

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*
D. W. Hayes, Chief
Engineering Support Section 1

Approved By: *G. Fiorelli*
G. Fiorelli, Chief
Reactor Construction and
Engineering Support Branch

9-3-80

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.

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.

The meetings contained discussion of the background of the embedded plate 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:

<u>Number of Plates</u>	<u>Number of Studs</u>	<u>Number of Indications</u> ¹
7543	81,643	457
<u>Number of Failures</u> ²	<u>% of Studs w/Indications</u>	<u>% of Studs Failed</u>
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 7543 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 welds less than 5/16 inch are permissible based on an analysis that the smaller weld develops 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 1/8 inch undersize are as follows:

<u>Plate Type</u>	<u>Load Capacity (lbs)* per Dwg C-0012 Sht. 9</u>	<u>Reduced Capacity (lbs) Due to 1/8 Inch Undersize</u>
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 strength 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 quantify 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
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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.

0) AWS D1.1 section 8.15 does

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