UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNION ELECTRIC COMPANY	)	Docket Nos. 50-483 OL
	)	
(Callaway Plant, Unit 1)	)	

AFFIDAVIT OF EUGENE J. GALLAGHER IN SUPPORT OF NRC STAFF MOTION FOR SUMMARY DISPOSITION ON THE ISSUE OF JOINT INTERVENORS'S CONTENTION I-A

I, Eugene J. Gallagher, being duly sworn, depose and state:

1. I am a civil engineer with the U.S. Nuclear Regulatory Commission. Since February 1981, I have been assigned to the Reactor Engineering Branch, Division of Resident and Regional Reactor Inspection, Office of Inspection and Enforcement. Prior to February 1981, I was a reactor inspector assigned to the Region III, Reactor Construction and Engineering Support Branch, Office of Inspection and Enforcement. I was assigned to the Callaway Plant (among others) during the period of December 1977 through September 1980. A statement of my professional qualifications is appended hereto.

2. As a civil engineer inspector for the Region III office of Inspection and Enforcement I conducted five inspections with respect to the Callaway Plant, Unit 1, in order to: (1) ascertain whether adequate quality assurance plans, instructions and procedures had been established for the construction of concrete structures; (2) provide an independent evaluation of the performance, work in progress and completed work to

ascertain whether activities relative to concrete construction were accomplished in accordance with NRC requirements, and (3) review the quality related records to ascertain whether these records reflected work accomplished consistent with NRC requirements and license commitments. The results of these inspections are contained in the following NRC inspection reports:

50-483/77-11,	conducted December 13, 1977 through January 8, 1978.
50-483/78-01,	conducted January 10, 1978 through February 8, 1978.
50-483/78-03,	conducted March 29, April 18-19, 1978.
50-483/80-14, (Attachment 1)	conducted April 10, 1980 through August 14, 1980.
50-483/80-16,	conducted June 10-12, 1980.

3. The purpose of this affidavit is to address Joint Intervenors' Contention I-A as identified in the Special Prehearing Conference Order, dated April 21, 1981.

4. Embedded plates are steel plates set in concrete to serve as supports for piping, electical conduits and cable trays, HVAC components, and structural steel framing. The plates are constructed by welding studs to one side of the plate. A plate is then positioned before concrete for the walls is poured. The concrete hardens around the studs, thereby affixing the plate to the wall.

5. Studs are welded to the plates by one of two methods. They can either be manually welded to the plate material by use of the shield metal are process in accordance with American Welding Society (AWS) code, or the studs can be welded to the plates by use of automatically-

timed machine in accordance with AWS code. Both manual and machine-welded plates are used at the Callaway Plant. All the plates for the facility were welded by the Cives Steel Company at their plant in Gouverneur, New York.

6. On June 9, 1977, during a routine NRC inspection (documented in Report No. 50-483/77-05), an NRC inspector identified embedded plates with machine-welded studs which did not contain full 360 degree weld (flash) material and had not been bend tested as required by AWS D1.1-75 (Part F) welding code. The bend test requires studs without 360 degree weld to be bent fifteen degrees in the direction opposite to the gap in the weld. If a crack in the weld appears (or if the stud breaks off from the plate), repairs must be made. Otherwise, the weld and the stud may be used as is.

7. As a result of the NRC inspection, Union Electric issued two "stop work" orders pending a complete investigation of the problem. One stop work order prevented further placement of concrete with embedded plates; the other prohibited Cives from transporting any additional plates from its factory to the Callaway site. Prior to June 9, 1977, 480 safety-related plates had been embedded in concrete. 255 of these plates used machine-welded studs; 225 used manually-welded studs.

8. As a first step in resolving the problem, a 100% reinspection program of all welds was initiated by Applicant, its architect-engineer (Bechtel), and Daniel Construction, of all the plates at the Cives plant and at the Callaway site. This inspection included manually-welded as well as machine-welded studs.

9. Machine-welded studs that upon visual inspection did not reveal a complete 360 degree weld were subjected to the required AWS bend test. Of 81,643 machine-welded studs, only 66 studs failed the AWS bend test. This defect rate of 0.08% is exceedingly low and demonstrates that adequate quality controls were in effect during fabrication of the embedded plates. The studs that failed were subsequently repaired.

10. The inspection also revealed that certain of the manually-welded studs contained visual weld defects. These visual defects were all corrected before the affected plates were used at the site.

11. In addition to the 100% reinspection program, the NRC requested that Applicant have some tests performed on embedded plates to give assurance that the 480 installed plates would not constitute a safety problem. Twelve manually-welded studs with visual weld defects were tested at Lehigh University. Six studs were bend tested to 30 degrees; six studs were subject to tensile tests. None of the stud welds failed the tests. This provides adequate assurance that even if manually-welded stud, with visually defective welds had been embedded, they would behave acceptably over the life of the plant.

12. Six of the installed plates with machine-welded studs were randomly selected and tension-tested to design load conditions. All performed acceptably. This testing, coupled with the extremely low stud failure rate, provide adequate assurance that the machine-welded studs will not adversely affect the safe operation of the plant.

13. The Staff reviewed and evaluated the inspection and testing program related to the embedded plates. The results of our review are set forth in NRC Report 50-483/80-14 (Attachment 1). As there documented,

we find adequate assurance that the 480 installed plates will not threaten the safe operation of the plant and that none of the uninstalled plates contain any studs with defective welds.

14. Joint Intervenors complain that Applicant was improperly granted exceptions to the AWS code. The granted exceptions, which are listed in FSAR Section 3.8.3.6.4.3, pertain only to manually-welded studs. Briefly stated, the exceptions state: (1) a vertical leg of the weld may be up to 1/16 of an inch smaller than specified in the design drawing; (2) the vertical legs need not be equal in length; (3) weld profile and convexity requirements need not be imposed; and (4) an undercut of up to 1/16 of an inch for 10% of the weld length may be permitted. These exceptions are minor in nature and do not affect the basic weld design or the capacity of the connection.

Eugene J. Gallagher
Eugene J. Gallagher

Subscribed and sworn to before me
this 7th day of October, 1981.

Linda M. Eyler
Notary Public

My Commission expires: July 1, 1982.

EUGENE J. GALLAGHER

OFFICE OF INSPECTION AND ENFORCEMENT
U.S. NUCLEAR REGULATORY COMMISSION

PROFESSIONAL QUALIFICATIONS

I am a Civil Engineer in the Division of Resident and Regional Reactor Inspection, Reactor Engineering Branch, Office of Inspection and Enforcement.

I received a Bachelor of Engineering Degree in Civil Engineering from Villanova University in 1973 and a Master of Science Degree in Civil/Structural Engineering from Polytechnical Institute of New York in 1974. I am a registered Professional Engineer in the States of Illinois (#37828), Florida (#29114) and Louisiana (#16376). I am a member of the American Society of Civil Engineers, American Concrete Institute and Tau Beta Pi National Engineering Honor Society.

In my present work at the NRC, I provide technical assistance in the area of civil engineering to Regional offices and resident inspectors with particular emphasis on the design and construction of reinforced and prestressed concrete structures, foundations, structural steel buildings and in structural testing and surveillance. In addition, I provide technical input for the development and interpretation of industry codes, standards and regulatory requirements relating to inspection activities.

From 1978 to 1981 I was a member of the NRC Region 3 inspection staff responsible for the inspections of civil engineering aspects of plants under construction and in operation. This included the Inspection of laboratory and field testing of concrete, steel and soils materials, earth embankments and dams, material sources, piping systems and reinforced and prestressed concrete structures. In addition, a review of management controls and quality assurance programs were performed at plants under construction. I participated in approximately 90 inspections of reactor facilities.

Prior to joining the NRC Staff I was employed by EBASCO Services, Inc. in New York City from 1973 to 1978. I performed designs of reinforced concrete and steel structures, design of hydraulic and water supply systems and preparation of specifications for construction. From 1976 to 1978, I was the civil resident engineer at the Waterford 3 Nuclear Plant site responsible for providing technical assistance to construction.

During 1972 and 1973 I was employed by Valley Forge Laboratory in Devon, PA performing inspection and testing on concrete, steel and soil materials.

ADDITIONAL NRC TRAINING

Fundamentals of Inspection, NRC, February 1978 (40 hours)
BWR Fundamentals Course, NRC, March 1978 (40 hours)
Concrete Technology and Codes, Portland Cement Assoc., May 1978 (80 hours)
Quality Assurance Course, NRC, August 1978 (40 hours)
Nondestructive Examination and Codes, Rockwell Int'l., August 1978 (120 hours)
PWR Fundamentals Course, NRC, November 1978 (40 hours)
Welding Metallurgy, Ohio State University, September 1980 (80 hours)

ATTACHMENT 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
799 ROOSEVELT ROAD
GLEN ELLYN, ILLINOIS 60137

80-14

SEP 16 1980

Docket No. 50-483

Union Electric Company
ATTN: Mr. John K. Bryan
Vice President - Nuclear
Post Office Box 149
St. Louis, MO 63166

Gentlemen:

This refers to the meeting conducted in your office in St. Louis, MO on April 10, 1980, by Messrs. E. J. Gallagher and R. Landsman of this office and a subsequent meeting held in our office in Glen Ellyn, IL by Mr. G. Fiorelli and members of his staff on May 28, 1980, for the purpose of discussing the resolution of the embedded plate matter at the Callaway Unit 1 plant. This also refers to an inspection of available embedded plates and review of quality records that was performed by Messrs. E. J. Gallagher and H. Wescott on June 10-12, 1980 at the Callaway site and the observation of physical testing of plates at Leigh University on August 6, 1980 and at the Callaway site on August 14, 1980.

The enclosed copy of the report documents the final review and evaluation of the embedded plate matter and details of items discussed during the meeting. Based on these reviews and evaluations, load test results, discussions with cognizant personnel of your staff and the Bechtel Power Company and direct NRC inspections, we concur in the findings that the subject embedded plates using both manually and automatic machine welded anchor studs meet requirements. We have no further questions at this time in regard to this matter.

No items of noncompliance with NRC requirements were identified during the course of this inspection.

In accordance with Section 2.790 of the NRC's "Rules of Practice," Part 2, Title 10, Code of Federal Regulations, a copy of this letter and the enclosed inspection report will be placed in the NRC's Public Document Room, except as follows. If this report contains information that you or your contractors believe to be proprietary, you must apply in writing to this office, within twenty days of your receipt of this letter, to withhold such information from public disclosure. The application must include a full statement of the reasons for which the information is considered proprietary, and should be prepared so that proprietary information identified in the application is contained in an enclosure to the application.

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We will gladly discuss any questions you have concerning this inspection.

Sincerely,

James G. Keppler
James G. Keppler
Director

Enclosure: IE Inspection
Report No. 50-483/86-14

cc w/encl:
Mr. W. H. Weber, Manager
Nuclear Construction
Central Files
Reproduction Unit NRC 20b
PDR
Local PDR
NSIC
TIC
Regions I & IV
Ms. K. Drey
Mr. Ronald Fluegge, Utility
Division, Missouri Public
Service Commission

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

Report No. 50-483/80-14

Docket No. 50-483 License No. CPPR-139

Licensee: Union Electric Company
P. O. Box 149
St. Louis, MO 63166

Facility Name: Callaway, Unit 1

Meetings/Inspection At: Union Electric Office, St. Louis, MO
Callaway Site, Callaway County, MO
NRC Region III Office, Glen Ellyn, IL

Meetings/Inspection Conducted: April 10, 1980
May 29, 1980
June 10-12, 1980
August 6 and 14, 1980

Inspector: E. J. Gallagher Eugene J Gallagher 9-2-80

Reviewed By: D. W. Hayes, Chief
Engineering Support Section 1

Approved By: G. Fiorelli, Chief 9-3-80
Reactor Construction and
Engineering Support Branch

Meetings/Inspection Summary

Meetings/Inspection on April 10, May 29, June 10-12, and August 6 and 14, 1980 (Report No. 50-483/80-14)
Items Discussed: Callaway Unit 1 submittal of March 10, 1978 entitled "Acceptability of Embedded Plates Installed at Callaway Plant, Unit 1". The review, evaluation and inspection involved 160 inspector-hours by two NRC inspectors.
Results: Resolution of embedded plate item at Callaway Unit 1.

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DETAILS

1. Meeting Attendees at Union Electric Office, April 10, 1980

NRC Region III

E. J. Gallagher, Civil Engineer Inspector
R. B. Landsman, Civil Engineer Inspector

Union Electric Personnel

D. F. Schnell, Manager, Nuclear Engineering
D. W. Capone, Assistant Manager
F. Field, Quality Assurance Manager
R. L. Powers, Quality Assurance Supervisor
D. B. Stecko, Nuclear Engineering
K. W. Kuechenmeister, Construction Engineering

Meeting Attendees at NRC Region III Office, May 29, 1980

NRC Region III

G. Fiorelli, Chief, RC&ES Branch
E. J. Gallagher, Civil Engineer Inspector
R. B. Landsman, Civil Engineer Inspector
H. Wescott, Project Inspector

Union Electric Company

D. F. Schnell, Manager, Nuclear Engineering
W. Zvanut, Supervisor, Nuclear Engineering
R. L. Powers, Quality Assurance Site Superintendent
K. W. Kuechenmeister, Construction Engineer

Bechtel Power Company

B. L. Meyers, Project Manager
E. V. Thomas, Supervising Civil Engineer
P. H. Divjak, Project Engineer
A. Pagano, Assistant Supervising Civil Engineer
K. G. Parikh, Engineering Specialist

Inspection Exit Meeting Attendees at Callaway Site June 10-12, 1980

NRC Region III

E. G. Gallagher, Civil Engineer Inspector
H. M. Wescott, Project Inspector

Union Electric Company

D. F. Schnell, Manager, Nuclear Engineering
W. H. Weber, Manager, Nuclear Construction
F. D. Fields, Manager, Quality Assurance
R. L. Powers, Superintendent, Site Quality Assurance
M. Doyne, General Superintendent
K. W. Kuechenmeister, Construction Engineer

Daniels Construction

H. J. Starr, Project Manager

2. References

The following references were used for the review and evaluation of the embedded plates installed at the Callaway Plant Unit 1:

a. NRC Reports

(1) Inspection Report 483/77-05 dated July 8, 1977
(2) Investigation Report 483/77-10 dated December 27, 1977
(3) NRC Region III Action Item A/I F30360H1 to Headquarters dated April 6, 1978
(4) Transfer of Lead Responsibility to Region III for evaluation of Callaway report on embedded plates dated April 14, 1980

b. Union Electric Reports

(1) Letter ULNRC-197 dated August 4, 1977, response to inspection report 483/77-05

(2) Letter ULNRC-221 dated January 27, 1978, response to investigation report 483/77-10

(3) Letter ULNRC-238 dated March 10, 1978 entitled, "Acceptability of Embedded Plates Installed at Callaway Plant, Unit 1" including enclosures 1 through 9

(4) Letter ULNRC-349 dated April 24, 1980, NRC questions on Union Electric embedded plate report

(5) Letter ULNRC-354 dated May 23, 1980, responses to NRC questions on Union Electric embedded plate report with attachments A through D

(6) Letter ULNRC-361 dated June 19, 1980, additional responses to NRC Questions

c. Other References

(1) SNUPPS letter SLU 6-14 dated November 1, 1976
(2) SNUPPS letter SLBM 6-514 dated November 5, 1976
(3) CIVES letter SL:124 dated June 30, 1977
(4) CIVES letter SL:126 dated July 12, 1977
(5) SNUPPS letter SLBM 7-302 dated July 27, 1977
(6) BECHTEL letter BLSM-5959 dated August 8, 1977
(7) CIVES letter SL:134 dated August 18, 1977
(8) SNUPPS letter SLM 7-108 dated August 18, 1977
(9) DANIEL memo PQWP-152 dated October 26, 1977
(10) BECHTEL letter BLSE-5195 dated November 21, 1977
(11) BECHTEL letter BLSE-5227 dated November 29, 1977
(12) CIVES Telecopy dated May 22, 1980

3. Background

Embedded plates supplied prior to June 9, 1977 to the Union Electric Company Callaway Plant Unit 1 were accepted and installed based on the fabricator's, Cives Steel Corporation, and Bechtel's vendor inspection program. A total of 480 safety-related embedded plates were installed in concrete prior to June 9, 1977, of which 255 plates utilize headed stud anchors attached by automatically timed stud welding equipment, and 225 plates with threaded rod anchors attached using manually welded fillet welds by the shielded metal arc process.

An NRC inspection conducted June 7-9, 1977 (Report No. 483/77-05) identified machine welded studs to embedded plates which did not contain full 360 degree weld material (flash) and was not bend tested as required by AWS D.1.1-75 welding code, Part F (stud welding).

As a result of the NRC inspection, Union Electric Company issued "stop work order" #9 on June 9, 1977 suspending the use of safety-related embedments until a reinspection program was initiated at the Cives fabrication plant and on uninstalled plates at the Callaway site. This reinspection included both machine welded and manually welded anchors and is discussed later in this report.

An NRC investigation was also conducted between October 14 and November 22, 1977 (Report No. 483/77-10) which included the question of the adequacy of the concrete embeds used in construction prior to June 9, 1977. The investigation report indicated that the embedded plate matter would be reviewed by the NRC Headquarters staff.

Union Electric Company's analysis of the acceptability of the embedded plates dated March 10, 1978 (Letter ULNRC-238) concluded that "all embeds installed at Callaway are sound and meet design load requirements".

Upon receipt of Union Electric's analysis, the NRC Region III office issued Action Item A/I F30360H1 dated April 6, 1978 for NRC Headquarters review. The following review and evaluation was conducted by Region III staff in order to address this unresolved matter.

4. Meeting Details

Meetings between NRC, Union Electric Company, and Bechtel were held on April 10, 1980 in St. Louis, Missouri and on May 29, 1980 in Glen Ellyn, Illinois. During these meetings a series of questions from the NRC were presented and responses provided by Union Electric and Bechtel. The questions and responses are documented in letters ULNRC-349 dated April 24, 1980, ULNRC-354 dated May 23, 1980, and ULNRC-361 dated June 19, 1980. These are included as attachments A, B, and C to this report.

meetings contained discussion of the background of the embedded pl .e matter, results of reinspection by Cives and Bechtel, analysis of the data, AWS Welding Code requirements, specification requirements, and Daniels nonconformance reports.

5. NRC Inspection of Embedded Plates at Callaway Site

During the NRC inspection on June 10-12, 1980, a visual inspection of embedded plates installed in concrete prior to June 9, 1977 was performed. The manually embedded plates used to support the structural steel framing was substantially loaded by the floor slab dead loads with no sign of distress or indication of overstress. The machine welded embedded plates, some of which were loaded with support attachments and others not yet loaded, were observed to be fully intact with no sign of distress.

6. Evaluation of Embedded Plates at Callaway Unit 1

The evaluation as to the acceptability of the embedded plates installed at the Callaway plant is separated into two categories: (a) machine welded studs installed prior to June 9, 1977 and (b) manually welded threaded rod anchors installed prior to June 9, 1977.

a. Machine Welded Anchors (Headed) Studs

Embedded plates in concrete with automatically timed machine welded headed studs to plates are used to provide support for attachments of piping and components to the concrete structure.

In an effort to identify the condition of the 255 embedded plates installed in concrete prior to June 9, 1977, the licensee initiated a 100% reinspection of plates not installed as of that date and available on-site in storage or located at the supplier's fabrication shop. The reinspection was performed by both Bechtel and Cives Steel Corporation.

The results of the reinspection were reported as follows:

Number of Plates	Number of Studs	Number of Indications[1]
7543	81,643	457

Number of Failures[2]	% of Studs w/Indications	% of Studs Failed
66	0.56%	0.08%

NOTE: 1. Indications were studs on which a full 360° weld flash was not obtained when machine welded and were required to be bend tested.

2. Failures were identified by striking the studs with a hammer and bending the studs to an angle of 15 degrees according to AWS D1.1-75, Section 4.30.1.

It was also indicated in Union Electric Company response (Item 8) of ULNRC-354, attachment "C" that the 66 studs that failed when bend tested were contained on 43 plates out of the total 7543 plates. Of these plates, 10 had multiple stud failures with 4 of the 10 plates having adjacent stud failures. Therefore, the percentage of plates having 1 or more stud failures relative to the total number of plates reinspected was 43/7543 or 0.57%.

The above information regarding machine welded studs was considered not completely sufficient in itself to base a final decision on the acceptability of embedded plates. The NRC requested the licensee to test actual embedded plates installed in concrete prior to June 9, 1977. The licensee developed test procedures which were reviewed by the NRC prior to being implemented. The test program was entitled "Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" dated August 5, 1980 and is included in Attachment D. The tests were performed at the Callaway site under the supervision of Drs. R. Slotter and J. Fisher of Leigh University. The results of these tests were as follows:

> Six plates were loaded to allowable design load without plate failure or plate deflection more than 1/4 inch. The plates tested exhibited acceptable behavior under the applied load.

Details of the test and results are contained in Union Electric submittal ULNRC-380 dated August 28, 1980 (Attachment E).

The automatically machine welded embedded plates installed prior to June 9, 1977 are considered to provide adequate structural support for piping and component supports based on the following:

(1) The 100% reinspection of 7541 plates which contained 81,643 machine welded head studs, of which 66 studs (0.08%) were identified as not meeting AWS bend test requirements.

(2) Actual load tests to rated capacity performed on embedded plates in concrete prior to June 9, 1977.

b. Manually Welded Anchors (Threaded Rods)

Embedded plates fabricated by manually welded threaded rods to plates are used for structural steel framing supports at the Callaway Site.

The original licensee commitment in the PSAR, Section 3.8.1. 6.6.2 (Steel Construction stated that, "AWS D1 1-72 and D1.1 Revision 73, Structural Welding Code, is used without exception for welding structural steel". This commitment has been revised in the current FSAR submittal for Callaway. FSAR Section 3.8.3. 6.4.3 now states that, embedded items are erected in accordance with AWS D 1.1 Structural Welding Code, except that the qualification of welders and welding operators may, alternatively, be in accordance with ASME Section IX. The following exceptions are permitted for welding between anchor rods and plates embedded in concrete:

(1) Vertical leg of weld may be up to 1/16 inch smaller than that specified on drawings.

(2) Unequal legs are permitted.

(3) Weld profile and convexity requirements for these welds need not be imposed.

(4) An undercut of up to 1/16 inch for 10% of weld length may be permitted.

In addition to these exceptions it was also determined that welds were less than the minimum AWS requirement of 5/16 inch. The licensee demonstrated that the the welds less than 5/16 inch are permissible based on an analysis that the smaller weld developes the strength required.

The above exceptions were incorporated in Revision 9, dated July 21, 1977 of Specification C-131, Miscellaneous Metal, Section 8.4 and 8.6.

During the months of July and August 1977 Cives Steel Corporation reinspected over 400 manually welded plates of which 80 did not meet the specification requirements of C-131, Revision 9.

However, the licensee indicated in Letter ULNRC-354 dated May 23, 1980 (Item 9) that the welds inspected had an undersize not exceeding 1/8 inch.

Enclosure 1 to Union Electric letter ULNRC-238 entitled "Investigation of Welded Studs" provides an analysis which calculates the reduced load capacity of the anchor due to a 1/8 inch undersize (assumed full 360° around) and a 1/16 inch undercut defect. The results of the analysis indicate that the reduced load capacities as shown below are not significantly effected by the 1/8 inch undersize. The analysis for the 1/16 inch undercut does not effect the load capacity of the anchor since the reduced diameter due to the threads on the anchor rods control the rated capacity of the anchor.

The reduced capacity of the plates due to 1/3 inch undersize are as follows:

Plate Type	Load Capacity (lbs)* per Dwg C-0012 Sht. 9	Reduced Capacity (lbs) Due to 1/8 Inch Undersize
EP 211	200,000	187,000
EP 312	175,000	168,000
EP 412, EP 511	75,000	60,000
EP 611	50,000	47,000

NOTE: *Load capacity shown on Drawing C-0012 are for vertical loads from structural steel framing reactions.

Sample calculations used to determine the reduced load capacities were reviewed. The reduced capacities provide adequate stength for the design load.

A number of Daniel inspection reports generated after June 9, 1977 indicated more than allowable undersize on many studs; however, the extent of undersize was generally not recorded. These reports are contained in NCR-2-0831.

In order to illustrate that the Daniel inspectors overstated the weld deficiencies in their reports, 47 available manually welded plates typical and fabricated in the same manner as those installed prior to June 9, 1977 were reinspected by a team of Union Electric, Bechtel and Daniel inspectors. All 47 plates were originally rejected by Daniel site inspection and recorded in NCR-2-0831.

The reinspection was performed in order to characterize and quantity the cause of the rejection since this was not fully recorded on the original Daniel inspection. The results of the reinspection indicated that 39 of 47 plates did not meet the requirements of Specification C-131, Revision 9 or AWS including the four exceptions described previously. The reinspection did indicate that none of the anchors on the plates exceeded the 1/8 inch undersize or 1/16 inch undercut assumed in the analysis of determining reduced capacities The reinspection finding indicated undersized welds of 1/8 inch for a portion of the weld circumference.

These 47 plates have been retained on hold at the site. During an NRC inspection on June 10-12, 1980 the NRC inspectors visually inspected the subject plates. The results of this inspection determined that the Union Electric, Bechtel, and Daniel team inspection was valid. The visual appearance of the welds did indicate poor workmanship characteristics.

To demonstrate that the welds provide adequate structural integrity the NRC inspectors requested the licensee to perform load tests on selected welds which appeared to have poor workmanship. In addition, selected anchors were bend tested. These structural tests were performed in accordance with procedure entitled "Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" dated August 5, 1980. The tests were performed at Leigh University on August 6, 1980.

The results of the load and bend tests are as follows:

(1) Six anchor rods were bend tested to approximately 30 degrees. All of the welds successfully withstood the bend test with no sign of failure.

(2) Six anchor rods were tension tested to ultimate load. All of the welds and rods exceeded the minimum allowable load acceptance criteria established prior to the test and included in Appendix A of the test procedure attached to this report.

Detailed discussion of the test and results are contained in Union Electric submittal ULNRC-380 dated August 28, 1980 (Attachment E).

The manually welded embedded plates installed prior to June 9, 1977 are considered to provided adequate structural integrity for the intended loads based on the following:

(1) The reinspection of manually welded plates available in storage which indicated that in no case was the welds undersized by more than 1/8 inch.

(2) The analysis that the reduced load capacities are not significantly effected by an 1/8 inch undersized weld or 1/16 inch undercut due to capacity being controlled in the threads of the anchor rods.

(3) NRC inspection of 47 plates retained on hold at the Callaway site which appear to have poor welding workmanship; however, adequate structural strength.

(4) Load test performed on undersized welds and welds of poor workmanship quality which demonstrate adequate structural strength.

(5) NRC inspection of manually welded embedded plates substantially loaded by structural steel framing and floor slab dead load without sign of distress.

7. Closure of Embedded Plate Report at Callaway Unit 1

Based on the foregoing review and evaluation of the referenced documents, results of reinspections of embedded plates, the analysis of reduced load capacities due to weld deficiencies, direct NRC inspection and actual load test performed, it is considered that the embedded plates using both manually welded and automatic machine welded anchor studs are capable of providing the intended support for structural steel framing, piping, and component support.

ATTACHMENTS:

A. Union Electric Submittal ULNRC-349 dated April 24, 1980
B. Union Electric Submittal ULNRC-354 dated May 23, 1980
C. Union Electric Submittal ULNRC-361 dated June 19, 1980
D. Detailed Procedure for Test Program to Evaluate Welds on Anchor Rods and Studs to Embedded Plates, Revision 2, dated August 5, 1980
E. Union Electric Submittal ULNRC-380 dated August 28, 1980 final report on test of embedded plates

UNION ELECTRIC COMPANY
1901 GRATIOT STREET · ST. LOUIS

April 24, 1980

MAILING ADDRESS
P.O. BOX 149
ST. LOUIS, MO 63166

Mr. E. Gallagher
U. S. Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, Illinois 60137

ULNRC- 349

Dear Mr. Gallagher:

NRC QUESTIONS ON UE EMBED REPORT
CALLAWAY PLANT

The following generally summarizes the questions transmitted to Bechtel as a result of our April 10, 1980 meeting on the subject report:

1. NRC takes exception to statement in J. K. Bryan cover letter,

   P.1: "As noted in the Bechtel specification for these embeds, even AWS requirements limiting undersize, profile and other weld characteristics cannot be applied to manually-welded embeds and are unnecessary to assure their ability to carry design loads."

   Mr. Gallagher has talked to Moss Davis of AWS plus NRR and I&E HQ people expert in AWS requirements. He posed this question: "Are AWS weld profile, undercut, etc. requirements applicable to manually-welded studs?" The answer from these people is "YES".

2. How does Bechtel support deviations from D1.1 on undercut, profile & allowable underthickness in fillet lengths as allowed in Rev. 9 of Specification C131?

   It was unclear to the NRC from specification C131 whether AWS D1.1 is a full requirement. Bechtel is to clarify specification intent that AWS D1.1 is applicable with exceptions clearly defined.

3. Even though Bechtel specification allows 1/16" under on vertical leg, can we confirm that minimum weld leg is 5/16"? Apparently anything less than 5/16" violates AWS code for fillet welds in this application.

4. NRC noted that current (1980) AWS D1.1 section 8.15 does not allow 1/16" undercut.

Dupe of
8006170260

5. Did Cives Corp. inspect the same mechanically-welded embeds reported in Daniel Data Package under cover D.UC-2399 (Enclosure 7 to ULNRC-238)?

6. Why was section 9.6 added to Bechtel Specification C131? Prior to this revision (9) didn't Cives bend test machine-welded studs with less than 360° weldflash? Wasn't Cives following D1.1 4.30.1 prior to June 8, 1977? If Cives was not bend testing questionable studs prior to this time, how or what were they inspecting prior to shipment? If they were performing bend tests, is there any documentation?

   Note: Several Cives & Bechtel letters in NRC files indicate that bend tests were not being done prior to Rev. 9 (e.g.: Cives letters to Bechtel, SL:126, July 12, 1977, and SL:134 dated July 14, 1977 and Bechtel letters BLSM-5959, dated Aug. 8, 1977 and BLSE-5195, dated Nov. 21, 1977). Was there any Bechtel follow-up to these letters?

7. Reference Cives letter to Bechtel SL:134, dated Aug. 18, 1977. NRC is concerned about several things in this letter--References to "new" inspection criteria, statement about "no other sections of AWS apply to our work" and "tolerance for welds having less than 360° flash". Also, was request in this letter to use '77 version of AWS acted upon by Bechtel?

   See also BLSE-5227 dated Nov. 29, 1977 which may respond to concerns in SL-134.

8. Enclosure 1 to UE report (Bechtel probability study):

   Messrs. Gallagher & Landsman of NRC are not expert in probability analysis and will not personally support an analysis of this type to defend acceptability of machine-welded embeds.

   NRC concerned not with probability of stud failure but number of defective studs per embed and probability of embed failure. D. Schnell pointed out the study does cover probability of failure of plate for each area of plate. NRC was suspicious of this analysis. NRC would like to see complete dialogue for probability report.

   Do we have evidence of multiple defects per embed? How many plates were involved in the 66 stud defects? Bechtel is to provide a list of plates which contain the 457 defective studs (including 66 failed studs) and determine how many plates had more than 1 defective or failed stud.

9. Bechtel states in Enclosure 1 (pg. 1 in Bechtel Report) that

the "majority" of manually-welded plates did not meet dimensional/profile requirements of specification.

How many plates are in this "majority"?

How many plates were considered acceptable (meeting spec) after relaxations (items a, b, c & d) listed in Bechtel Report?

In a general statement the NRC questioned whether AWS D1.1 was fully implemented prior to June 8, 1977. Bechtel is to verify that AWS was fully utilized as criteria before specification C131 was relaxed and determine how effectively it was imposed.

* 10. DIC memo PQWP-152, dated October 26, 1977 has results of inspections of machine-welded embeds which differ markedly from numbers in Enclosure 1. How is difference explained? Was different criterial used in inspection?

11. Enclosure 1, Appendix B, Table I,:

Why were different allowable stress levels used (27ksi vs. 36ksi) to calculate embed "load capacity" and "reduced load capacity" because of assumed undersize?

Using Nelson "cookbook" rules for determining load capacity, it appears capacity of EP-512's should vary for the different configurations A thru F. (NRC could not verify any Bechtel capacities for any configuration of 512's.) How did Bechtel compute capacities and why don't capacities vary for different configurations of EP-512's? Would also like to see calculations to determine how "reduced load capacity" for all types of plates was arrived at.

12. Enclosure 1, Appendix B, Table 3:

Rationale followed by Bechtel in Table 3b on allowing 1/16" undercut is based on fact that area of threaded stud is less than area with 1/16" undercut. NRC & UE confirmed that some unthreaded studs are manually-welded. It appears that load capacities for manually-welded Nelson (or headed) studs with 1/16" undercut are not addressed in Bechtel report.

Are load capacities in table nos. 1 and 3 based on tension, shear or a combination?

Demonstrate how calculations are made to show that reduced fillet weld legs either affect or don't affect load capacity of plate.

A copy of BLUE-675, dated April 9, 1980 was handed out which provides a listing of manually-welded embeds with loads calculated assuming 1/8" undersize welds. After a short discussion, NRC requested to see calculations of how the reduced load capacities were determined.

13. Regarding Bechtel recommendations in Enclosure 6:

On plates deemed acceptable with an average undersize of 1/8", if undersize is concentrated in one area of plate and load is applied at this point, does theory that plate is acceptable remain valid? (localized undersize)

Furthermore, if the average weld undersize of 1/8" resulted in a weld profile of less than 5/16", are the Bechtel conclusions on load capacity still valid in light of AWS limit on weld size of 5/16" minimum? The NRC's concern is that AWS indicates welds less than 5/16" do not contribute sufficient strength to be reliable.

14. Cives letter SL:124 dated June 30, 1977:

Table 1: Attempts to show 1/16" undersize is acceptable but in making this point, allowable stress of 43ksi is used instead of 36. What is rationalle?

15. Bechtel letter to Cives dated June 24, 1977, from Divja . to Ross:

How do the numbers quoted in this letter (no. of studs inspected, etc.) fit with the numbers in the probability study?

* 16. Seiken letters to Schnell, SLU:6-41, dated Nov. 1, 1976 & SLBM-6:514, dated Nov. 5, 1976:

Letters indicate Cives was not in control of production quality based on Bechtel/SNUPPS inspection findings. What measures were taken? Did DIC/UE perform the recommended inspections at the site? NRC believes this should have highlighted problems before embeds were installed.

17. Enclosure 6 (to UE submittal) contains a Bechtel attempt to analyze NCR 0831. At random, NRC picked entry #44 of Attachment V, pg. 3 and asked why the corresponding DIC inspection report was eliminated as a data point.

NRC suggested (but did not insist on) a reanalysis of each manual and machine-welded embed installed prior to June 9, 1977. About 225 manually-welded embeds and 255 machine welded embeds are in this group. A program to evaluate each might consist of:

a. Identification of each plate location.

b. Determine where load is applied on plate.

c. Calculate actual load (vs. plate capacity).

d. Assume most heavily-loaded stud fails and determine what happens.

Investigation may show that-

a. Some plates may not have been used. Some may have all load applied now.

b. Some may be so lightly loaded that failure is precluded (even with failing stud).

c. Some may not involve safety-related attachments.

d. Failure analysis may show that failure does not threaten any system or structure from a safety point of view.

The above analysis may remove most of the embeds in question from further concern. It is recognized, however, that this approach may be totally impractical.

NRC would like to have answers to foregoing questions within 30 days. Mr. Gallagher is attempting to complete his analysis of the Callaway embed report by the end of June (1980).

* Response must have UE/DIC input.

Please call me if you have any questions or if something of importance was omitted from the foregoing list.

Very truly yours,

Donald F. Schnell

Donald F. Schnell
Manager - Nuclear Engineering

DFS/sla

UNION ELECTRIC COMPANY
1901 GRATIOT STREET · ST. LOUIS

May 23, 1980

MAILING ADDRESS
P. O. BOX 149
ST. LOUIS, MO 63166

Mr. E. Gallagher
U. S. Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, Illinois 60137

ULNRC-354

Dear Mr. Gallagher:

RESPONSES TO NRC QUESTIONS ON
UE EMBED REPORT--CALLAWAY PLANT

My letter to you dated April 24, 1980 (ULNRC-349) listed 17 questions generated during our meeting of April 10, 1980 concerning the subject report. The following summarizes our responses to these questions:

1. AWS D1.1-75 is applicable for the manual welding of threaded rods and as such, is invoked for welding in Specification 10466-C131, with technically acceptable exceptions as noted for undersize, profile, uneven legs and undercut.

2. The welding of threaded rods or anchors is in accordance with D1.1-75 with the following exceptions:

   A. The leg of the weld adjacent to the anchor may be up to 1/16 inch smaller than specified on the design drawings.

   B. Unequal leg welds are permitted.

   C. Weld profile and convexity requirements for these welds need not be imposed (but concavity limits apply).

   D. An undercut of up to 1/16 inch for 10% of the weld length may be permitted.

   These deviations are supported as follows:

   A. The undersize leg is satisfied by oversizing the welds on the design drawings such that even with the undersize deviation the welds will satisfy design requirements.

   B/C. The variation in weld profile including unequal legs and convexity does not result in an effective throat thickness less than required to satisfy the design strength.

dyre q
8011170262

PDR (D)

D. Undercut is limited such that the reduction in cross-sectional area is less than that which occurs as a result of the threads.

The installation (fabrication) of welded studs is in accordance with AWS D1.1-75, Section 4.0 Part F as it applies to "other than shear connectors." In Rev. 9 of Specification 10466-C-131 the inspection requirements of Section 4.30.1 (applicable to shear connectors) were imposed in lieu of the requirements of Section 4.30.2 (applicable to other than shear connectors). See also response to question 6.

3. The smallest weld size shown on the drawings has been and is 3/8 inch. Therefore even with 1/16 inch undersize the minimum weld size is in accordance with AWS D1.1.

4. Permissible weld undercut values for buildings have been revised in the 1980 edition of AWS D1.1 (see Attachment "A"). The permissible weld undercut values of 1/16 inch, however, are not applicable to the embeds in question.

5. We are certain that Cives inspected many of the plates listed in NCR 2-0831-C-B of which some were machine-welded and others were manually-welded. It should be noted, however, that NCR 2-0831-C-B was generated over a period of several months; thus Cives may not have inspected all the plates contained in the NCR.

6. AWS D1.1-75 (Section 4, Part F) identifies two types of studs, characterized by their intended use.

   A. <u>Shear connectors</u> - used in composite steel-concrete construction (see Section 4.25) and

   B. <u>Concrete anchors</u> - for other than composite steel-concrete construction to attach membersand connection devices to concrete.

AWS provides appropriate installation and inspection criteria for each of these stud types. By AWS definition the machine-welded studs in question are concrete anchors and it was on this basis that production initially proceeded. During the in-process inspection (quality control), studs-on which a 360 degree weld fillet was not obtained were either replaced or repaired in accordance with AWS D1.1-75 Subsection 4.29 for concrete anchors. During the final inspection, at least one stud in every 100 was bend tested in accordance with Subsection 4.30.2.

Section 9.6 of Bechtel Specification 10466-C-131 Revision 9 upgraded inspection requirements by adding bend testing of studs having less than a full 360 degree weld fillet, in accordance with AWS D1.1 Subsection 4.30.1. This addition provided visual evidence that studs with less than 360 degree weld fillet were inspected and minimized the possibility of future questions or another massive reinspection effort to prove the acceptability of the welded studs. No documentation of the bend tests was required either before or after Revision 9 of Specification 10466-C-131; however, Bechtel inspection reports indicate that bend testing was performed as required.

7. The Cives letter to Bechtel (SL:134) emphasizes Cives' viewpoint that the product is classified as concrete anchors and not shear connectors. The basis for this is explained in the answer to Question 6. Please note that the statement in Question 7: "No other sections of AWS apply to our work" does not appear in the referenced Cives letter. Rather, the letter states that: "No other sections which refer to shear connectors will apply to our work."

   The referenced Bechtel letter to SNUPPS (BLSE 5227) was written purely to clarify commercial considerations. The letter further reiterates the need for a full 360 degree weld fillet or bend test.

   The revisions cited to AWS D1.1-77, Section 4.0 resulted in relaxations to the AWS code which were not granted to the supplier.

8. The probability analysis was performed using well-defined and accepted statistical rules. The data used was generated by field inspection of 81,673 studs and analytical computation of load carrying capacity of machine-welded plates embedded prior to June 9, 1977. The analysis established that the probability of a plate failure affecting a safety-related system was significantly low.

   There is evidence of multiple defects per embed; ten plates are in this category and they are shown in Attachment "B". Embeds with defective studs (less than 360° weld) and failed studs are listed in Attachment "C".

9. During the months of July and August, 1977 Cives Corporation reinspected over 400 manually-welded plates of which 80 plates (not a majority) were found in violation of the Specification 10466-C-131, Rev. 9 and design drawings C-0011, Rev. 7 and C-0012, Rev. 8, and were therefore repaired by Daniel under Cives' supervision. The welds inspected had an undersize not exceeding 1/8 inch. Bechtel Quality Surveillance prior to June 9, 1977 was performed in accordance with AWS D1.1-75 and Specification 10466-C-131. Circa 10 percent of the material for this order was inspected by Bechtel which constitutes

more than a representative sample. The items in the sampling were visually inspected 100%. There was no indication at the time of a generic welding problem. In addition to welds, Bechtel Supplier Quality inspects for physical dimension, paint thickness, documentation, general workmanship, etc.

10. The difference in number of machine-welded studs inspected is simply due to the fact that the inspections were conducted at different times and the quantity of embeds available for inspection changed. DIC used the term "reject" to indicate failure. DIC rejected 106 studs out of 96,472 inspected, a failure rate of 0.11%. Cives rejected 66 out of 81,673, a failure rate of 0.08%. These results are comparable.

11. The load capacities shown in Appendix B Table 1 under the heading: "Load Capacity for 27 ksi" represent the allowable tension load on the plate assuming that the load was applied in the middle of the plate bounded by a four-stud cluster. Note that the capacity is computed only for a four-stud cluster regardless of the number of studs on the plate; hence, the same capacity is listed for all lengths of plates. The reduced load capacities in Zones 1, 2 and 3 were determined using a plate-bending stress of 36 ksi (the minimum yield strength of 36 ksi was used since this is a failure analysis) and assuming that one of the adjacent studs failed (zero load capacity). The reduced load capacities were used to determine the probability of plate failure due to imposed loads.

12. The reduced load capacities for manually-welded unthreaded (or headed) studs are not addressed in the report since the relaxed welding requirements of Specification 10466-C131 are not applicable to welded studs of this type. The appropriate inspection requirements for the manual welding of unthreaded studs are found in AWS D.1.1. The fabricator has confirmed that he is utilizing these requirements for manually welding headed studs. The load capacities in Table 1 are based on tension applied in the middle of a four-stud cluster on each plate; the capacities for Table 3 are based on a combination of shear and bending moment. The weld size required is that necessary to develop the capacity of the threaded rod. When the specified weld size exceeded that required, the plate capacity was not affected.

13. An average weld deficiency of 1/8 inch or less for all studs provides adequate strength (within allowable stresses) for design loads only if the individual welds have average deficiencies of 1/8 inch or less. A plate having localized weld deficiencies greater than 1/8 inch average per stud could be locally overstressed. In Enclosure 8 to UE's March 10, 1978 report, we attempted to characterize the condition of manually-welded embeds

using DIC inspection reports with less than complete information. As indicated in the ground-rules for the survey made in this enclosure, if a DIC inspection report indicated a weld deficiency greater than 1/8" without identifying the extent of the undersize around the circumference of the stud, it was assumed that the deficiency extended 360° around the periphery. An average weld deficiency for all studs on the plate was then calculated, recognizing that the resulting weld deficiency would be overstated. This survey did not consider localized undersize as a determining factor.

14. The yield stress of 43 ksi was based on CMTRs for the threaded rod material used prior to June 1977. The CMTRs were an attachment to Cives letter SL:124. Note that the results of this analysis were not used to arrive at the conclusions in the report.

15. The referenced letter was written when the reinspection effort was in process and provides only partial results. The numbers in the probability analysis incorporated this data along with the reinspection results of the balance of the plates.

16. As a result of the referenced letters, an inspection of embeds was initiated at Callaway. The results did not indicate evidence of weld problems. This is documented in Attachment"D".

17. Entry #44 was rejected since a reinspection report by Cives found the plate to be acceptable.

The probability analysis, based on the reinspection of more than 81,000 machine-welded studs, was performed using well-defined and accepted statistical rules. This is an appropriate approach since an individual stud or plate failure does not necessarily compromise the overall safety of the system or the plant. The degree of redundancy in design, and the strict overall quality control employed in the design and construction of nuclear power plants limits the mode of ultimate failure of various components and systems and reasonably assures that an undue risk is not imposed by failure of an individual component such as a stud. The probability analysis underlines this rationale by incorporating various factors which must be considered in assessing the impact of the inspection results on the safety of the plant.

In the case of manually-welded threaded rods, an analysis was made assuming an undersize of 1/8 inch for a full 360 degrees on every stud. This assumption was supported by the Cives reinspection of approximately 400 plates and a reinspection effort by DIC, UE and Bechtel on 45 plates. Assuming the 1/8" undersize extends completely around the periphery of every anchor is a significant conservatism.

In addition, the level of conservatism in the design for this type of embed is much higher since shear action engages all studs. Also note that the analysis prepared during the investigation of these anchors shows that the actual imposed loads on these plates are lower than the calculated design capacity.

We will be prepared to discuss these responses with you in our meeting May 29.

Very truly yours,

Donald F. Schnell
Manager - Nuclear Engineering

size in any length of six times the effective throat or weld size. When the length of the weld being examined is less than six times the effective throat or weld size, the permissible sum of the greatest dimensions shall be proportionally less than the effective throat or weld size.

(b) The space between two such discontinuities which are adjacent is less than three times the greatest dimension of the larger of the discontinuities in the pair being considered.

8.15.2.2 Independent of the requirements of 8.15.2.1, discontinuities having a greatest dimension of less than 3/32 in. (2.4 mm), if the sum of their greatest dimensions exceeds 3/8 in. (9.5 mm) in any linear inch of weld.

8.15.3 Ultrasonic Inspection. Welds that are subject to ultrasonic testing, in addition to visual inspection, shall be acceptable if they meet the requirements of Table 8.15.3. Ultrasonically tested welds are evaluated on the basis of a discontinuity reflecting ultrasound in proportion to its effect on the integrity of the weld.

8.15.4 Liquid Penetrant Inspection. Welds that are subject to liquid penetrant testing, in addition to visual inspection, shall be evaluated on the basis of the requirements for visual inspection.

8.15.5 When welds are subject to nondestructive testing in accordance with 8.15.2, 8.15.3, and 8.15.4, the testing may begin immediately after the completed welds have cooled to ambient temperature. Acceptance criteria for ASTM A514 and A517 steels shall be based on nondestructive testing performed not less than 48 hours after completion of the welds.

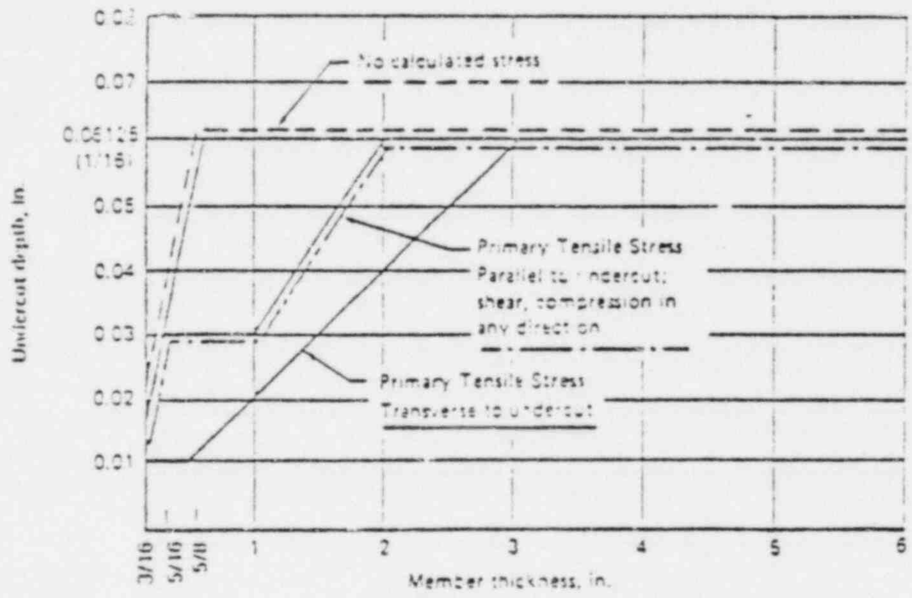

Fig. 8.15.1.5 – Permissible undercut values for buildings

ATTACHMENT "B"

Plates with multiple failed studs

A 115 - 214 (EP 912D)*

A 114 - 39

A 114 - 170

A 114 - 29

A 115 - 34 (EP 912D)*

A 115 - 251 (EP 912D)*

A 115 - 62

A 115 - 457

A 116 - 35 (EP 812A)*

A 103 - 43

* These plates had 2 failed studs in a four stud cluster.

EMBEDS WITH DEFECTIVE AND FAILED STUDS

Type of Embed	Piece Mark	Number of Defective Studs	Number of Failed Studs
Non-Q Sleeves	A98	1	1
	A98	3	3
	A98	3	3
	A100	1	1
	A98	1	1
Non-Q Sleeves	E5031-A73	1	0
	E5027-A26	2	2
	E5052-A30	2	2
	E5053-A47	1	1
Plates with Machine Welded Studs	A127-8	1	1
	A127-25	1	0
	A127-26	1	0
	A127-27	2	0
	A115-214	3	3*
	A115-216	2	0
	A114-134	1	0
	A114-396	1	0
	A114-29	2	2*
	A115-152	1	1
	A115-67	2	0
	A115-72	4	0
	A115-69	1	1
	A127-55	5	0
	A127-466	1	0
	A127-15	3	0
	A127-14	4	0
	A127-13	4	0
	A115-126	7	0
	A115-310	2	0
	A115-133	5	0
	A115-134	6	0
	A115-130	7	0
	A115-281	1	0
	A115-280	1	0
	A115-112	8	0
	A115-25	1	0
	A115-114	7	0
	A115-115	5	0
	A115-290	6	0
	A115-73	1	0
	A115-131	8	0
	A115-132	7	0
	A115-135	7	0
	A115-22	1	0
	A115-277	7	0
	A115-276	5	0
	A115-124	5	0
	A115-105	8	0
	A115-118	7	0
	A115-108	7	0

Plates with Machine Welded Studs	A115-64	1	0
	A115-294	4	0
	A115-342	1	0
	A115-274	7	0
	A127-184	3	0
	A127-156	1	0
	A127-330	1	0
	A115-34	2	2*
	A115-35	4	0
	A115-1	2	0
	A115-270	4	0
	A115-136	8	0
	A115-116	4	0
	A115-123	8	0
	A115-23	7	0
	A115-80	1	1
	A115-101	1	1
	A115-106	10	0
	A115-107	6	0
	A115-127	9	0
	A115-128	8	0
	A115-16	1	0
	A115-106	8	0
	A115-129	6	0
	A115-337	1	0
	A115-122	4	0
	A115-117	5	0
	A115-109	6	0
	A115-110	6	0
	A115-20	1	1
	A115-46	1	0
	A115-159	1	1
	A115-168	1	1
	A115-251	2	2*
	A115-275	9	0
	A115-121	5	0
	A115-120	6	0
	A127-121	1	0
	A127-120	1	0
	A127-112	1	0
	A127-118	2	0
Door Frames	A818	11	3
	A816	2	0
	A806-5	1	1
	A806-6	2	2
Angle Frames	A541-6	1	0
	A542-5	1	1
	A542-4	1	0
	A542-8	1	0
	A570-1	1	0
	A526-14	1	0
	A526-12	1	0
	A568-4	1	0
	A568-2	1	0
	A568-7	2	0

Angle Frames	A568-8	1	0
	A543-6	2	0
	A543-10	2	0
	A543-13	1	0
	A543-7	1	0
	A543-12	1	0
	A543-8	1	0
Plates with Machine Welded Studs	A114-198	1	1
	G108-2	5	0
	A108-3	3	0
	A108-5	2	0
	A108-6	3	1
	G108-7	2	0
	G108-6	1	0
	G108-8	1	0
	A115-198	1	1
	A115-203	1	1
	A115-202	1	1
	A115-62	2	2*
	A115-65	1	1
	A115-307	1	1
	A115-457	2	2*
	A115-456	1	1
	G108-10	2	0
	A108-1	8	0
	G108-14	10	0
	A114-171	1	1
	A114-173	1	1
	A114-158	1	1
	A261-14	1	0
	A261-431	1	0
	A261-454	1	0
	A261-391	1	0
	A261-16	1	0
	A231-7	1	0
	A231-4	1	0
	A231-3	1	0
	A114-145	2	0
	A114-71	1	0
	A114-67	1	0
	A114-90	1	0
	A114-146	1	0
	A114-119	4	0
	A114-92	4	0
	A167-36	2	0
	A167-414	1	1
	A167-234	1	1
	A162-377	2	1
	A116-35	2	2*
	A162-190	1	1
	A113-10	3	0
	A123-22	1	0
	A123-13	1	0
	A123-20	1	0
	A123-29	1	0
	A103-43	5	3*
	161	485	66

*Plate with multiple failed studs (10)

TOTAL UNITS INSPECTED 7543

Attachment "D"

DANIEL INTERNATIONAL CORPORATION

CALLAWAY PLANT
P. O. BOX 108
FULTON, MISSOURI 65251
(314) 676-3111

P. J.

May 22, 1980

DLUC-5407

No Response Required

Union Electric Company
P. O. Box 149 (Code 470)
St. Louis, Missouri 63166

Attention: Mr. W. H. Weber
Manager, Nuclear Construction

Subject: Response to UTD 6936, Item 16 - "NRC Questions on UE Embed Report - Callaway Plant"

Reference: DLUC-990 (Attached)
SLU 6-41
SLBM 6-514

Dear Walt:

The subject UTD (Item 16) raises questions regarding the actions taken as a result of SLU 6-41 and SLBM 6-514. These letters indicated that Cives was allegedly not in control of production quality based on Bechtel/SNUPPS inspection findings. As a result, DIC performed an inspection of 10% of the Cives embeds supplied prior to 11/15/76. The results of this inspection were documented via DLUC-990 (Attached).

Should you have further questions in this regard, please do not hesitate to contact the writer.

Very truly yours,

5-23-80

H. J. Starr
Project Manager

HJS:EDM:DJO:ECT:has

Attachment: DLUC-990

CC: E. D. McFarland (6)
K. Kuechenmeister (advance copy)
M. K. Smith
B. C. Tye
File (A11.56)

DANIEL INTERNATIONAL CORPORATION
CALLAWAY PLANT
P. O. BOX 108
FULTON, MISSOURI 65251
(314) 676-3111

December 3, 1976

DLUC - 990

Union Electric Company
P. O. Box 149
St. Louis, Missouri 63166

Attention: Walter H. Weber
Manager, Nuclear Construction

Subject: Miscellaneous Steel Specification C-131

Reference: SLU: 6-41 Telecon S. J. Seiken of 11/2/76

Dear Walt:

In accordance with the referenced requests, we have completed an inspection of miscellaneous steel shipped to the project from the Cives Corporation as indicated by the following tabulation:

Number of pieces received at project to 11/15/76....3740

Number of pieces inspected........................ 374

Discrepancies....................................... 4

Piece EP-312-A126-5 (Dwg. C-0012-Q)
Weld undercut

Piece EP-411-A10-43
Weld undercut

Piece EP-614-A814
Weld undercut, visible slag and incomplete weld

Piece EP-912-D-A115-168
Defective weld on stud

Nonconformance reports have been initiated for the four discrepant pieces.

In view of the above findings, we conclude that uncertainties expressed in the referenced SLU:6-41 are unfounded, and the material does in fact adhere to the standard of quality required.

Very truly yours,

M. R. Hamby, Jr.
Project Manager

MRH/CBB/clm

cc: L. Harmon
F. Field
D. Schnell
S. Saiken
W. van der Zalm

UNION ELECTRIC COMPANY
1901 GRATIOT STREET · ST. LOUIS

June 19, 1980

MAILING ADDRESS
P.O. BOX 149
ST. LOUIS, MO 63166

Attachment C

Mr. James G. Keppler, Director
Region III
Office of Inspection & Enforcement
U. S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, Illinois 60137

ULNRC- 361

Dear Mr. Keppler:

NRC QUESTIONS ON UE EMBED REPORT
ADDITIONAL INFORMATION
CALLAWAY PLANT

In response to requests by NRC Region III representatives at a meeting at your offices on May 29, 1980 for additional input on the subject report we are submitting herewith one copy of the following information.

1. BLUE-700, dated June 12, 1980, including all attachments.

2. Daniel International Corp. Telecon Record Sheet, dated May 29, 1980, Acceptance Criteria Used for Inspection of Undercut Welds, including attachments.

3. Daniel International Corp. Quality Control Procedure QCP-507, Rev. 5, Inspection of Structural and Misc. Safety Related Welding.

In reference to our investigation to determine the exact number of embeds involved in the subject report, we are in the process of determining this count and expect to be completed in the first part of July.

Very truly yours,

S. W. Capone
for
Donald F. Schnell
Manager - Nuclear Engineering

DBS/sla

cc: E. Gallagher w/a

dupe of
8011170221 PDR (0)

JUN 23 1980

SOLVING PROBLEMS THROUGH INVENTION & INNOVATION

Bechtel Power Corporation
Engineers—Constructors
15740 Shady Grove Road
Gaithersburg, Maryland 20760
301-258-3000

Mr. D. F. Schnell
Manager - Nuclear Engineering
Union Electric Company
Post Office Box 149
St. Louis, Missouri 63166

JUN 12 1980

BLUE- 700 File: 0499.4/C-131
Bechtel Job Number 10884-001
SNUPPS Project
Investigation of Welded Studs - Additional Information

Ref:
1. ULNRC 238 dated 3/10/78
2. ULNRC 349 dated 4/24/80
3. ULNRC 354 dated 5/23/80
4. AIF Program Report on Reactor Licensing and Safety, Vol. 2, No. 1, May, 1975

Encl:
A. Cives Steel Company Letter SL:367 dated June 10, 1980
B. Bechtel Surveillance Inspection Reports for Assignment 10466-C-131 Report Nos. 2, 3, 7, and 45
C. Sample Calculation for Manually Welded Plate Assemblies (EP 312)
D. Sample Calculation for Machine Welded Plate Assemblies (EP 512) - Reduced Capacity Due to a Postulated Ineffective Stud
E. DIC Memo - Subject: UE Inquiries - Stud Welding

Dear Mr. Schnell:

This letter provides additional input requested by NRC Region III representatives at a meeting in their office on May 29, 1980. Specifically, this information includes:

1. Documentation of the fabricator's stud welding practices for machine welded embed plates prior to June 9, 1977.

RECEIVED
JUN 19 1980
D. F. SCHNELL

2. A sample calculation, including discussion of approach, for establishing the reduced capacity of machine welded plates due to a postulated loss of one weld stud. Embed Plate EP 512A is used as a basis for this discussion.

3. A sample calculation, including discussion of approach, to determine the reduced capacity of manually welded embed plates (specifically embed plate EP 312) resulting from a postulated 1/16 and 1/8 inch undersize weld, as well as the analytical basis for accepting a 1/16 inch undercut on the shank of the anchor rod.

The following additional information is also offered as an aid to the NRC personnel in their evaluation of the welded studs:

4. The effect of a maximum 1/32 inch undercut on the shank of manually welded machine weld studs.

5. A discussion of the logic employed in the probability analysis for machine welded studs.

Item I

In response to Item 1 above, the practice employed by the machine welded embed plate supplier for installation and inspection of machine welded studs prior to June 9, 1977 is summarized in Enclosure A. Enclosure B provides examples of Bechtel inspection reports which indicate the review of welded studs (and stud bending) by the Bechtel inspector during the period in question.

Items 2 and 3

Sample calculations for the embed plates discussed in Items 2 and 3 above are included in Enclosures D and C respectively.

Item 4

Although the vast majority of machine welded studs are installed automatically with special "guns" under controlled conditions, there are a limited number of occasions where the studs may have either been installed or repaired by manual fillet welding. As indicated by field personnel in Enclosure E, such field welding was on a very limited basis. UE has indicated that the field practice in inspecting these limited number of studs for undercut was to use a 1/32 inch acceptance criterion on the shank of the stud in lieu of the more restrictive requirements of .01 inches as specified in AWS D1.1-75 Para. 3.6.4. The result is that some reduction in the safety margins could occur on these isolated studs. However, in the unlikely case that a maximum 1/32 inch undercut is postulated to extend around the entire perimeter of a stud, the revised stud capacity, as computed using the minimum specified yield strength, still would exceed the design requirements. Design drawings have been revised to clarify the design intent.

Item 5

The probability analysis for plates with machine welded studs presented in Reference 1 was prepared to evaluate the potential for failure of plates installed in concrete prior to the reinspection effort. In order to establish this probability the analysis accounts for several factors; the probability of a stud being ineffective (P_1), the probability of a plate (which is assumed to have an ineffective stud) supporting a safety related attachment (P_2), the probability of a load on a plate being of sufficient magnitude and at a location relative to an assumed failed stud to exceed the failure capacity of the plate (P_3) and the probability of the plate to ever experience the attachment design load (P_4). None of these factors in itself is representative of plate failure. Rather the resultant probability against a single plate failure is the product of these factors, or:

$$P = \sum_{n}(P_1 \cdot P_2 \cdot P'_{n3} \cdot P''_3 \cdot P'''_3 \cdot P_4)$$

The factor (P_1) is established from the reinspection data of 81,673 studs which were installed and shop inspected in the same manner as those studs on the plates in question. One could express the results of this reinspection in terms of a "Confidence Level" in a fashion similar to that employed by the NRC in IE Bulletin 79-02. This bulletin requires licensees to review concrete expansion anchors which serve essentially the same function as the embed plates in question. The acceptance criterion established in this bulletin was to have a 95% confidence level that less than 5% defects exist. Using the formulations included in the bulletin (which are based on a 95% confidence level) and the reinspection results, less than 0.1% defects are identified. Many of the plates support attachments which are not safety related. Although these plates share an equal probability of having ineffective studs there is no safety consequence. Plates retrieved from the laydown area prior to June 9, 1977 would have been taken from the same stock whether used for a safety related or non-safety related function. The factor (P_2) accounts for those plates which have safety related attachments.

The factor (P_3) addresses the effect the attachment load and its location have on a given plate, assuming the plate has an ineffective stud on or adjacent to the attachment location. Actual loads resulting from the attachment for each plate were determined. In order to include the possibility that the attachment may be at any location on the plate, the load was applied in each of 9 zones shown in Sketch 1a of the report (Reference 1). It is assumed the load has an equal possibility of being in any one of nine zones, hence $P''_3 = 1/9$. This is a conservative assumption in that the load will normally be appl[illegible] the center of the plate. In fact a drawing revision since the report was prepared requires that the centroid of the attaching weld be within the middle third of the plate. These applied loads were compared to the failure load in each zone of each plate assuming the stud in zone I to be ineffective. If the actual load exceeded the failure load a postulated failure was identified. The failure load is identified for each of these zones if any of the stresses reach the minimum specified yield stress. For computational purposes the ineffective stud was assumed to occur in zone I. A finite number of postulated failures were identified for zones I, II, III and VI as shown in the report (P'_3). Since the ineffective stud has an equal chance of occurring in any one of the four studs within a cluster the chance of it being in zone I is one in four. Conversely, zones IV, VII and IX have as equal chance as zone I of having the load applied over a postulated ineffective stud. Combining the random possibility of an ineffective stud at a given corner with the possibility that one of four corner zones could have a load over a postulated ineffective stud yields a factor of 1/4 X 4/1 = 1 (P'''_3). A similar argument holds for loads applied in other zones. Since a one in nine chance was assumed for the load to be applied in a given zone, it is necessary to sum the result for all nine zones. In fact, since no potential failures were identified for zones IV, V, VII, VIII and IX ($P''_{n3} = 0$) the actual summation includes only zones I, II, III and VI. Note that P_3 indicates only the probability of a plate failure for a postulated ineffective stud adjacent to the load point which is a safety related attachment with the computed attachment load applied.

The factor P_3 in itself is meaningless for it is computed on the premise that every attachment is on or adjacent to an ineffective stud. Furthermore, it is based on applying each attachment load in each of the nine zones to deliberately seek postulated failures. Realizing that plates with safety related attachments have a combined total of approximately 2,500 studs, the reinspection results would suggest that only approximately two studs could be postulated to fail. Of course these two studs may be located in areas of the plate not affected by the attachment loads. The point is that one cannot isolate one factor independent of others in the probability analysis. Rather, the probability of a plate failure must consider all factors in concert.

An equally important consideration is the possibility of the plate ever experiencing the design load. As one example, a significant contribution to the loads imposed on the plate is due to the seismic event. Dr. Newmark, in Reference 4 suggests that in combining the safety margins used to identify the seismic event and the multiplication of margins of safety resulting from the criteria and analytical methods imposed, a probability that the structure will ever experience the design loads may be in the order of 10^{-8}. A probability of 10^{-4} was conservatively assumed in the report for this consideration.

In summary the probability of a plate failure is the product of the probability of having an ineffective stud, the probability of the plate with an assumed ineffective stud supporting a safety related load, the probability of that load exceeding the plate capacity due to an assumed adjacent ineffective stud, and the probability of the attachment load actually occurring.

As provided in Reference 1, a total of 10 plates had multiple stud failures. Multiple stud failures on a given plate have no additional effect on the probability analysis unless they occur on adjacent studs. Four occurrences of adjacent stud failures can be identified from the data. No case exists where more than two studs failed within a stud cluster (the basis for design being a four stud cluster).

An analysis has not been conducted to evaluate the probability effect if a two adjacent stud failure were considered. Based on some simple comparisons we believe it is evident that this consideration will not substantially affect the results. The probability computation for a two stud failure is similar to that given above for a single stud failure, except that rather than considering the probability of a failed stud to the total number of studs inspected (P_1) one must compare it to the total number of stud clusters available. Based on a total of 81,673 studs, at least 81,673/4 = 20,418 stud clusters exist. Actually there are somewhat more than this number of stud clusters available since plates with more than 4 studs have studs that can be in more than one stud cluster. However, a similar equal increase in the number of cluster possibilities for the pair of ineffective studs also exists so that the effect is essentially self-cancelling. The result is that P_1 becomes $\frac{4}{20,418} = \frac{1}{5,104}$ or less than 1/4 the value for the single stud failure.

An increase in the probability of P_3 will occur. Although the calculations have not been generated to establish magnitude of this increase firmly we believe it to be in the neighborhood of a factor of 2 to 4. All other factors remain essentially the same as for a one stud failure. The net result is that the probability for plate failure due to a postulated multiple stud failure is of the same magnitude (exponent wise) as for a one stud failure i.e., the increase in P_3 is approximately offset by the decrease in P_1.

Since the probability for a one stud failure and a two stud failure are additive, the overall probability may at worst double. However the order of magnitude (exponent wise) remains essentially the same as presented in Reference 1.

Very truly yours,

J. H. Smith
Project Engineering Manager

EWT:bg
cc: N. A. Petrick

8 CHURCH STREET, GOUVERNEUR, NEW YORK 13642 (315) 287-2200 TWX 510-257-6951

Cives Steel Company
Northern Division

June 10, 1980
SL: 367

Bechtel Power Corporation
P.O. Box 607
Gaithersburg, MD 20760

Attention: Mr. Paul Divjak

Reference: SNUPPS Project
10466-C-131
Miscellaneous Metals

Gentlemen:

In regard to Purchase Order Item No. 2 embedded plates with concrete anchors, we hereby verify that Cives intent since the beginning of the production of these plates has been to obtain a 360° fillet on the machine welded studs. If the applied stud did not have 360°, the stud was either a) bend tested per AWS 4.30.1, or b) repaired per AWS 4.29.3, or c) replaced.

Very truly yours,

CIVES STEEL COMPANY
Northern Division

Ted Totten
Project Manager

TT:sw

CC: Dean W. Parshley

DETAILED PROCEDURE

FOR

TEST PROGRAM TO EVALUATE

WELDS OF ANCHOR RODS AND STUDS

TO EMBEDDED PLATES

BECHTEL POWER CORPORATION

GAITHERSBURG, MARYLAND

Prepared by: K. Parikh

July 2, 1980

Revised July 11, 1980
Revised Aug. 5, 1980 2

dupe of
8411170227
PDR (D)

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1.0 Purpose of the Test Program

This program is authorized by Union Electric Company to evaluate the performance of weldments which secure anchor rods and studs onto embedded plates. These tests will supplement Union Electric's report of the Acceptability of Embedded Plates dated March 10, 1978 (ULNRC-238) and its findings. Although the referenced report established that the welds on both the manually welded anchor rods and the machine welded studs installed in concrete prior to June 9, 1977 were a "completely acceptable" product, physical tests on a random sample of those embeds manufactured during that period were requested by the NRC. The test program is directed only at the evaluation of the welds between the studs and anchor rods to the plates.

The bend tests as identified herein are being conducted for information only. Tests of this nature are not required by the governing codes or specifications, nor does such testing reflect loads imposed on the welded assembly by design intent. Therefore, failure of a weld during the bend test cannot of itself constitute a determination that the weld was not suitable for the purpose intended by the design.

2.0 Description of the Test Program

The following tests will be conducted:

2.1 Manually welded embeds

From the 45 plates segregated and stored at the Callaway jobsite twelve plates have been selected for testing. Six rods on six separate plates have been selected for bend tests. The specific rods have been designated and their direction of bend specified by the NRC. Six additional rods on six other plates were selected by Union Electric for tension testing. The selections included rods having welds with most apparent visual deviations. These selections will be available for NRC review before the test. Bend and tension testing will be done at Lehigh University.

2.2 Machine welded plates

Six plates, embedded in concrete prior to June 9, 1977 shall be identified at the jobsite and tested in place to a load not exceeding the design load conditions (plus load tolerances). The plate selections will be reviewed by the NRC prior to testing.

2.3 Results and Reports

The testing will be witnessed at the jobsite and/or the laboratory by the persons specified below or their authorized representatives. A report, based on the tests, will be issued shortly thereafter.

3.0 Organizat or for the Test Progrem

The following lists various entities and their affiliated personnel involved in the test program including their primary respon ilities, where applicable.

Union Electric Company

D. Schnell - Overall responsibility and coordination with NRC

W. Zvanut - UE coordinator and witness for testing

K. Kuechenmeister - Field coordinator with DIC

R. Powers - QA and witness for testing

Nuclear Regulatory Commission

E. Gallagher - Witness and observer for test program;
Review test program for acceptability to NRC

Bechtel Power Corporation

P. Divjak - coordinator between UE/NRC.

E. Thomas/A. Pagano - Technical direction, responsible for the test set-up.

K. Parikh - Overall coordinator for test program and report.
Witness for the test program.

Daniel International, Inc.

____________________ - Assistance in the field test program. Furnishing labor, materials and transportation as required for the test program.

Dr. Fisher and Dr. Slutter - Consultants; advise test set-up and test procedures and for conducting testing at Lehigh University and at the jobsite as well as recording and reporting all test results at both the laboratory and jobsite.

4.0 Detailed Procedures

4.1 Manually welded rods

From the 45 plates isolated and held in storage at the jobsite, twelve plates designated herein shall be shipped to Dr. Roger Slutter, Lehigh University, Department of Civil Engineering, Fritz Engineering Laboratory #13, Bethlehem, PA 18015. The following plates and anchor rods are to be used for the designated testing method.

Tension Tests			Bend Tests		
EP412	A16-19 Left,	Rod #5	EP611	A31-2	Rod #2
EP711	A7-155	Rod #5	EP511	A32-2	Rod #5
EP511	A11-1	Rod #5	EP511	A11-46	Rod #9
EP412	A16-18 Bot.,	Rod #12	EP511	A11-42	Rod #10
EP412	A16-18 Top,	Rod #10	EP611	D24-1	Rod #5
EP711	A7-223	Rod #6	EP611	A24-2	Rod #1

Upon arrival at the test laboratory, the plates shall be properly stored in a secure place.

The anchor rods which are to be tested shall be visually examined for any damage during the shipment. If the anchor rod or the 3" x 3" plate at the end of the rod is found to be damaged, the overall coordinator shall determine its suitability for the test program.

The welds that are tested shall then be photographed from at least two angles.

The 3" x 3" plates for the qualified bolts shall be painted red for the tension test and green for the bend test. At least one additional anchor rod other than those identified previously in each category shall be selected for use in refining the loading procedures. Thus, seven bolts in each category are required for the test program. The selection process described above shall be performed in the presence of a consultant and the overall coordinator. In the event the selection of an anchor rod for the test program has changed, the overall coordinator shall notify Union Electric, before testing proceeds.

2 The selected anchor rods shall be isolated by cutting a nominal 4" x 4" square plate around each bolt. The initial "rough" cutting of the plate may be done by gas torch; however, the final cutting shall be done by sawing the plate under the supervision of the consultant. Precautions shall be taken to assure that the weld at the juncture of anchor rod and the plate is not affected by the cutting processes.

The individual assemblies obtained shall be sequentially numbered with a waterproof marker such that the marks or tags will be visible during testing. A record referencing the assembly numbers to the original plate numbers shall be maintained by the consultant.

The testing shall take place in the presence of designated personnel. The tension tests and the bend tests shall be done in the 300,000# capacity Baldwin machine. Certified calibration records indicating dates of calibration of the Baldwin machine, strain gages, and associated instrumentation shall be given to the overall coordinator prior to testing. Photographs of each test and a video cassette of test progress shall be recorded and referenced in accordance with the rod numbers.

4.1.1 TENSION TEST - RODS

Tension tests shall be conducted by gradually increasing the load in 10 kip increments until failure of the rod shank or the failure of the weld occurs. The change in the length of the rod shall be recorded for each load increment. Additional intermediate readings may be taken to obtain sufficient data to develop an elastic curve with a well defined yield point. All test data shall be recorded by the consultants and the originals of the recorded data shall be signed by at least one person from each entity represented.

4.1.2 BEND TEST - RODS

A bend test shall first be performed on a selected anchor rod other than those listed above to establish detailed loading procedures. During this first test the relationship of the applied load to deflection angle, the grip at base to hold the assembly, recovery of deflection when the load is released and approximate bend line above the plate shall be noted.

For bend tests on the designated anchor rods a strain gage shall be attached to the shank of the rod where maximum strain is expected, based on results of the initial test. The load shall be applied in 100 lb. increments or less as required to develop data for a load-strain curve. The applied loads and the corresponding strains from the strain gage shall be recorded. The anchor rod shall be bent up to a 30 degree angle with tolerances of ± 2 degrees. The welds shall be observed for any sign of cracking during the application of the load. If cracking occurs, the corresponding strain in the rod shall be recorded.

Upon completion of the tests all assemblies shall be packed and shipped to Daniel International Corporation, State Highway CC - 3 miles north of Highway 94, Portland, MO 65057, Attention: K. Kuechenmeister.

4.2 Machine welded studs

The overall coordinator, with the assistance of field personnel, shall select six plates which were embedded in concrete prior to June 9, 1977. The field coordinator shall obtain copies of material certificates for the plates and concrete cylinder test results for the applicable pours and forward them to the overall coordinator. The selection shall be based upon accessibility to the plates and feasibility of mounting a test rig for the plates. The selected plates shall be sequentially numbered and a record of the assigned number to the designated plate number shall be maintained by the field coordinator.

The testing rig, a 30-ton jack and accessories, and two dial gages to measure deflection shall be supplied by the consultants. Certified calibration records indicating the date of calibration for the jack and associated instrumentation shall be given to the overall coordinator prior to testing.

A 1-1/2 inch diameter threaded rod of at least ASTM A-36 quality as shown in Figure 1 shall be welded to each plate near the center of a four stud cluster as defined by the overall coordinator. The weld shall be examined by the magnetic particle method prior to testing. The attachment shall be welded 24 hours prior to the actual testing and care shall be exercised to ascertain that the attachment is not loaded by the construction personnel prior to testing. For holding the testing rig in place 4 expansion anchors 1/2 inch diameter and 4" long shall be installed as shown on Figure 1 (See Specification C-103A).

The testing rig shall be mounted on the expansion anchors and firmly secured in place. The jack shall be installed on the threaded attachment to the plate and the hydraulic pump shall be set on a table next to the wall. Dial gages shall be mounted by the consultants on the plate at desirable locations. Load shall be increased gradually on the plate and the deflection readings corresponding to the applied load shall be recorded. The maximum applied load shall be at least the design load but shall not exceed the design load plus 15%. When the maximum load is reached, the final reading for the deflection shall be taken two minutes later and the load shall be released. The test rig shall be moved to the next plate and the same procedure shall be continued.

The originals of the field results shall be signed by the overall coordinator and the consultant. Photographs and a video cassette shall record the test progress.

Note: Minor concrete spalling may occur during plate testing and should not be considered an unusual occurrence.

5.0 Results and Report

The recorded results shall be represented in a tabular and a graphic format in a report. The report shall be prepared by Bechtel with assistance from the consultants. The report shall include conclusions of the test.

APPENDIX A

Acceptance Criteria for Welds

of Anchor Rods and Studs to

Embed Plates

1. Tension Test on Anchor Rods (Laboratory)

   All rods selected for testing are 1 inch in diameter. The design load (allowable load) based on a factor of safety of 1.6 (load factor) on these rods is 13.65 kips maximum for an EP511 plate. The design load of 13.65 kips is related to the rated plate capacity of 75 kips (in actual use the maximum load on an EP511 plate embedded in concrete prior to June 9, 1977 did not exceed 60 kips). The welds between the anchor rods and plates shall be deemed acceptable if the connection carries a load of 13.65 kips without any sign of distress. In any event the testing shall be carried out to failure as specified in the detailed procedure.

2. Pull Test on Machine Welded Plates (Field)

   The selected plates are EP512 and EP912 in one or more four-stud clusters.

   For EP512 plates the acceptance criteria shall be a 14.5 kip load applied within a four-stud cluster without plate failure or plate deflection more than 1/4 inch. Similarly, EP912 plates shall be deemed acceptable at a 29.2 kip load safely applied within a four-stud cluster.

ATTACHMENT E

INTERIM TEST REPORT

WELDS OF ANCHOR RODS AND STUDS

TO EMBEDDED PLATES

BECHTEL POWER CORPORATION

Gaithersburg, Maryland

August 27, 1980

Prepared by:
K. Parikh

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1. Statement of Problem

The testing program described herein was authorized by Union Electric Company following a request by the NRC. The tests furnished physical evidence regarding the adequacy of welds at the junction of anchor rods and studs to plates which were to be embedded in concrete. The testing program supplements a previous study and report submitted to the NRC on March 10, 1978 (see ULNRC-238).

2. Description of Testing

All tests were performed in accordance with the "Detailed Procedures for the Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" which was submitted to the NRC (see ULNRC-365 dated July 17, 1980).

Six anchor rods selected by Union Electric for tension testing were tested at Lehigh University on August 6, 1980. Six additional anchor rods were bend tested to a 30° angle at Lehigh University on the same day. The rods chosen and direction of bend were specified by the NRC.

With NRC concurrence six readily accessible embedded plates with machine welded studs were selected at the Callaway jobsite by Union Electric (D. Stecko and K. Kuechenmeister) and Bechtel (K. Parikh) for tension testing. The plates were prepared for testing by Daniel International Corp. in accordance with the program test procedures and were tested on August 14, 1980.

All test results were observed and recorded by Dr. R. Slutter of Lehigh University. Dr. Slutter also assisted with the development of test procedures and implementation of the test program. An NRC representative witnessed all tests.

3. Test Results

Field data sheets of the test results and a graphical representation of the data obtained for the tension and bend tests are included in Appendix A.

Tension tests on the six designated rods showed the capacities of the welds to be fairly close to the ultimate strength of the rod material, and significantly higher than the 13.65 kips designated in the criteria for acceptability of the welds. The ultimate loads on the six rods were found to be between 46.2 and 51.5 kips.

The six bend tests were successfully completed to an angle of $30\overline{+}$ degrees without any sign of visual distress or other detrimental effect on the welds.

Jobsite tension tests on four EP512 embedded plates tested to a load of 15 kips and two EP912 embedded plates tested to a load of 30 kips indicated that the embeds satisfactorily support the imposed load (note - design loads were 14.5 kips and 29.5 kips respectively). Recorded deflections were less than one tenth of the acceptance criteria.

4. Conclusions

Samples were selected for testing either randomly (embeds at the Callaway jobsite) or specifically (rods with the most undesirable visual weld characteristics). All test results met or exceeded the design requirements and acceptance criteria and further demonstrate the acceptability of the subject embeds.

The testing supports the conclusions presented in the report forwarded by ULNRC-238 dated March 10, 1978 that the embeds at the Callaway jobsite are an acceptable product.

APPENDIX A

TEST RESULT DATA S: TS

TENSION TEST OF ·—

PLATE ________________

SPECIMEN F 1

FRITZ ENGINEERING LABORATORY #13
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

LOAD CELL	LOAD (kips)	LEFT DIAL	DIFF	RIGHT DIAL	DIFF	AVG.	REMARKS
105	1000	.829	0	.812	0	0	
302	3000	.827	0.001	.812	0	0.0005	
622	6000	.824	0.004	.812	0	0.0020	
900	9000	.8225	0.0055	.812	0	0.0025	
1202	12000	.8205	0.0075	.812	0	0.0038	
1499 ~~[illegible]~~	15000	.8185	0.0095	.812	0	0.0043	
1495	15000	.8185	0.0093	.812	0	0.0043	Load held 2 Min. No spalling or [illegible]

Dial Readings in Inches, 7/8" diameter pull rod used

8/14/80 [illegible] Lehigh Univ.
8/14/80 O.B. [illegible] VE
8/14/80 [illegible] Bechtel
8/14/80 [illegible] (VE)
8/14/80 [illegible] VE

TENSION TEST

PLATE ____________________

F2

FRITZ ENGINEERING LABORATORY
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

LOAD CELL	LOAD (Kips) lbs.	LEFT DIAL	DIFF	RIGHT DIAL	DIFF	AVG.	REMARKS
105	1000	.757	0	.2675	0	0	
302	3000	.7720	0.0020	.2670	0.0005	—	
602	6000	.7650	0.0015	.2625	0.0010	0.0012	
900	9000	.7595	0.0175	.2625	0.0010	0.0143	
1200	12000	.7565	0.0305	.2625	0.0010	0.0158	
1493	15000	.7535	0.0325	.2625	0.0010	0.0172	
1496	15000	.7530	0.0340	.2625	0.0010	0.0175	[illegible]

No Spalling & Cracks

Dial Gage readings in Inches

1/2" diameter pull rod used

Loading [illegible]

[illegible] on plate

[illegible] on [illegible]

8/14/80 [illegible signature] Lehigh Univ.

8/14/80 OB [illegible signature] OE

8/14/80 [illegible signature]

8/14/80 K. W. Kirchenmeister (OE)

8/14/80 [illegible signature] OE

TENSION TEST OF

PLATE ______________________

F 3

FRITZ ENGINEERING LABORATORY #13
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

LOAD CELL	LOAD (Kips) lbs.	LEFT DIAL	DIFF	RIGHT DIAL	DIFF	AVG.	REMARKS
105	1000	0.844	0	0.021	0	0	
302	3000	0.844	0	0.021	0	0	
600	6000	0.844	0	0.0205	0.0005	0.0003	
900	9000	0.8425	0.0015	0.0185	0.0025	0.0020	
1200	12000	0.8400	0.0040	0.0175	0.0035	0.0038	
1498	15000	0.8370	0.0070	0.0165	0.0045	0.0058	Load held 2 min
1448	15000	0.8368	0.0072	0.0165	0.0045	0.0058	

No Spalling of Concrete

Dial gage readings in inches
7/8" diameter rod used

8/14/80 [illegible] Lehigh University
8/14/80 [illegible] UE
8/14/80 [illegible]
8/14/80 [illegible] (UE)
8/14/80 [illegible] UE

FRITZ ENGINEERING LABORATORY [illegible]
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015
200.80.240.1

PLATE

F 4.

LOAD CELL	LOAD (kips)	LEFT DIAL	DIFF	RIGHT DIAL	DIFF	AVG.	REMARKS
190	2000	.5645	0	.7255	0	0	
605	5000	.5565	0.0080	.7260	-0.0005	0.0038	
999	10000	.5530	0.0115	.7260	-0.0005	0.0055	
1403	14000	.5495	0.0150	.7260	-0.0005	0.0075	
1776	18000	.5465	0.0180	.7260	-0.0005	0.0090	Ram out of stroke
2200	22000	.5345	0.0300	.7260	-0.0005	0.0150	
2595	26000	.5300	0.0345	.7255	0	0.0173	
2991	30000	.5235	0.0410	.7230	0.0025	0.0218	
2991	30000	.5225	0.0420	.7228	0.0027	0.0224	Hold load 2 hr

Dial gage readings in inches

1" Diameter pull rod used

No spalling of concrete

8/14/80 [illegible] Lehigh Univ.

8/14/80 [illegible] IE

8/14/80 [illegible] Bechtel

8/14/80 [illegible] (IE)

8/14/80 [illegible]

PLATE
F5

LOAD CELL	LOAD (Kips)	LEFT DIAL	DIFF	RIGHT DIAL	DIFF	AVG.	REMARKS
105	1000	0.7645	0	0.6860	0	0	
302	3000	0.7659	-0.0007	0.6812	0.0050	0.0021	
602	6000	0.7662	-0.0017	0.6765	0.0095	0.0039	
900	9000	0.7642	0.0003	0.6755	0.0105	0.0054	
1200	12000	0.7610	0.0035	0.6745	0.0115	0.0075	
1400	15000	0.7580	0.0065	0.6725	0.0125	0.0095	
1495	15000	0.7580	0.0065	0.6725	0.0135	0.0095	Load [illegible]
							No Spalling at Concrete

Dial readings in inches

7/8" diameter pull rod used

8/14/80 [illegible signature] Lehigh Univ
8/14/80 [illegible signature] OE
8/14/80 [illegible signature] Bechtel
8/14/80 [illegible signature] OE
8/14/80 [illegible signature]

TENSION TEST OF

PLATE F6

FRITZ ENGINEERING LABORATORY #13
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

LOAD CELL	LOAD (KIPS)	LEFT DIAL	DIFF	RIGHT DIAL	DIFF	AVG.	REMARKS
199	2000	0.5880	0	0.6097	0	0	
605	6000	0.5855	0.0025	0.6098	-0.0001	0.0012	
999	10000	0.5830	0.0050	0.6098	-0.0001	0.0025	
1403	14000	0.5795	0.0085	0.6097	0	0.0043	
1799	18000	0.5770	0.0110	0.6097	0	0.0055	
2200	22000	0.5745	0.0135	0.6097	0	0.0068	
2595	26000	0.5670	0.0210	0.6154	-.0057	0.0077	
2991	30000	0.5545	0.0335	0.6220	-.00123	0.0106	load held [illegible]
3091	30000	0.5540	0.0340	0.6221	-.00124	0.0108	No spalling of concrete

Dial gage readings in inches

1" diameter pull rod used.

8/14/80 [illegible] Lehigh Univ.

8/14/80 [illegible] UE

8/14/80 [illegible] Bechtel

8/14/80 [illegible] UE

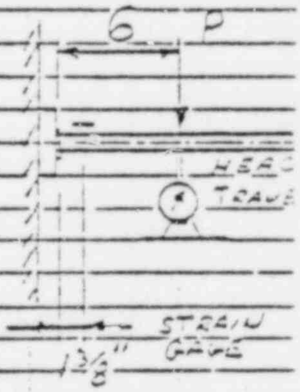
8/14/80 [illegible] UE

BEND TEST

SPECIMEN B1
PLATE EPG11 A31-Z Rod#2

LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015
200.80.240.1
SHEET 1 OF 12

LOAD (lbs.)	HEAD TRAVEL READING	HEAD TRAVEL DIFF.	ANGLE (degrees)	STRAIN DATA READING	REMARKS
0	~~0~~			0	
100	~~197~~	0.000	0	197	
200		0.009		330	
300		0.015		470	
400		0.023		614	
500		0.030		770	
600		0.039		922	
700		0.047		1074	
800		0.052		1200	
900		0.060		1364	
1000		0.069		1554	
1100		0.077		1730	
1200		0.088		1954	
1300		0.102		2214	
1400		0.129		2442	First Gap
1500		0.241		8540	
1600		0.346		15245	
1700		0.473		23010	
1800		0.600		29170	
1900		0.764		37560	
2000		0.917		44450	
2100		1.115		644	
2160		1.300			
2210	Reset	1.500			
2250	0.400	1.570			
2280	0.500	1.670			
2320	0.700	1.870			
2390	0.900	2.070	26° measured		Drop to 2280
2400	1.100	2.270			
2400	1.300	2.470			
2390	1.500	2.670	34° measured		
Reset	0.800				
2340	1.000	2.870			
2300	1.200	3.070			
2280	1.400	3.210	39½° measured		
0	—	—	37½°		



[signature] UF 8/6/80
Roy [signature] 8/6/80
[signature] 8/6/80

Testing Machine: 300,000 lb Capacity Baldwin Serial No. 39760

Test by: "Detailed Procedure for Test Program To Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Parikh Bechtel Power Corporation, Revised 7-11-80

BEND TEST

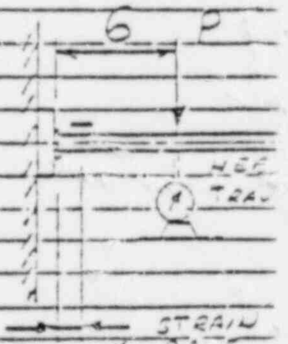
SPECIMEN B2
PLATE EPSII A32-2 Rd#5

LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

LOAD (lbs.)	HEAD TRAVEL READING	HEAD TRAVEL DIFF.	ANGLE (degrees)	STRAIN DATA READING	REMARKS
0		—		0	
100		0.000		199	
200		0.008		321	
300		0.015		[illegible]	
400		0.023		628	
500		0.032		792	
600		0.040		962	
700		0.047		1122	
[illegible]		0.056		1370	
[illegible]		0.065		1702	
1000		0.075		2160	
1100		0.090		2765	
1200		0.104		3515	
1300		0.029		4730	
1400		0.175		7350	
1500		0.364		12365	
1600		0.496		17470	
1700		0.474		24995	
1800		0.612		31715	
1900		0.975		39760	
2000		0.935		[illegible]050	
2100		1.102		—	
2200	[illegible]	1.349			
2280	0.400	1.576			
2300	0.457	1.663			
2340	0.700	1.876			
2380	0.900	2.076			
2400	1.100	2.276			
2400	1.300	2.476			
2380	1.500	2.676	32½ measured		
0			30½		

Dan [illegible] UE 8/5/80
Roy [illegible] 8/6/80
K[illegible] 8/6/80



Testing Machine: 300,000 lb. Capacity Baldwin Serial No. 39460

Test by: "Detailed Procedure for Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by L. Briggs Bechtel Power Corporation, Revised 7-11-80.

LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

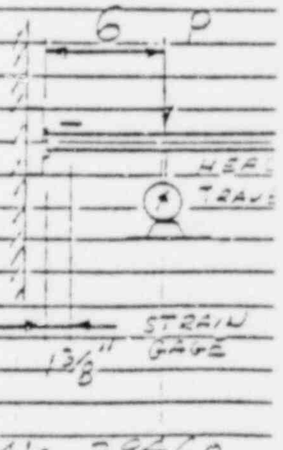
BEND TEST

SPECIMEN B3

PLATE EPSII A11-46 Rod #9

LOAD (lbs.)	HEAD TRAVEL READING	HEAD TRAVEL DIFF.	ANGLE (degrees)	STRAIN DATA READING	REMARKS
0	0			0	
100		0.000		204	
200		0.009		338	
400		0.023		642	
600		0.037		900	
800		0.053		1210	
1000		0.066		1500	
1200		0.085		1900	
[illegible]					
1300		0.182		5230	
1400		0.285		8390	
1500		0.402		21470	
1600		0.532		28580	
1700		0.712		37480	
1800		0.962		—	
1870		1.100			
1920		1.200			
1980		1.300			
2030	Reset	1.400			
2040	0.300	1.500			
2060	0.400	1.600			
2120	0.500	1.700			
2150	0.600	1.800			
2170	0.700	1.900			
2180	0.800	2.000			
2200	0.900	2.100			
2200	1.000	2.200			
2220	1.100	2.300			
2230	1.200	2.400			
2230	1.300	2.500			
2240	1.400	2.600			
2240	1.500	2.700	31½° measured		
Reset	0.800				
2220	0.900	2.800			
2230	1.000	2.900	34° measured		
0			32°		

[illegible] 8/6/80
[illegible] 8/6/80
[illegible] 8/6/80



Testing Machine: 300,000 lb Capacity Baldwin Serial No. 39460

Test by: "Detailed Procedure for Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Smith Bechtel Power Corporation, Revised 7-11-80

FRITZ ENGINEERING LABORATORY #13
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

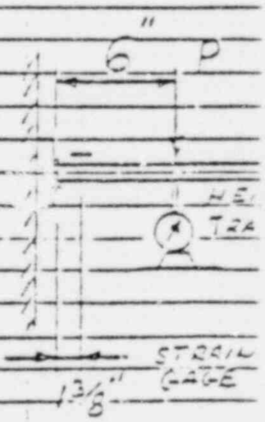
BEND TEST

SPECIMEN B4

PLATE EFSII A11-4C Rod #10

LOAD (lbs.)	HEAD TRAVEL READING	HEAD TRAVEL DIFF.		ANGLE (degrees)		STRAIN DATA READING	REMARKS
0		—				0	
100		0.000				160	
200		0.008				295	
400		0.023				660	
600		0.041				935	
800		0.056				1270	
1000		0.072				1595	
1200		0.098				2050	
1300		0.121				2790	
1400		0.236				7940	
1500		0.412				14525	
1600		0.522				26310	
1700		0.641				34150	
1800		0.902				43150	
1900		1.100				out	
2010		1.350					
2090	0.400	1.500					
2200	0.600	1.700					
2240	0.800	1.900					
2290	1.000	2.100	slip				
2290	1.200	2.300					
2340	1.400	2.500					
2320	1.500	2.600		32°	measured		
0				30°			

Don Hinkle 8/6/80
Roy [illegible] 8/6/80
Y. Parikh 8/6/80



Testing Machine: 300,000 lb. Capacity Baldwin Serial No. 39460

Test by: "Detailed Procedure for Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Parikh Bechtel Power Corporation [illegible]

BEND TEST

SPECIMEN 35
PLATE EP611 D29-1 Rod #5

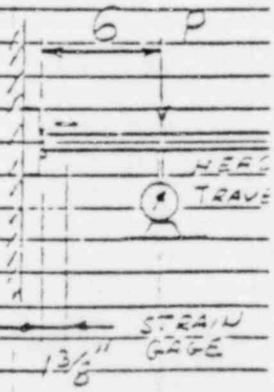
FRITZ ENGINEERING LABORATORY #13
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

SHEET 5 OF 12

LOAD (lbs.)	HEAD TRAVEL READING	HEAD TRAVEL DIFF.	ANGLE (degrees)		STRAIN DATA READING		REMARKS
0		–			1000	0	
100		0.000			1160 ~~1245~~	~~245~~ 160	
200		0.006			1310	310	
400		0.024			1610	610	
600		0.040			1905	905	
800		0.056			2185	1185	
1000		0.072			2485	1485	
1200		0.091			2465	1465	
1300		0.115			4050	3050	
1400		0.157			6510	5510	
1500		0.228			12085	11085	
1600		0.331			19920	18920	
1700		0.460			28225	27225	
1800		0.596			35825	34825	
1900		0.769			44875	43875	
2000		0.960			—		
2080		1.100					
2100	Reset	1.300					
2240	0.200	1.500					
2330	0.400	1.700					
2370	0.600	1.900					
2400	0.800	2.100					
2440	1.000	2.300					
2420	1.200	2.500					
2400	1.400	2.700	34°	measured			
0			32°	measured			

[illegible signature] 8/?/80
Roy Venton 8/?/80
Whaith 8/6/80



Testing Machine: 300,000 lb Capacity Baldwin Serial No. 39460

Test by: "Detailed Procedure for Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Baith Bechtel Power Corporation, Revised 7-11-80

BEND TEST

SPECIMEN B6

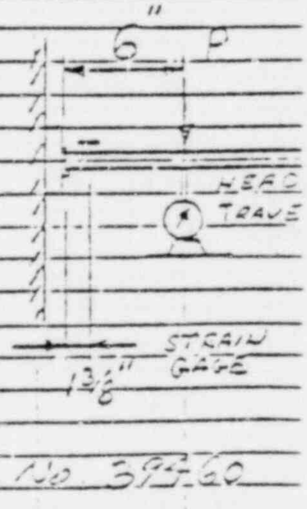
PLATE EP611 A24-2 Rod #1

FRITZ ENGINEERING LABORATORY #13
LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

LOAD (lbs.)	HEAD TRAVEL READING	HEAD TRAVEL DIFF.	ANGLE (degrees)	STRAIN DATA READING		REMARKS
0				1000	0	
100		0.000		1160	160	
200		0.009		1280	280	
400		0.026		1525	475	
600		0.041		1735	735	
800		0.058		2150	1150	
1000		0.074		2375	1375	
1200		0.096		2815	1715	
1300		0.228		7810	6810	
1400		0.356		16160	15160	
1500		0.526		26935	25935	
1600		0.800		36310	35310	
1700		0.960		43245	42245	
1800		1.122		—	—	
1920	Reset	1.300				
2000	0.400	1.500				
2040	0.600	1.700				
2080	0.800	1.900				
2130	1.000	2.100				
2170	1.200	2.300				
2210	1.400	2.500				
2180	1.600	2.700	31½° measured			
0			30° measured			

[illegible] 3/6/80
[illegible] 3/6/80
K Parikh 3/6/80



Testing Machine: 300,000 lb. Capacity Baldwin Serial No. 39960 Stno 020148

Test by: "Detailed Procedure for Test Program To Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Parikh Bechtel Power Corporation, Revised 2-11-80

TENSION TEST

SPECIMEN T1

PLATE EF412 A16-19 Left Rod #5

BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

SHEET 7 OF 12

LOAD (lbs.)	HEAD TRAVEL READING	DIFF		
1000	0.500	0.000		Gage Length 14 13/16"
2000	0.515	0.015		
4000	0.563	0.063		
6000	0.594	0.094		
8000	0.617	0.117		
10000	0.637	0.137		
12000	0.653	0.153		
14000	0.669	0.169		
16000	0.683	0.183		
18000	0.696	0.196		
20000	0.710	0.210		
22000	0.722	0.222		
24000	0.732	0.232		
26000	0.745	0.245		
28000	0.756	0.256		
30000	0.771	0.271		30,400 yield
30000	0.871	0.371		load dropped 24,600
32000	1.074	0.574		
34000	1.163	0.663		
36000	1.262	0.762		
38000	1.379	0.879		
38,000	0.600	0.976	Reset	
40,000	0.796	1.072		
42,000	0.816	1.194		
44,000	1.114	1.442		
46,000	1.432	1.760		
46,000	0.400		Reset	
47,000	0.642	2.002		Gage length = 16 5/8"
48,000	0.959	2.319		
48,500	1.285	2.645		
49,000	1.554			
49,000	0.200	2.919	Reset	
49,000	1.632			
49,000	0.100	4.351	Reset	
50,000	0.460	4.711		Ultimate Load

Gage length = 19 ½" after fracture

Failure in bar

[signature] 8/6/80

[signature] 8/6/80

[signature] 8/6/80

Testing Machine: 300,000 lb. Capacity Baldwin Serial No. 37460

Test by: Detailed Procedure for Test Program to Evaluate Welds at Anchor Rods and Studs to Embedded Plates" Prepared by K. Parikh, Bechtel Power Corporation Revised 7-11-80

LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

TENSION TEST

SPECIMEN T2

PLATE EF711 A7-155 Rod #5

Gage Length = 4"

LOAD (lbs.)	HEAD TRAVEL READING	HEAD TRAVEL DIFF	
1000	0.000	0.000	
2000		0.051	
~~3000~~			
4000		0.119	
~~5000~~			
6000		0.148	
~~7000~~			
8000		0.170	
~~9000~~			
10000		0.188	
12000		0.204	
14000		0.219	
16000		0.232	
18000		0.243	
20000		0.253	
22000		0.265	
24 000		0.276	
26 000		0.287	
28 000		0.299	
30 000		0.315	30,700 yield
32 000		0.421	
34000		0.462	
36 000		0.517	
38 000		0.565	
40 000		0.625	
42 000		0.695	
44 000		0.781	
46 000		0.900	
47 000		0.972	
48 000		1.059	
49 000		1.185	
50 000		1.318	
50,100		1.490	Failure in weld

[illegible signature] 8/6/80
[illegible signature] 8/6/80
[illegible signature] 8/6/80

Testing Machine: 300,000 lb Capacity Baldwin Serial No. 37460

Test by: "Detailed Procedure for Test Programs to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Smith, Bechtel Power Corporation Revised 7-11-80

TENSION TEST

SPECIMEN T3

PLATE EPSII A11-1 Rod #5

LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

Gage Length $4\frac{3}{8}$"

LOAD (lbs.)	HEAD TRAVEL READING	DIFF
1000		0.000
2000		0.011
4000		0.054
6000		0.082
8000		0.101
10000		0.117
12000		0.131
14000		0.143
16000		0.154
18000		0.165
20000		0.174
22000		0.184
24000		0.192
26000		0.205
28000		0.216
30000		0.241
32000		0.351
34000		0.402
36000		0.456
38000		0.575
40000		0.586
42000		0.670
44000		0.776
46000		0.920
47000		1.030
48000		1.155
49000	Reset	1.328
49500	0.000	1.500
50000	0.163	1.663
50500	0.430	1.930
50,750	1.050	2.550
	1.597	3.097

Yield 30,100 lbs.

50,750 ultimate

Failure in [illegible]

[illegible signature] 7/1/80
Ron Ueatel 8/6/80
[illegible] 8/6/80

Testing Machine: 300,000 lb. Capacity Baldwin Serial No. 3[illegible]60

Test by: "Detailed Procedure for Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Parikh, Bechtel Power Corporation Revised 7-11-80

LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.30.240.1

TENSION TEST

SPECIMEN T4

PLATE EPA12 A16-1B But Rod #12

Gage Length = 14 9/16"

LOAD (lbs.)	HEAD TRAVEL READING	HEAD TRAVEL DIFF
1000	0.100	0.000
2000	0.137	0.037
4000	0.178	0.078
6000	0.207	0.107
8000	0.226	0.126
10000	0.242	0.142
12000	0.257	0.157
14000	0.269	0.169
16000	0.291	0.191
18000	0.293	0.193
20000	0.304	0.204
22000	0.314	0.214
24000	0.324	0.224
26000	0.334	0.234
28000	0.347	0.247
30000	0.455	0.355
32000	0.601	0.501
34000	0.665	0.565
36000	0.771	0.671
38000	0.873	0.773
40000	0.992	0.892
42000	1.135	1.035
44000	1.320	1.220
46000	1.550	1.450
47000	1.721	1.621
48000	1.891	1.791
44000	2.141	2.041
50000	3.520	3.420
51000	4.000	3.900
51550	5.100	5.000

Yield 0.399 → 0.29
29,600 lbs.

Ultimate load
Failed in weld.

[illegible] 8/6/80
[illegible] 8/11/80
[illegible] 8/11/80

Testing Machine: 300,000 lb. Capacity Baldwin Serial No. 37460

Test by: "Detailed Procedure for Test Program to Evaluate Welds at Anchor Rods and Studs to Embedded Plates" Prepared by K. Parikh, Bechtel Power Corporation Revised 7-11-80

LEHIGH UNIVERSITY
BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

TENSION TEST

SPECIMEN TS

PLATE EPA12 A16-18 Top Rod #10

Gage Length = 14 7/8"

LOAD (lbs.)	HEAD TRAVEL READING	DIFF
1000	0.400	0.000
2000	0.448	0.048
4000	0.495	0.095
6000	0.524	0.124
8000	0.539	0.139
10 000	0.555	0.155
12000	0.571	0.171
14000	0.583	0.183
16000	0.595	0.195
18000	0.606	0.206
20000	0.617	0.217
22000	0.626	0.226
24000	0.635	0.235
26000	0.646	0.246
29000	0.659	0.259
30 000	0.679	0.279
32000	0.917	0.517
34000	0.994	0.594
36000	1.070	0.670
38000	1.175	0.775
40 000	1.292	0.892
42000	1.419	1.019
44000	1.591	1.191
46000	1.842	1.442
47000	1.987	1.587
48000	2.174	1.774
49000	2.437	2.037
50,000	2.808	2.408
51000	3.770	3.370
51300	4.450	4.050
Failure	5.075	4.675

yield = 30,000 lbs (at 30 000)

Ultimate Load (at 51300)
Failure in Bar.

Dean B. Hicks
Ray Ventch
[illegible] 8/6/80

Testing Machine: 300,000 lb. Capacity Baldwin Serial No. 39430

Test by: " Detailed Procedure for Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Parikh Bechtel Power Corporation Revised 7-11-80

TENSION TEST

SPECIMEN T6

PLATE EP711 A7-223 Rod #6

BETHLEHEM, PENNSYLVANIA 18015

200.80.240.1

SHEET 12 OF 12

Gage Length = 4"

LOAD (lbs.)	HEAD TRAVEL READING	DIFF	
1000	0.4000	0.000	
2000	0.431	0.031	
4000	0.450	0.050	
6000	0.496	0.096	
8000	0.512	0.112	
10000	0.528	0.128	
12000	0.542	0.142	
14000	0.554	0.154	
16000	0.566	0.166	
18000	0.578	0.178	
20000	0.588	0.188	
22000	0.598	0.198	
24000	0.607	0.207	
26000	0.617	0.217	
28000	0.626	0.226	Yield 29,700 (0.6...)
30000	0.727	0.327	
32,000	0.776	0.376	
34,000	0.823	0.423	
36,000	0.877	0.477	
38,000	0.936	0.536	
40,000	1.004	0.604	
42,000	1.0[illegible]	0.6[illegible]	
44,000	1.198	0.798	
46,000	1.351	0.951	
46,200	1.502	1.102	Failure in weld

[signature] 8/6/80

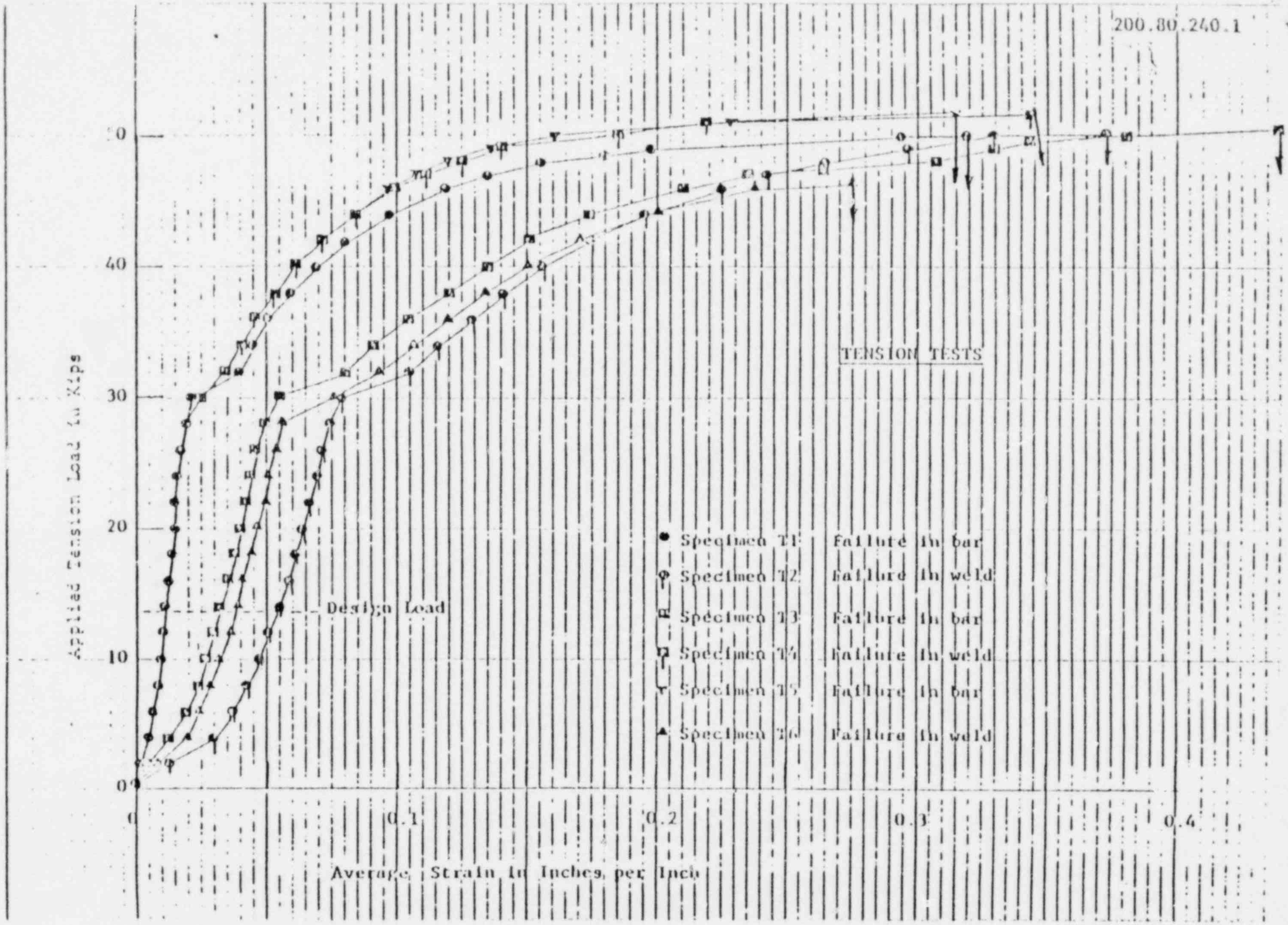
Roy Vaclik 8/6/80

[signature] 8/6/80

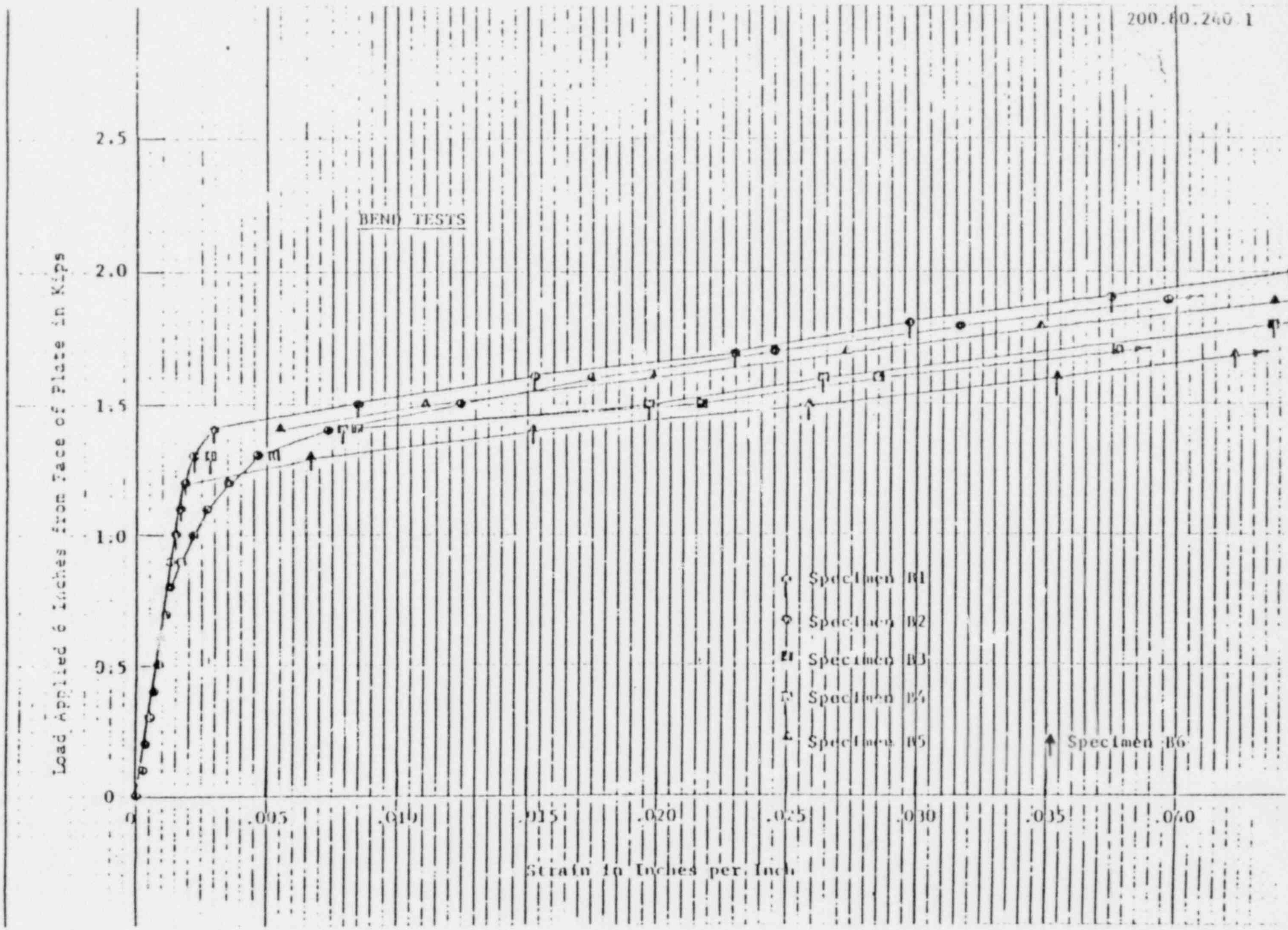
Testing Machine: 300,000 lb. Capacity Baldwin Serial No. 39460

Test by: "Detailed Procedure for Test Program to Evaluate Welds of Anchor Rods and Studs to Embedded Plates" Prepared by K. Kaniksky Bechtel Power Corporation Revised 7-11-80

46 0700



200.80.240.1
TENSION TESTS
Specimen T1 Failure in bar
Specimen T2 Failure in weld
Specimen T3 Failure in bar
Specimen T4 Failure in weld
Specimen T5 Failure in bar
Specimen T6 Failure in weld
Design Load
Applied Tension Load in Kips
Average Strain in Inches per Inch
0
10
20
30
40
50
0.1
0.2
0.3
0.4


200.80.240.1
BEND TESTS
Load Applied 6 Inches from Face of Plate in Kips
2.5
2.0
1.5
1.0
0.5
0
0
.005
.010
.015
.020
.025
.030
.035
.040
Strain in Inches per Inch
Specimen B1
Specimen B2
Specimen B3
Specimen B4
Specimen B5
Specimen B6

ATTACHMENT 2

All other welds are examined in accordance with AWS D1.1.

High strength bolted joints are examined in accordance with the requirements of the AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.

Examination of embedded anchor bolt materials used for RCS component support embeds meets the requirements of Section NF-2580 of the ASME Code for Class 1 component supports.

3.8.3.6.4.3 Erection

Restraints and embedded items are erected in accordance with the following:

a. AWS D1.1 Structural Welding Code is used, except that the qualification of welders and welding operators may, alternatively, be in accordance with ASME Section IX. In addition, weld procedures for joining structural steel and sleeves used for mechanical splicing of reinforcing steel may be qualified in accordance with ASME Section IX. The following exceptions are allowed for welding between anchor studs and plates embedded in concrete:

    1. Vertical leg of weld may be up to 1/16 inch smaller than that specified on drawings.

    2. Unequal legs are permitted.

    3. Weld profile and convexity requirements for these welds need not be imposed.

    4. An undercut of up to 1/16 inch for 10 percent of weld length may be permitted.

b. AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings Sections 1.23 and 1.25 are used without exception.

c. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts is used without exception.

d. Erection tolerances for pipe whip restraints, pipe whip restraint embeds, and RCS component support embeds are in accordance with the following:

    1. AISC Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings, for rolled plates and shapes

    2. AWS D1.1 Structural Welding Code for welded assemblies