The attached sheet show (sic) a history of all safety-related structural concrete placements and strength results of both lab and field cured cylinders representing these placements from June 1976 through March 25, 1977. A close look at these test results reveals that strength results of lab cured cylinders are uniform and consistent. Also, statistical analysis of all our 4000 psi mixes (the same lab cured cylinders) indicate good control.

CAR S-8 (Corrective Action Request), 6/9/77 (continued):

"Field cured concrete cylinder test results from the same composites, however, are revealed to be very inconsistent. Basically, field cured cylinders break at equal or higher strengths in hot weather than their sister lab cured cylinders. Their breaks drop off as weather becomes more moderate and begin to not even yield design strengths when ambient temperatures fall below 40 degrees F. for any extended periods.

"A review of all of B&R QC's curing reports indicates that curing methods for these placements were adequately employed including cure of the cylinders for the required curing time (7 or 14 days). The major cause of these erratic results have therefore been attributed to the cylinders being unprotected and exposed to the elements for the remaining 14 or 21 days after the placement curing ceased and they were broken.

"The method of handling field cured specimens for the time after curing at the structure was depleted until the cylinder is broken was revised after issuance of FICR-189. R. W. Hunt began immersing them in water for 24 to 48 hours prior to capping and breaking on April 1, 1977.

"There has not been any significant change in field cured cylinder test results since the implementation of FICR-189. To date (from April 1, 1977) there have been approximately 30 "Q" concrete placements; 16 of these placements have failing field cured cylinders. . ."

(Pages 3 and 4 of 5, emphases added. See also page 5 of 5, which is the reference chart of concrete placements.)

"CAUSE: The major cause of our inconsistent and below strength field cured specimens is not the field curing but rather the methods the specimens were stored after in place concrete curing (7 & 14 days) ended. See BRQ-0545 5-17-77.

"CORRECTIVE ACTION: When field curing ends (7 & 14 days) field specimens will be taken to laboratory and put in moist room for rest of curing time. See RFIC-C 1238." (Page 1 of 5.)

General:

It should be noted that, in several instances, it was not just the field cured concrete which tested lower than 4000; the standard cured concrete cylinders also tested lower than 4000. This calls into question the conclusion by Applicants that the field curing in cold weather was the reason for the low test values. There is no discussion or explanation of the low test values for the standard (or laboratory-tested) cylinders.

In addition, it should be noted that all of the DDR's were marked: "Reportable Deficiency: No." And, as discussed herein, there were changes made on NCR C642 regarding whether or not a CAR was even required:

NCR C642R0 was "not available for file."

NCR C642R1 initially was marked "CAR 8 Required," then this was lined through and marked "not required." C642R1 was marked "NOTE: Rev. 1 issued to delete CAR 8 requirement. See RFIC C-1238."

NCR C642R2 was marked "CAR 8 Required)" and "NOTE: Rev. 2 issued for CAR 8 requirement."

CAR S-8 was finally written on 6/9/77, but the cause and corrective action indicated are inadequate. There is no indication that there was ever any problem with any of the standard (or laboratory-tested) cylinders, although, as discussed herein, there were numerous instances where the standard tested concrete cylinders indicated compressive strengths of less than the design strength of 4000 psi-lbs. (And in all such instances, the field-tested concrete cylinders indicated even less than the standard-tested ones.) Further, in no instance, based on the documents included in the DDR's and NCR's discussed herein, were concrete rebound hammer tests done for the concrete pours where both the original field-tested cylinders and the original standard-tested cylinders indicated compressive strengths below 4000 psi-lbs.