September 10, 1981

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNION ELECTRIC COMPANY	)	Docket No. STN 50-483 OL
	)	
(Callaway Plant, Unit 1)	)	

APPLICANT'S ANSWERS TO INTERROGATORIES
OF JOINT INTERVENORS (SECOND SET)

Applicant UNION ELECTRIC COMPANY, pursuant to 10 C.F.R. § 2.740b, hereby submits the following responses to "Joint Intervenors' Second Set of Interrogatories to Union Electric." The provision of answers to these interrogatories is not to be deemed a representation that Applicant considers the information sought to be relevant to the issues to be heard in this proceeding.

INTERROGATORY NO. 1. Describe the tests performed by Bechtel in its identification of "nonconformances involving more than 300 pieces of misfabricated steel" based on a sampling level of 20-25 percent of the miscellaneous steel pieces produced by Cives Corporation as per the SLBM: 6-514 letter from S.J. Seiken of SNUPPS to R.H. Stone of Bechtel, dated November 5, 1976. In addition, provide the following information:

a. State the number of embedded plates which had been shipped to the Callaway site as of November 5, 1976.

DS03
S 0/1

b. State how many of those were manually welded.

c. Describe the actions taken, if any, designed to remedy the nonconformances.

d. State the number of plates shipped from Cives to the Callaway site prior to June 15, 1977, the date on which Bechtel initiated 100 percent shop inspection at Cives as per the enclosure to BLUE-446 dated October 20, 1977.

e. Identify relevant documents which contain the information sought in this interrogatory.

ANSWER: Identification of nonconformances was accomplished by normal surveillance activities. No special tests were required or performed.

(a) See Tables 3(b) and 5(c) attached to Applicant's Answers to Joint Intervenors' Interrogatories (First Set).

(b) See Table 5(c) attached to Applicant's Answers to Joint Intervenors' Interrogatories (First Set).

(c) Bechtel evaluated the Cives quality program, found no problems, confirmed that Cives was a competent supplier with an effective QA/QC program, and determined that no action was required at that time. SNUPPS was notified to that effect on February 4, 1977 (letter BLSM-3806).

(d) See Tables 3(b) and 5(c) attached to Applicant's Answers to Joint Intervenors' Interrogatories (First Set). No additional plates were received at the Callaway site between June 9, 1977 and June 15, 1977.

(e) See Applicant's answer to Joint Intervenors' Interrogatory Nos. 3(c) and 5(d) (First Set); BLSM-3806; BLSM-6-3500.

INTERROGATORY NO. 2. According to the Daniel Inter-Office Communication PQWP-152 dated October 26, 1977, 2729 manually welded studs were rejected out of 6103 inspected, or 44.72 percent. On how many plates were the defective studs located?

ANSWER: Unknown, because of redundant inspections and duplicated documentation in PQWP-152.

INTERROGATORY NO. 3. Explain why there are differences between the following documents and what information is correct with respect to the total number of embedded plates installed in Q buildings at Callaway prior to June 9, 1977:

a. According to DLUC-5414 dated May 23, 1980, Attachment #1: Of the 691 plates installed before June 9, 1977, 232 plates were manually welded and 459 were automatically welded. (The same numbers were provided by the Applicant in response to Interrogatories 4 and 6.)

b. According to the listing of plates attached to BLUE-675 dated April 9, 1980, 259 plates were installed in concrete by June 9, 1977, with manually welded studs on which "welding between bolts and plates [was] assumed to be undersized by 1/8".". (165 plates in the Auxiliary Building, 60 in the Control Building, and 34 in the Communications Corridor.)

ANSWER: The listing of plates in BLUE-675 dated April 9, 1980, included plates in both safety and non-safety related concrete poured prior to June 9, 1977 and not available for inspection. The plates identified in DLUC-5414 dated May 23, 1980, included plates only in safety-related structures.

Therefore, 34 plates in the Communications Corridor were included in the BLUE-675 list and not in DLUC-5414. Nine additional plates included in DLUC-5414 were at the top of the concrete pours made prior to June 9, 1977 and were sufficiently exposed so as to allow inspection after that date and, therefore, were not included in the BLUE-675 listing. Additionally, two of the plates reported in DLUC-5414 as mechanically welded were actually manually welded and were properly considered as manually welded in the plate evaluation.

INTERROGATORY NO. 4. Explain the meaning of plates with or without CMTR's attached, as per Attachment #1 to DLUC-5414.

ANSWER: Plates with Certified Mill Test Reports (CMTR's) attached means that a copy of the CMTR for an individual plate was attached to the survey form for that plate. Plates without CMTR's attached means that a copy of the CMTR for an individual plate was not attached to the survey form for that plate. The survey is as described on DLUC-5406, dated 22 May, 1980.

INTERROGATORY NO. 5. Holds had been placed on the concrete pours at Slab Elevations 1988 and 2000 in the Auxiliary Building at the time the NRC discovered that faulty embeds from Cives were on site at Callaway. In the fall of 1977 the holds were lifted, and the pours proceeded. State whether the embeds which had been installed in the forms for the above two pours had been removed, tested, repaired and/or replaced prior to the pours in the fall of 1977. Identify all documents on which the answer to this interrogatory is based.

ANSWER: All embeds not embedded in concrete as of June 9, 1977, whether or not installed in forms, were inspected by Daniel International Welding Quality Control. Any embeds found

defective during this inspection were repaired or replaced. Such inspections were required pursuant to the provisions of Stop Work Order #8 and NCR 2-0831-C-B previously produced in response to Joint Intervenors' Document Request Nos. 8 and 9 (First Set).

INTERROGATORY NO. 6. Explain the discrepancy between the number of embeds reportedly returned to Cives in the following two documents:

a. "Defective embeds" returned to vendor "Cives" as per Warehouse Superintendent's Report of Shipment, Out-Bound Shipment Number 1077, dated June 27 1977 in which "Number of Packages" is listed as 60 (NCR 2-1193-C-B, Attachment "B"); and

b. Applicant's Answers to Interrogatories of Joint Intervenors (First Set) dated July 10, 1981, Answers to Number 8(c)(ii) and (iv) which state 12 manually welded and 36 mechanically welded embeds were returned to Cives, or a total of 48.

ANSWER: Applicant's answer to interrogatory nos. 8(c)(ii) and (iv) only addressed the number of manually and mechanically welded embedded plates which were returned to Cives. Superintendent's Report of Shipment, Out-bound Shipment Number 1077, dated 27 June 1977, includes embedded plates, embedded sleeves, and embedded frames.

INTERROGATORY NO. 7. State if any additional documents or reports of shipment exist other than the Engineered and Material Equipment Return #1077, dated June 27, 1977, concerning the return of defective embeds to Cives. If so, identify those documents or reports.

ANSWER: No documents or reports of shipment concerning the return of such embeds to Cives are retained at the Callaway

site, other than the engineering material and equipment return #1077, dated June 27, 1977.

INTERROGATORY NO. 7A. State whether any embeds have failed after being installed in the plant requiring their replacement. If so, provide the following information separately for each such embed failure:

a. Location in plant.

b. Structures supported by the failed embed.

c. Date of failure.

d. Date of installation of failed embed.

e. Consequences of the failure, including structures or systems that fell or were damaged.

f. Cause of the embed failure.

ANSWER: Yes, there has been one (1) embed failure at the Callaway site.

(a) Failed embed was an FP512F located on the West face of the RF wall in the Radwaste Tunnel, 22'-9" South of Column Line A14, between elevations 1974'-6 5/8" and 1981'-6 5/8".

(b) 12" pipe line #EG-061-HBD-12.

(c) Failure occurred on, or about, August 26, 1977.

(d) Embed was installed in Pour #2C713W06 on April 26, 1977.

(e) and (f) The pipe, which was supported in part by the subject embed, accidentally rolled during a welding operation, causing the pipe to roll off all its supports except

for the subject embed and fall to the floor. The embed was required to support most of the weight of the pipe, thereby causing the parent metal to be pulled from the embedded plate.

INTERROGATORY NO. 8. This interrogatory pertains to cracks in concrete walls in the Control Building. Provide the following information:

a. State the dates of each of the following:

(i) Concrete pours: 2C351W01 and 02; and 2C361W01 through 05.

(ii) The dates when cracks were first noticed in each of the above pours.

(iii) The date(s) when repairs were made in each area.

(iv) The date and pour number of lifts adjacent to each of the areas with cracks.

b. State the date of each of the following Bechtel drawings, as revised, was issued: C-OC3901, revision 8; C-OC3902, revision 8; C-OC3903, revision 6; and C-OC3904, revision 7.

c. State whether the crack depths were ever measured with instruments, as per page 1 of NCR 2-2173-C-A "Description of Nonconformance."

d. Explain the disparity in NCR 2-2173-C-A between the recommended dispositions "Use As Is" dated February 24, 1978, and the instruction dated March 14, 1978, to repair the cracks.

e. Regarding Crack No. 7 on page 4 in NCR 2-2081-C-A:

(i) State why Daniel Engineering considered only cracks 11, 13 and 15 to be a reportable condition, but not Crack 7 which extends through the depth of the wall, has

a width which also is described as not exceeding 1/16", and is over 34 feet long, longer than cracks 11, 13 and 15.

(ii) State whether instrument measurements were made of the length, width and depth of Crack 7 on the outside face of the wall; and if the answer is affirmative, state the results of each measurement.

f. State the reason(s) why there was a delay of over one year before NCR 2-2081-C-A was signed off, as per "Statement of Completed Action."

g. Regarding Crack 6 in NCR 2-2081-C-A: State whether this crack is visible from only the Control Building side of the wall, as per Applicant's Answer to Interrogatory No. 18 (July 10, 1981).

h. Describe the stresses or other phenomena which explain why some of the cracks in the Control Building walls extend from one concrete lift to an adjacent one.

i. State whether additional measurements of the cracks were made by Daniel Civil Engineering on or about June 18, 1981, and if the answer is affirmative, the results of the measurements. State further whether any cracks other than those delineated on NCR 2-2081-C-A were located during the inspection, and if so, specify locations and sizes.

j. State whether an NCR was issued on February 21, 1978, which superceded 2-2081-C-A, and if so, identify said NCR and state why it was then superceded by 2-2173-C-A, as per the commert on page 1 of the latter, "originally issued 2-21-78."

ANSWER: (a) (i) Pour No. 2C351W01 Pour Date 10/10/77

Pour No. 2C351W02 Pour Date 10/26/77

Pour No. 2C361W01 Pour Date 11/16/77

Pour No. 2C361W02 Pour Date 12/20/77

Pour No. 2C361W03 Pour Date 01/12/78

Pour No. 2C361W04 Pour Date 12/23/77

Pour No. 2C361W05 Pour Date 01/11/78

(ii) The date when cracks were first noticed in each of the above pours was February 8, 1978.

(iii) The date(s) when repairs were made in those areas of the above pours that needed repairs was June 12, 1979.

(iv) Pour No. 2C361W06 Pour Date 01/25/78

Pour No. 2C261W07 Pour Date 02/28/78

Pour No. 2C361W08 Pour Date 02/22/78

Pour No. 2C371W01 Pour Date 03/03/78

Pour No. 2C371W02 Pour Date 03/15/78

Pour No. 2C371W03 Pour Date 04/05/78

Pour No. 2C371W04 Pour Date 03/31/78

Pour No. 2C341W01 Pour Date 08/12/77

Pour No. 2C341W02 Pour Date 09/02/77

Pour No. 2C341W03 Pour Date 09/23/77

Pour No. 2C341W04 Pour Date 09/14/77

(b) C-OC3901, Rev. 8, January 11, 1978;

C-OC3902, Rev. 8, January 11, 1978;

C-OC3903, Rev. 6, September 12, 1977;

C-OC3904, Rev. 7, September 12, 1977.

(c) No.

(d) The appearance of the crack with respect to its length, width, and location indicated that a cosmetic repair

was appropriate. The structure, both prior to and after the repair, served its intended structural purpose.

(e) (i) Although crack #7 was long, the condition of the crack did not meet the criteria of a reportable crack.

(ii) No.

(f) Statement of Completed Action for NCR #2-2081-C-A was signed off on February 21, 1978 per PCE 865, dated February 21, 1978. NCR #2-2173-C-A was initiated on February 23, 1978 and closed June 15, 1979. The order of priorities for construction was such that the action indicated under the Revised Disposition was not completed until June, 1979. Normally, repairs of a minor nature are completed when several are available for work at the same time.

(g) Crack #6 is visible above the slab at elevation 2056'-10" from the Control Building side of the wall. Below this slab, the wall is painted and the crack does not show. On the Communication Corridor side of the wall, the crack is visible as a hairline crack.

(h) Concrete is inherently weak in tension, and no tensile capacity is assumed in design. With this type of material, cracking will occur perpendicular to the tensile stress field. Such a tensile stress field can be generated when the concrete undergoes a volumetric change and is restrained from moving at its edges. This restraint may be provided by adjacent pours. When a crack forms, the stress level rises at the crack tip and the crack runs until this

stress level at the crack tip drops below the tensile limits of the material. This may not occur until the crack has partially extended into another pour level.

(i) Yes. The results of the measurements are indicated on Table 8(i) attached hereto. No further cracks were located during the inspection.

(j) The NCR that superseded NCR #2-2081-C-A was NCR #2-2173-C-A. The original of NCR #2-2173-C-A that was initiated on February 21, 1978 was determined not to be of a reproduceable quality to send to Bechtel and was, therefore, re-typed on February 23, 1978 with the original issue date indicated.

INTERROGATORY NO. 9. Explain why Paper Calmenson should have been advised "to reject such [cracked Turbine Pedestal leg] bars before they are shipped," as per the SNUPPS (Bechtel) Trip Report of May 10-11, 1977, regarding the Reactor Pit Moat Area crack, page 1 of 4.

ANSWER: The cracked Turbine Pedestal leg bars referred to in the (Bechtel) Trip Report of May 10-11, 1977, contained no crack, but did have a cosmetic imperfection which gave the appearance of a crack. These bars are manufactured in accordance with ASTM-615 (an industry standard) which allows this type of imperfection, since it has no effect on the performance of the bar. It was suggested in the Trip Report that Paper Calmenson "reject such bars before they are shipped" to avoid unnecessary questions and paperwork with this type of non-significant bar imperfection. The bars referred to in the Trip Report are in a non-safety related structure.

INTERROGATORY NO. 10. Describe the dimensions and circumferential function of the M4 x 13 beam embedded in the reactor cavity moat area to which the one-fourth inch liner plate was welded.

ANSWER: The cross-sectional properties are given in AISC Manual of Steel Construction. See Attachment 10, attached hereto. The M4X13 embedded beam is located on a radius of 12'-7" from the Reactor centerline. The beam provides a means of aligning the liner plate, and serves as a backing bar for welding the liner plate together. It serves no structurally significant function.

INTERROGATORY NO. 11. This interrogatory applies to the following partial sentence in the Answer of the NRC Staff to Joint Intervenors' Interrogatories numbers 35 and 36 with regard to the Tendon Access Gallery: "The details of removing unsound concrete surrounding the main steel and in back of base plates were accomplished by one man (skilled laborer) . . ."

a. State the number of manhours expended on the chipping operation.

b. State whether the skilled laborer was a concrete finisher, or if not, the craft in which he is skilled.

ANSWER: (a) 1460 manhours.

(b) Concrete finishers and their helpers performed the chipping.

INTERROGATORY NO. 12. This interrogatory applies to the grouting of the voids in the Tendon Gallery Roof:

a. State whether it is correct, according to the Applicant's Answer to Interrogatory No. 42(c)(3), that all grout and drypack were placed on September 26, 28 and 29, and on December 7, 1978.

b. If the answer to (a) is negative, explain.

c. If the answer to (a) is affirmative, state the reason(s) for the delay of two months in the completion of the repair procedure.

d. State the number of manhours expended in the placing of the grout and drypack.

e. State the quantity of grout and drypack placed.

ANSWER: (a) Yes.

(b) Not applicable.

(c) All grout repairs required by NCR 2-0856-C-A were completed between September 26 and 29, 1978. Drypacking, as described on Attachment "B" of NCR 2-0856-C-A was not considered significant and took place at the convenience of DIC Construction.

(d) 1770 manhours were expended for forming, placing and curing.

(e) Quantity of grout used was 150 cubic feet (estimated). Quantity of drypack used was 3 cubic feet (estimated).

INTERROGATORY NO. 13. State the diameters or sizes of those reinforcing bars in the bottom lift of the base mat which were exposed following the chipping of the defective concrete.

ANSWER: #18 reinforcing bars were exposed following the chipping of the concrete in the tendon access gallery ceiling.

INTERROGATORY NO. 14. Explain the relationship of the hemispherical dome and cylindrical shell cited by Applicant in response to Joint Intervenors' Interrogatory No. 60.

ANSWER: The Callaway Unit 1 Containment consists of a cylindrical shell supporting the hemispherical dome.

INTERROGATORY NO. 15. State whether the matter of flaking concrete referred to in Joint Intervenors' First Set of Interrogatories numbers 68 and 69 has been closed. Identify all documents pertaining to the current status of this nonconformance.

ANSWER: No. The matter is being carried as an open item by the NRC in Report No. 50-483/80-27. No further action is required of Applicant.

INTERROGATORY NO. 16. Explain the following discrepancies:

a. In the "Answers of the NRC Staff to Joint Intervenors' First Set of Interrogatories . . ." the NRC Staff provided a list entitled "NCR's Related to Concrete Placement 2C231WO3" in answer to Interrogatory No. 68. Although this NRC list contains 23 NCRs, it does not include Number 2-1683-C-A or Number 2-1042-C-A, both of which were included by the Applicant in its document production.

b. The Applicant, on the other hand, did not provide NCR Number 2-1411-C-A or Number 2-1594-C-A among the 23 NCRs it produced in response to Interrogatory No. 80 and Document Request No. 47. Both of these NCRs were included in the NRC list of 23.

c. NCR Number 2-1532-C-B is listed by the Applicant in response to Interrogatory 81 as one of nine NCRs outstanding on November 21, 1977, the eve of the third lift pour, but it is not included in the NRC Staff's list and was not included by the Applicant in its document production.

ANSWER: The Applicant's list of 23 Nonconformance Reports produced in response to Interrogatory No. 80 (First Set) and Document Request No. 47 (First Set) should have included NCR

Numbers 2-1411-C-A, 2-1594-C-A and 2-1532-C-B. This would bring the total NCR's applicable to Pour No. 2C231W03 to 26.

Included in the Applicant's list, however, were NCR 2-1683-C-A and NCR 2-1571-C-A. These two NCR's should not have been included, as NCR 2-1683-C-A was originated after Pour No. 2C231W03 was completed, and NCR 2-1571-C-A was superseded by NCR 2-1605-C-B. The removal of these two NCR's from the list results in a total of 24.

A total of 24 versus the 23 referred to in NRC Report No. 50-483/77-10 can be explained in that NCR 2-1594-C-A had an incorrect Pour No. referenced which was not corrected until December 2, 1977. Thus, it was not entered on Quality Control's pre-pour checklist for Pour No. 2C231W03, which was most likely the source of the 23 NCR's mentioned in the referenced report.

INTERROGATORY NO. 17. Provide the following information about the NCRs provided in response to Document Request No. 47:

a. Explain how the Applicant is able to tell which nine NCRs out of the 23 pertaining to the third lift were still outstanding--that is, not yet "closed out"--as of the evening of November 21, 1977 (as per the Applicant's answer to Interrogatory No. 81).

b. Explain how the Applicant knows that an NCR has been reworked or repaired prior to concrete placement when the only information included on the NCR form in the section entitled "Statement of Completed Action" is either the notation, "work completed per approved disposition," signed and dated a few days or months after the concrete pour, and/or "Hold tag destroyed" or "Hold tag

lost in field," also dated after the pour.

c. State on what part of the NCR form the following two notations appear: (i) the prepour disposition action completion date, and (ii) the evidence that the "rework" or "repair" has been completed as per the recommended disposition.

d. Regarding NCR Number 2-1613-C-A, describe the actions taken and the relevant dates to indicate that the Applicant corrected the interference of the rebars with the tendon sheathing at the feedwater line and blow down line areas (Areas P8-P12, P7-P11, P6-P10 and P5-P9), prior to the concrete pour number 2C23f1WO3.

e. Describe the rework or repair actions taken on each of the following NCRs which were still outstanding as of November 21, 1977, prior to the third lift pour: NCR Nos. 2-1470-C-D; 2-1511-C-A; 2-1595-C-D; 2-1605-C-B; and 2-1634-C-A. State whether the actions were taken in each case after the departure from the Callaway site of the two NRC staff members, the evening of November 21, 1977, if the information is available.

f. If the recommended disposition on NCR Number 2-1532-C-B was to "rework" or "repair," rather than to "use as is," describe the actions taken to correct the nonconformance.

g. At what time of day on November 23, 1977, did Concrete Pour Number 2C231WO3 begin?

ANSWER: (a) The list of nine Nonconformance Reports which were still outstanding on the evening of November 21, 1977 (per the Applicant's answer to Interrogatory No. 81 (First Set), were determined by examination of the dates on which the

Quality Control Inspector initialed the "Statement of Completed Action" box which was verification that work had been completed per the approved Disposition.

All Nonconformance Reports which were initialed by the Quality Control Inspector on or after November 21, 1977, were included in the list as being open the evening of November 21, 1977 since, as stated in Applicant's answer to Interrogatory No. 91 (First Set), it is impossible to determine the actual hour of close-out.

(b) In accordance with the requirements of site nonconformance procedures, "Work complete per approved Disposition" or a similar statement is made in the "Statement of Completed Action" box and signed and dated by the person stating that action is complete. An Inspector's initials and date are also required within the "Statement of Completed Action" box, as a verification that the required action has been accomplished in accordance with the approved Disposition. Both of these items are required to be completed prior to a concrete placement.

The statement "HOLD TAGS DESTROYED" OR "HOLD TAGS LOST IN FIELD" is usually applied during the final review and formal close-out cycle of the Nonconformance Report, which can be significantly after the work has been completed and verified.

(c) (i) The pre-pour Disposition Action completion date appears in the lower, left hand corner of the "Statement

of Completed Action" box beside the Signature and Title of the individual stating that action has been completed.

(ii) Evidence that "REWORK" or "REPAIR" has been completed per the recommended disposition, appears within the "Statement of Completed Action" box as the verifying Inspector's initials and date verification was provided.

(d) The "Statement of Completed Action" box on NCR 2-1613-C was annotated "Work completed per approved Disposition" and signed by the Reactor Building Superintendent on 11-23-77. Action was verified on the same date and indicated by the Quality Control Inspector placing his initials, and the date, near the "Action Verified" blank in the "Statement of completed Action" box.

(e) Description of Rework or Repair actions taken is as follows:

NCR No. 2-1470-C-A

Involved cutting, rotating and cadwelding 180° hooks on inside face vertical reinforcing bars near the main steam and feed water penetration area to avoid interferences with horizontal tendon sheathing.

NCR No. 2-1511-C-A

Involved chipping concrete in Pour No. 2C231WO2 (Second Lift) to allow installation of a sheathing drain for a tendon which runs directly above the construction joint between the second and third lifts.

NCR No. 2-1595-C-D

Involved cutting the 180° hooks off two (2) #18 vertical bars near a main steam penetration and cadwelding them together.

NCR No. 2-1605-C-B

Involved cutting excess length from two (2) #14 inside face horizontal bars with 180° hooks which had been misfabricated.

NCR No. 2-1634-C-D

Involved the installation of shear ties in the main steam penetration area which had not been detailed on placement drawings but were required by the design drawings.

It is not known whether the above actions were taken before or after the evening of November 21, 1977.

(f) The Recommended Disposition of NCR 2-1532-C-B was neither "REWORK", "REPAIR" or "USE AS IS" but rather to REJECT the damaged bars. The damaged bars were discarded and replacement bars were fabricated on site.

(g) Pour Number 2C231W03 began at approximately 10:30 a.m. on November 23, 1977.

INTERROGATORY NO. 18. This interrogatory refers to the Applicant's response of July 10, 1981, to Interrogatory No. 71 in which the Applicant refers to January 5, 1978, as the date on which "the NRC [Staff] was conducting a special, announced investigation into allegations regarding, among other things, improper concrete cover for reinforcement."

a. State whether Eugene Gallagher and James Foster of the NRC Staff also inspected the placement of reinforcing bars for the Fourth Lift of the Containment

Building with William Smart, ironworker, on January 3, 1978.

b. If the answer to (a) above is affirmative, explain why this date was omitted from the Answer to Interrogatory No. 71.

c. State whether the NRC Staff directed questions orally or in writing to representatives of Union Electric or its contractors in early January 1978 about the placement of the reinforcing steel, maximum and minimum concrete cover tolerances, and/or other potential nonconformances with regard to the Fourth Lift.

d. If the answer to (c) above is affirmative, state what actions were taken, if any, by the Applicant. State further how many manhours were expended on any reworking.

e. State how close (in terms of time and stage of preparation) the Applicant was to having the concrete placement proceed at the time the NRC Staff inspected the Fourth Lift with William Smart.

f. State the date of the commencement of the installation of the Fourth Lift reinforcing steel.

g. Explain the reason(s) why the Applicant spent 50 days installing reinforcing steel for Pour #4 as compared with 33 days for Pour #3, as per Applicant's Answer to Interrogatory No. 92 (July 10, 1981).

ANSWER: (a) It is not known whether William Smart accompanied NRC Staff to inspect the Fourth Lift.

(b) Not Applicable.

(c) Questions were directed orally by the NRC and were followed up in writing in NRC Report No. 50-483/77-11, p. 20.

(d) Actions taken by Applicant are summarized in NRC Report No. 50-483/77-11. Manhours are not tracked for work of this nature.

(e) The Fourth Lift was placed on February 6, 1978. Therefore, the construction stage was approximately one month prior to concrete placement.

(f) Approximately April 8, 1977.

(g) Rebar around the feedwater penetrations, rebar around the electrical penetrations, additional cadwelds and poor weather conditions are reasons for the additional time spent.

INTERROGATORY NO. 19. In response to Joint Intervenors' Document Request No. 48 (First Set) Union Electric states, "The purchase orders to Dravo do not specify the pipe manufacturer and therefore Applicant is unable to differentiate purchase orders applicable to Youngstown Welding and Engineering manufactured pipe from pipe manufactured by other entities." In a letter to the NRC Region III office (ULNRC-314) dated May 11, 1979, from Union Electric the following statement is made: "A survey of current SNUPPS suppliers of pipe spools and preassembled pipe formations indicates that only Dravo Corporation, Marietta, Ohio has supplied pipe spools containing fusion welded SA-312 type 304 pipe (without filler material) manufactured by Youngstown Welding and Engineering Company." Attached to the letter is a list of 65 pipe spools containing the SA-312 pipe manufactured by YW&E.

a. In conducting the survey cited in the above letter, identify the documents that were examined to locate and identify the 65 pipe spools containing the SA-312 pipe manufactured by YW&E.

b. Can the Applicant locate and identify the purchase orders used to procure the 65 pipe spools cited in the letter to the NRC?

c. If the answer to the preceding question is affirmative, please identify the

purchase orders, with attachments including all specifications, for the 65 pipe spools listed in the UE letter.

d. The list of 65 pipe spools attached to the UE letter has a heading which reads "Enclosure 5." Was this attachment a part of or included with another letter, report, memo or written document?

e. If the answer to the above question is affirmative, please identify the document with all of its enclosures and attachments.

f. If the answer to question (d) is other than affirmative, please explain what "Enclosure 5" means since there is only one attachment to the UE letter.

ANSWER: (a) See BLSE-7136, dated April 26, 1979 and enclosures thereto.

(b) Yes.

(c) Dravo purchase order nos. E-3002-14 and E-3000-22.

(d) Yes.

(e) BLSE-7136, dated April 26, 1979.

(f) Not Applicable.

INTERROGATORY NO. 20. In a letter from Aptech Engineering Services of Los Altos, California (re: Lack of Fusion in Stainless Steel Welded Pipe) to W.R. Smith, Bechtel National Inc., dated May 15, 1979, Geoffrey R. Egan states, "We believe the defects we have seen will be more significant from the point of view of fatigue failure (rather than fracture)."

a. Are the defects more significant from a fatigue point of view than from a fracture point of view?

b. State the reasons and factual basis for your answer to the preceding question.

c. Identify all documents you rely upon to substantiate your answers to (a) and (b) above.

d. Can fatigue affect the structural integrity of SA-312 pipe containing lack-of-penetration defects?

e. State the factual basis for your answer to the preceding question.

f. Identify all documents you rely upon to substantiate your answer to questions (d) and (e) above.

g. Has a fatigue evaluation been made for SA-312 pipe with lack-of-penetration in the longitudinal welds?

h. If the answer to the preceding question is affirmative, please state the extent of the evaluation and identify the documents which contain the evaluation.

i. Did Bechtel evaluate fatigue failure prior to making the recommendations in its June 1979 report titled, "Report on Investigation of Weld Imperfections in ASME SA-312 Double Welded Austenitic Stainless Steel Pipe for Compliance with NRC I&E Bulletin 79-03"?

j. If the answer to the preceding question is affirmative, state the extent of the evaluation and identify all documents which reflect the evaluation.

k. If the answer to the question (i) is other than affirmative, state the reasons and factual basis for not evaluating fatigue failure.

ANSWER: (a) The referenced letter was written prior to the completion of the fracture mechanics analysis and the fatigue analysis. These analyses conclude that the effect of center-line lack of penetration (CLP) is negligible on both the fatigue and fracture of SA-312 pipe.

(b) These are the conclusions of APTECH Engineering Services Inc. Reports AES-79-08-8 and AES-80-03-15.

(c) APTECH Engineering Service Inc. Reports AES-79-08-8 and AES-80-03-15.

(d) The effect of CLP on the fatigue life of SA-312 pipe is negligible and any such difference in fatigue life does not affect the structural integrity of SA-312 pipe containing lack-of-penetration defects.

(e) This is the conclusion of APTECH Engineering Services Inc. Report AES-80-03-15.

(f) APTECH Engineering Services, Inc. Reports AES-79-08-8 and AES 80-03-15.

(g) Yes.

(h) APTECH Engineering Services, Inc. Report AES-80-03-15.

(i) No.

(j) Not applicable.

(k) The referenced Bechtel Report of June, 1979, was an investigation of the metallurgical aspects of the CLP problem and made no attempt to assess the effect of fatigue on piping containing CLP. ASME Section III does not require a fatigue analysis on Class 2 piping systems; however, it was considered that the potential effects on fatigue were sufficiently important that the fatigue analysis was subsequently performed.

INTERROGATORY NO. 21. Concerning Residual Heat Removal system integrity, Regulatory Guideline 1.139 states, "The RHR system should be designed and constructed to have the capability to remove heat from the reactor coolant during normal and following accident conditions." In the attachment to the Union

Electric letter (ULNRC-314), dated May 11, 1979, to the NRC Region III, 56 spool pieces containing Youngstown Welding and Engineering SA-312 pipe are listed as parts of the RHR system, as identified by the EJ designation.

a. Could fatigue failures in the longitudinal seam welds of SA-312 piping impede the capability of the RHR system to remove heat from the reactor coolant during normal or following accident conditions?

b. State the factual basis for your answer to the preceding question.

c. Identify and supply a copy of all the documents you rely upon to support your answer to questions (a) and (b) above.

d. What is the maximum amount of irradiation SA-312 piping could be exposed to following accident conditions?

e. What is the longest period of time following an accident, that the RHR system could be required to remove heat from the reactor coolant?

f. Could irradiation affect the mechanical properties of SA-312 piping with lack-of-penetration defects in a manner that would alter the significance of the defects?

g. State the factual basis for your answer in question (f) above.

h. Identify all the documents you rely upon to substantiate your answer to questions (f) and (g) above.

i. At what percentage level of chemical composition does copper affect the crack susceptability of irradiated austenitic stainless steel using the amount of radiation and exposure time given in answer to questions (d) and (e) above?

ANSWER: (a) No. As stated in SNUPPS FSAR Section 6.3.2.5, and consistent with the NRC criteria in 10 C.F.R. 50 Appendix

A, the RHR system is designed such that it can sustain a single passive failure during the long-term accident recovery phase and still effect the removal of decay heat from the core.

(b) See SNUPPS FSAR Section 6.3.2.5.

(c) See answer to interrogatory no. 21(b).

(d) The maximum amount of irradiation that SA-312 piping associated with the SNUPPS Residual Heat Removal System (RHR) could be exposed to following accident conditions has not been specifically identified; however, as stated in SNUPPS FSAR Table 3.11(B)-2, the expected design basis accident dose for the equipment in the RHR pump rooms is less than 5×10^5 Rad.

(e) The longest period of time following an accident that the RHR system could be required to remove heat from the reactor coolant has not been specifically identified and would depend on the type and extent of the accident, and the accident recovery operations. As a basis for equipment qualification, the RHR system is designed to maintain operability in the post-accident environment for at least 1 year. (See FSAR Table 3.11(B)-2).

(f) Beta and gamma rays following accident conditions, which are the only types of irradiation to which SA-312 piping in the RHR system could be exposed, do not affect the mechanical properties of stainless steels in any way.

(g) There is insufficient energy in beta and gamma rays to cause or create the changes in the atomic structure of the materials which lead to changes in mechanical properties on a macroscopic scale.

(h) Reactor Handbook, Second Edition, Volume 1, edited by C. R. Tipton, 1960, pp. 42 and 43.

(i) At a level of radiation exposure of 5×10^5 Rad. there are no limits on the quantity of copper content of the stainless steel as it might affect the cracking susceptibility.

INTERROGATORY NO. 22. An NRC Region IV Vendor Inspection Branch report, No. 99900029/79-01 concerns SA-312 pipe manufactured by Youngstown Welding and Engineering and states, "Welding procedure No. 750 has been in use since 1972 and although it was requalified in March 1975, the "Welding Procedure 750 Supplements" limiting parameters to wall thickness, were not implemented until December 1978, and therefore the SA-312 piping welded prior to this date using WPS No. 750 may be considered suspect in quality of the welds." In the Union Electric letter (ULNRC-314) dated May 11, 1979, to the NRC Region III reference is made to 65 spool pieces containing SA-312 piping manufactured by Youngstown Welding & Engineering.

a. What welding procedure was used by YW&E in manufacturing the SA-312 pipe referred to in the Union Electric letter?

b. When was the SA-312 pipe referred to in the Union Electric letter welded?

c. Were radiographic or ultrasonic methods of examination used in qualifying YW&E welding procedure No. 750 and its supplements?

d. Identify the YW&E procedure qualification record used to qualify procedure No. 750.

e. Are radiographic and/or ultrasonic methods reliable means of qualifying welding procedures that may produce lack-of-penetration without a discrete gap between abutting joint surfaces?

f. State the factual basis for your answer to the preceding question.

ANSWER: (a) Youngstown Welding and Engineering procedure 750.

(b) The SA-312 pipe referred to in the Union Electric letter was welded during the same time period as the other YW&E piping in question.

(c) No.

(d) YW&E welding procedure qualification record SD-485-3, dated March 12, 1975.

(e) No.

(f) Bechtel report titled "Report on Investigation of Weld Imperfections in ASME SA-312 Double Welded Austenitic Stainless Steel Pipe for Compliance with NRC I&E Bulletin 79-03," dated June, 1979.

INTERROGATORY NO. 23. A SNUPPS letter (SLNRC 79-16) to the NRC, dated October 5, 1979, refers to 'efficiency factors'.

a. What is the function or purpose of 'efficiency factors'?

b. What procedure or method is used to determine an efficiency factor, specifically the .85 efficiency factor referred to in Note 3 to Table I-7.2 of Appendix I of Section III of the ASME Code for butt welds made without filler metal?

c. Define and elucidate the term "volumetric examination" as used in the phrase, "volumetric examination of the longitudinal weld" used in the above cited letter.

d. According to Note 3 to Table I-7.2, Appendix I, Section III of the ASME Code, what is the efficiency factor for butt welds, made without filler metal, and examined by the radiographic method according to ASME Section III, NC-2550?

ANSWER: (a) Efficiency factors provide design engineers with a mechanism for utilizing reduced or lower design stresses for various materials depending on the type and quantity of nondestructive examination performed on the material. Cast materials and longitudinally welded pipe materials are usually the materials to which factors are applied.

(b) The efficiency factors shown in Table I-7.1 of Appendix I of Section III have been established by the appropriate ASME Code Committees based on data and experience obtained over a considerable period of time. The exact procedure which was used to obtain the specific efficiency factors may not be available, but their use through the years for failure proof design has shown that they are suitably conservative.

(c) A "volumetric examination" is defined as an examination to determine the presence of discontinuities throughout the volume of material. The examination may be conducted from either the inside or outside surface of a component.

(d) The efficiency factor under the referenced circumstances is 1.00.

INTERROGATORY NO. 24. An enclosure with the SNUPPS letter (SLNRC 79-16), cited above, is a June 1979 Bechtel report titled, "Report on Investigation of Weld Imperfections in ASME SA-312 Double Welded Austenitic Stainless Steel Pipe for Compliance With I & E Bulletin 79-03."

a. Basing your answer on the Bechtel report, could SA-312 pipe installed at Callaway have undetected amounts of ceterline lack-of-penetration (CLP)?

b. What is the maximum size CLP defect that could have been produced using the welding procedure in effect when SA-312 pipe was manufactured by Youngstown Welding and Engineering prior to mid-November 1978?

c. Will pipe with up to 26% CLP pass a flattening test, using the criterion of ASME Section II, SA-312, paragraph 10.2 and SA-530 paragraph 4.2?

d. Is evidence of CLP a cause for rejection in conducting flattening tests, as those flattening tests listed in the material test reports of YW&E?

e. Does the pipe that was returned by Pullman Power Products represent the total sample of production pipe used in conducting the tests cited in the Bechtel report?

f. If the answer to question (e) above is other than affirmative, list and identify other samples of production pipe used in testing.

g. Is the pipe returned by Pullman Power Products typical of all the SA-312 pipe produced prior to mid-November 1978?

h. State the factual basis for your answer to question (g) above.

i. Could CLP defects exist in SA-312 pipe now installed at Callaway that exceed the 26% worst case cited in the Bechtel report?

j. State the factual basis for your answer to question (i) above.

k. Identify all of the documents you rely upon in responding to questions (i) and (j) above.

l. Would reducing the wall thickness of the test samples by 12.5% significantly affect the test results or fracture analysis cited in the Bechtel report?

m. State the factual basis for your answer to question (l) above.

n. Identify all the documents you rely upon in responding to questions (l) and (m) above.

ANSWER: (a) Yes.

(b) The Bechtel report showed that the maximum dimension of CLP found in examinations of 71 sections of approximately 520 feet of production pipe was 26% of the wall thickness.

(c) All SA-312 pipe was tested by the flattening method to the requirements of paragraph 10.2 of SA-312 and paragraph 4.2 of SA-530. All tests were reported as satisfactory, whether the pipe contained CLP or not.

(d) Flattening test acceptance criteria are provided in paragraphs 4.2 and 4.3.1 of SA-530. CLP is not specifically addressed as a rejectable defect.

(e) Yes.

(f) Not applicable.

(g) The pipe returned by Pullman Power Products was typical of all the SA-312 pipe produced prior to mid-November 1978.

(h) Since the same material specification and fabrication procedures were employed, it is appropriate to assume that similar and typical results were obtained.

(i) There is no reason to believe that the extent of CLP will be any worse on the Callaway piping than was discovered during the test program.

(j) The piping used at Callaway was made by the same process, same machines, same procedures, same personnel, and during the same time frame as the piping supplied to Pullman Power Products and used for the Bechtel test program.

(k) Bechtel report titled, "Report on Investigation of Weld Imperfections in ASME SA-312 Double Welded Austenitic Stainless Steel Pipe for Compliance with NRC IE Bulletin 79-03," dated June 1979; ASME SA-312, "Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipe"; YW&E Welding Procedure Specification No. 750 and Procedure Qualification Record No. 5D-485-3; Union Electric letter (ULNRC-314) to NRC, dated May 11, 1979.

(l) No. Taking the worst case of CLP as 26%, and reducing the wall thickness of this pipe by 12.5% would result in an increase in CLP up to 29.7% of the reduced wall thickness. Results from the Bechtel report show that with CLP at this level a slight decrease in the ultimate tensile strength might be expected, but this decrease is not considered significant.

(m) See June 1979 Bechtel and Aptech Reports.

(n) See June 1979 Bechtel and Aptech Reports.

INTERROGATORY NO. 25. In response to Joint Intervenors' Interrogatory No. 94 Union Electric states, "In dealing with fittings made in accordance with SA-403, the fittings may be fusion welded or forged."

a. Is Union Electric able to identify and locate fusion welded SA-403 fittings used in safety related piping at the Callaway plant?

b. If the answer to the above question is affirmative, list the spool piece number, size of fitting and line number of all of the fusion welded SA-403 fittings used in safety related piping.

c. Could SA-403 fittings contain undetected amounts of centerline lack-of-penetration if a discrete gap does not exist between the abutting surfaces of the joint?

d. State the factual basis for your answer to question (c) above and in your answer account for the inability of radiographic and ultrasonic methods of examination to detect CLP as reported in the Bechtel report cited in interrogatory 24 above.

OBJECTION: Applicant objects to subpart (b) of this Interrogatory on the grounds (1) that it is overly broad, burdensome and oppressive; and (2) that it seeks information which is irrelevant to the issues in this proceeding and which is not reasonably calculated to lead to the discovery of admissible evidence.

ANSWER: (a) Yes.

(b) Objected to.

(c) Yes, fittings made to the requirements of SA-403 from SA-312 welded pipe could contain CLP to the levels discovered in the pipe material.

(d) ASME SA-403 permits the use of welded SA-312 pipe as 'starter' material for the manufacture of fittings. All applicable non-destructive examination of such fittings is performed on the pipe material prior to fitting fabrication.

Consequently, the responses to Interrogatory No. 24 above apply to the SA-403 fittings made from the welded SA-312 pipe.

INTERROGATORY NO. 26. NRC Region III, IE Report No. 50-483/81-04 states, "Review of vendor radiographs indicated that one approximately four inch area of the pipe piece (the area of the alleged pipe crack) should have received further vendor review and possibly rework to remove excess weld reinforcement."

a. What caused the excess reinforcement cited in the report?

b. Photographs of the excess reinforcement indicate a blackened and rough appearance of the weld after the pipe was pickled. Is this typical of welds made with the Submerged Arc Welding Process?

c. Could the appearance of the weld indicate that the excess reinforcement was caused by a welding pass from the outside of the pipe burning through the pass or passes made from the inside of the pipe?

d. Would exposing the weld puddle to the atmosphere affect the mechanical properties of the weld?

e. Nonconformance Report No. 2SN-0496-P concerns a minimum wall violation and states under the heading, Cause of Nonconformances and Actions to Prevent Recurrence, "Vendor should be notified by Bechtel to prevent recurrence."

(i) Did Bechtel notify the vendor as here stated?

(ii) Identify all documents you rely upon to answer the preceding question.

ANSWER: (a) The excess reinforcement could have been caused by a momentary change in any one (or any combination) of the welding parameters used to make the longitudinal weld, such as

welding current, arc voltage, travel speed, wire feed speed, etc.

(b) The condition quoted is not untypical for areas which have undergone parameter changes described in (a) above.

(c) No. Burn through of the weld being made from the outside of the pipe would have resulted in a surface condition on the inside of the pipe which would be totally unacceptable. Burn through is a condition wherein total passage of molten weld metal occurs through the root of the weld and causes slag and metal to adhere to the inside surface in a totally unacceptable condition from both a visual and radiographic point of view.

(d) Exposure of the weld puddle to the atmosphere could affect the mechanical properties.

(e) (i) No.

(ii) The nonconformance report (NCR-2SN-0496-P) documenting the minimum wall violation was dispositioned by Bechtel as "use as is." The basis for that conclusion was a calculation utilizing design conditions as described in ASME Section III, Division 1, subsection NC (Class 2), Article NC-3640. During review of this nonconformance, Bechtel determined that the defect reported was a random occurrence and no future corrective action was required on the part of the spool fabricator. Consequently, the spool fabricator was not notified. It is Bechtel's responsibility to establish whether a vendor should be contacted for any follow up action on its

part. In this case, Bechtel determined that vendor notification and follow up was not required. Such reviews are an integral part of the process of NCR evaluation and disposition, and are performed on essentially all NCR's irrespective of whether or not follow up action is explicitly specified or suggested by the site constructor.

INTERROGATORY NO. 27. A Bechtel Power Corporation report dated November 28, 1979 and titled, "Final Report on Gulf & Western Preassembled Formation for Callaway Plant Unit One [Union Electric] and Wolf Creek [Kansas Gas and Electric]", concerns rejectable indications found in welds in preassembled pipe formations.

a. Apart from inspections and audits of vendor's quality assurance program, what actions has the Applicant taken to insure the quality and conformance to specifications of items and materials purchased from vendors?

b. Is the Applicant dependent on non-required or voluntary examination to discover significant rejectable defects in vendor supply items that have not been rejected by the vendor quality control program and delivered to the construction site?

c. State the factual basis for your answers to the above questions.

ANSWER: (a) Surveillance Inspection was increased to 100% - Daniel was responsible for on-site inspection of spools.

(b) No.

(c) Reliance on G&W's Quality Assurance Program, adherence to purchase order requirements, quality surveillance and specification.

INTERROGATORY NO. 28. Identify, separately for each of the above interrogatories and subparts thereof, the person(s) providing the answer.

ANSWER: William H. Zvanut, Supervising Engineer - Nuclear, Union Electric Co., 1901 Gratiot Street, St. Louis, Missouri 63166, provided information in response to the following interrogatories:

No. 18(c) and (d)

Alan C. Passwater, Superintendent, Licensing, Union Electric Co., 1901 Gratiot Street, St. Louis, Missouri 63166, provided information in response to the following interrogatories:

No. 15
No. 19(d)-(f)

Kenneth W. Kuechenmeister, Supervising Engineer - Nuclear Construction, Union Electric Co., Callaway Plant, Fulton, Missouri 65251, provided information in response to the following interrogatories:

No. 11
No. 18(a), (b), (d)-(g)

Dr. Bernard Meyers, Project Manager, Bechtel Power Corporation, P.O. Box 607, 15740 Shady Grove Road, Gaithersburg, Maryland 20760, provided information in response to the following interrogatories:

No. 1(c) and (e)
No. 3
No. 8(b), (d) and (h)
No. 9
No. 10
No. 14
No. 19(a)-(c)
Nos. 20 through 27

R. David Neal, Project Civil Engineer, Daniel Construction Company, Callaway Plant, P.O. Box 108, Fulton, Missouri 65251, provided information in response to the following interrogatories:

No. 1(a), (b), (d) and (e)
Nos. 2 through 7A
No. 8(a), (c)-(g), (i) and (j)
No. 12
No. 13
No. 15
No. 17

Objection submitted by,

SHAW, PITTMAN, POTTS & TROWBRIDGE

Richard E. Galen

Thomas A. Baxter
Richard E. Galen

Counsel for Applicant

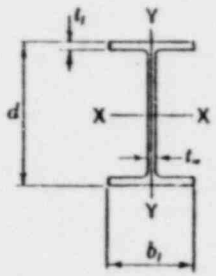
1800 M Street, N.W.
Washington, D.C. 20036
(202) 822-1000

TABLE 8(i)

Crack #	Length	Width	Starts Loc/Elev.	Ends Loc/Elev.
1	12'-0"	Less than 1/32"	1'-6" South of Col. C5 El. 2047'-6"	1'-3" North of Col. C5 El. 2059'-6"
2	Inaccessible for measurement			
3	Inaccessible, Slab at El. 2056'-10" covers area			
4	Inaccessible, Slab at El. 2056'-10" covers area			
5	Inaccessible except for area above El. 2056'-10"			
	2'-8"	Less than 1/32"	3'-10" East of Col. CC El. 2056'-10"	4'-0" East of Col. CC El. 2059'-6"
6	Covered with paint except for area above 2056'-10"			
	2'-8"	Less than 1/32"	3'-7" West of Col. CB El.2056'-10"	4'-0" West of Col. CB El. 2059'-6"
7	34'-6"	Less than 1/16"	Col. C5 El. 2037'-0"	6'-10" North of Col. C5 El. 2071'-6"
8	7'-6"	Less than 1/32"	7'-6" South of Col. C3 El. 2047'-6"	9'-6" South of Col. C3 El. 2055'-0"
9	24'-0"	Less than 1/32"	1'-6" North of Col. C3 El. 2047'-6"	2'-6" South of Col. C3 El. 2071'-6"
10	20'-0"	Less than 1/64"	1'-3" North of Col. C3 El. 2049'-6"	3'-6" South of Col. C3 El. 2069'-6"
11	Crack patched per NCR #2-2173-C-A			
12	Crack patched per NCR #2-2173-C-A			
13	Crack patched per NCR #2-2173-C-A			
14	12'-0"	Hairline	3'-0" East of Col. CC El. 2047'-6"	5'-0" East of Col. CC El. 2059'-6"
15	Crack patched per NCR #2-2173-C-A			

M SHAPES
Properties for designing

Designation	Area A	Depth d	Flange Width b_f	Flange Thickness t_f	Web Thickness t_w	Elastic Properties Axis X-X I	Axis X-X S	Axis X-X r	Axis Y-Y I	Axis Y-Y S	Axis Y-Y r
	In.²	In.	In.	In.	In.	In.⁴	In.³	In.	In.⁴	In.³	In.
M 14× 17.2	5.05	14.00	4.000	0.272	0.210	147	21.1	5.40	2.65	1.33	0.725
M 12× 11.8	3.47	12.00	3.065	0.225	0.177	71.9	12.0	4.55	0.930	0.639	0.532
M 10× 29.1	8.56	9.88	5.937	0.389	0.427	131	26.6	3.92	11.2	3.76	1.14
× 22.9	6.73	9.88	5.752	0.389	0.247	117	23.6	4.16	10.0	3.48	1.22
M 10× 9	2.65	10.00	2.690	0.206	0.157	38.8	7.76	3.83	0.609	0.453	0.480
M 8× 34.3	10.1	8.00	8.003	0.459	0.378	116	29.1	3.40	34.9	8.73	1.86
× 32.6	9.58	8.00	7.940	0.459	0.315	114	28.4	3.44	34.1	8.58	1.89
M 8× 22.5	6.60	8.00	5.395	0.353	0.375	68.2	17.1	3.22	7.48	2.77	1.06
× 18.5	5.44	8.00	5.250	0.353	0.230	62.0	15.5	3.38	6.82	2.60	1.12
M 8× 6.5	1.92	8.00	2.281	0.189	0.135	18.5	4.62	3.10	0.343	0.301	0.423
M 7× 5.5	1.62	7.00	2.080	0.180	0.128	12.0	3.44	2.73	0.249	0.239	0.392
M 6× 22.5	6.62	6.00	6.060	0.379	0.372	41.2	13.7	2.49	12.4	4.08	1.37
× 20	5.89	6.00	5.938	0.379	0.250	39.0	13.0	2.57	11.6	3.90	1.40
M 6× 4.4	1.29	6.00	1.844	0.171	0.114	7.20	2.40	2.36	0.165	0.179	0.358
M 5× 18.9	5.55	5.00	5.003	0.416	0.316	24.1	9.63	2.08	7.86	3.14	1.19
M 4× 13.8	4.06	4.00	4.000	0.371	0.313	10.8	5.42	1.63	3.58	1.79	0.939
× 13	3.81	4.00	3.940	0.371	0.254	10.5	5.24	1.66	3.36	1.71	0.939



M SHAPES
Properties for designing

Nominal Weight per Ft.	r_T	$\frac{d}{A_f}$	Compact Section Criteria $\frac{b_f}{2t_f}$	F_y'	$\frac{d}{t_w}$	F_y''	F_y'''	Torsional Constant J	Warping Constant C_W	Plastic Modulus Z_x	Z_y
Lb.	In.			Ksi		Ksi	Ksi	In.⁴	In.⁶	In.³	In.³
17.2	0.925	12.8	7.34	50.6	66.7	38.2	14.9	0.110	125	24.8	2.21
11.8	0.690	17.4	6.81	58.7	67.8	36.9	14.4	0.053	34.0	14.3	1.09
29.1	1.40	4.28	7.63	46.8	23.1	—	—	0.587	251	30.9	6.51
22.9	1.40	4.42	7.39	49.8	40.8	—	39.6	0.343	226	26.4	5.80
9	0.616	18.0	6.53	63.9	63.7	41.3	16.3	0.033	14.6	9.19	0.755
34.3	2.08	2.18	8.72	35.9	21.2	—	—	0.747	497	32.6	13.9
32.6	2.08	2.20	8.65	36.4	25.4	—	—	0.673	484	31.6	13.6
22.5	1.28	4.20	7.64	46.7	21.3	—	—	0.374	109	19.7	4.79
18.5	1.28	4.32	7.44	49.3	34.8	—	54.6	0.243	99.8	17.4	4.35
6.5	0.535	18.6	6.03	—	59.3	48.3	18.8	0.019	5.22	5.42	0.502
5.5	0.493	18.7	5.78	—	54.7	56.8	22.1	0.015	2.89	4.03	0.398
22.5	1.55	2.61	7.98	42.7	16.1	—	—	0.385	97.7	15.6	6.63
20	1.54	2.66	7.82	44.5	24.0	—	—	0.295	91.5	14.5	6.25
4.4	0.444	19.0	5.39	—	52.6	61.3	23.8	0.010	1.40	2.80	0.296
18.9	1.32	2.40	6.01	—	15.8	—	—	0.344	41.3	11.0	5.02
13.8	1.05	2.69	5.38	—	12.8	—	—	0.216	11.8	6.31	2.88
13	1.04	2.73	5.30	—	15.7	—	—	0.190	11.1	6.06	2.74

ATTACHMENT 10

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNION ELECTRIC COMPANY	)	Docket No. STN 50-483 OL
	)	
(Callaway Plant, Unit 1)	)	

AFFIDAVIT OF ROBERT J. SCHUKAI

City of St. Louis)
) SS
State of Missouri)

Robert J. Schukai, being duly sworn according to law, deposes and says that he is General Manager-Engineering of Union Electric Company; that the answers contained in "Applicant's Answers to Interrogatories of Joint Intervenors (Second Set)" are true and correct to the best of his information, knowledge and belief; and that the sources of his information are the officers, employees, agents and contractors of Union Electric Company.

Robert J. Schukai

Sworn to and subscribed before me this 8th day of September, 1981.

Barbara J. Pfaff
Notary Public

My commission expires 4/22/85.

BARBARA J. PFAFF
NOTARY PUBLIC, STATE OF MISSOURI
MY COMMISSION EXPIRES APRIL 22, 1985
ST. LOUIS COUNTY

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNION ELECTRIC COMPANY	)	Docket No. STN 50-483 OL
	)	
(Callaway Plant, Unit 1)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "Applicant's Answers to Interrogatories of Joint Intervenors (Second Set)" and "Applicant's Response to Joint Intervenors' Second Request for Production of Documents to Union Electric" were served this 10th day of September, 1981 by deposit in the U.S. mail, first class, postage prepaid, to the parties identified on the attached Service List.

Richard E. Galen

Richard E. Galen

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
UNION ELECTRIC COMPANY	)	Docket No. STN 50-483 OL
	)	
(Callaway Plant, Unit 1)	)	

SERVICE LIST

James P. Gleason, Esquire
Chairman
Atomic Safety and Licensing Board
513 Gilmoure Drive
Silver Spring, Maryland 20901

Mr. Glenn O. Bright
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dr. Jerry R. Kline
Atomic Safety and Licensing
Board Panel
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Roy P. Lessy, Jr., Esquire
Office of the Executive Legal Director
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

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

Joseph E. Birk, Esquire
Assistant to the General Counsel
Union Electric Company
P.O. Box 149
St. Louis, Missouri 63166

Treva J. Hearne, Esquire
Deputy General Counsel
Missouri Public Service Commission
P.O. Box 360
Jefferson City, Missouri 65102

Kenneth M. Chackes, Esquire
Chackes and Hoare
314 N. Broadway
St. Louis, Missouri 63102

Mr. John G. Reed
Route 1
Kingdom City, Missouri 65262

Mr. Howard Steffen
Chamois, Missouri 65024

Mr. Harold Lottmann
Route 1
Owensville, Missouri 65066

Mr. Earl Brown
P.O. Box 146
Auxvasse, Missouri 65231

Mr. Fred Luekey
Rural Route
Rhineland, Missouri 65069

Mr. Samuel J. Birk
P.O. Box 243
Morrison, Missouri 65061

Mr. Robert G. Wright
Route 1
Fulton, Missouri 65251

Eric A. Eisen, Esquire
Birch, Horton, Bittner & Monroe
1140 Connecticut Avenue, N.W., #1100
Washington, D.C. 20036