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September 18, 1984

Ivan W. Smith, Chairman
and Administrative Judge
Atomic Safety and Licensing
Board
U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

Dr. Richard F. Cole
Administrative Judge
Atomic Safety and
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U.S. Nuclear Regulatory
Commission
Washington, D.C. 20555

Dr. A. Dixon Callihan
Administrative Judge
Atomic Safety and Licensing
Board
c/o 102 Oak Lane
Oak Ridge, Tennessee 37830

Dear Administrative Judges:

Enclosed is Intervenors' proposed supplemental initial decision. For convenience, it is in the form of a mark-up of Edison's proposal, with handwritten interlineations indicating our changes. In addition, where we have proposed additional or substitute paragraphs, they are inserted at the appropriate location in between Edison's pages.

We have utilized this form because we believe it is easiest to follow. Please do not hesitate to inquire if any part of it is unclear.

Respectfully submitted,

Douglass W. Cassel, Jr.
Attorney for Intervenors League
of Women Voters and DAARE/SAFE

DWC:beg
Encl.
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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket No. 50-454 OL
	)	50-455 OL
(Byron Nuclear Power Station, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that I have, on this 19th day of September, 1984, served copies of Intervenors' Proposed Supplemental Initial Decision on the following persons by having said copies placed in envelopes, properly addressed, and delivered by mail, except that John Streeter's copy was hand delivered.

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September 19, 1984

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
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COMMONWEALTH EDISON COMPANY	)	50-455 OL
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(Byron Nuclear Power Station, Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that I have, on this 18th day of September, 1984, served copies of **Intervenors' Proposed Supplemental Initial Decision** on the following persons by having said copies placed in envelopes, properly addressed, and delivered via Federal Express, except that Mr. Miller's copy was hand-delivered.

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September 18, 1984

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In The Matter of	)	
	)	
COMMONWEALTH EDISON COMPANY	)	Docket Nos. 50-454 OL
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(Byron Nuclear Power Station, Units 1 & 2)	)	

INTERVENORS' ~~COMMONWEALTH EDISON COMPANY'S~~ PROPOSED SUPPLEMENTAL INITIAL DECISION

I. INTRODUCTION

1. On January 13, 1984 this Board issued its initial decision denying Commonwealth Edison Company's ("Applicant's" or "CECo's") application for a license to operate the Byron Nuclear Power Station ("Byron"). Although we ruled in Applicant's favor on seven of the eight issues in controversy which were litigated during public hearings in the spring and summer of 1983, we found that CECo had not met the burden of proof on the issue of quality assurance.

2. The quality assurance issue as set forth in Intervenors' contention 1A and as originally litigated in the spring of 1983 was quite broad. Applicant was required to demonstrate its "willingness and ability to implement and maintain an adequate quality assurance program." To make this broad showing, CECo submitted the testimony of a range of witnesses with both corporate and Byron specific QA experience and insight.

[Intervenors' proposed ¶¶ 2a, 2b and 2c follow on → the next two pages]

INTERVENORS' PROPOSED PARAGRAPHS 2a, 2b AND 2c

2a. Our initial decision summarized our findings with respect to CECo's quality assurance program by stating that CECo has "failed in its responsibility to assure that its contractors carried out their delegated quality assurance tasks" (p. 4); that we had not concluded that CECo "is institutionally unable or unwilling to maintain a reliable quality assurance program," but rather that CECo "began to deal effectively with its contractors' problems too late, but is catching up" (pp. 6-7); that there were "widespread failures in the contractors' quality assurance programs" at Byron (p. 7); and that although we had not found widespread hardware or construction problems, "we are not confident that such problems would have been discovered" (id.). (See e.g., D-429, 433, 434, 441, 442, 448, and 449.)

2b. In affirming that an operating license for Byron could not issue on the prior record because of a "cloud overhanging the adequacy of safety-related facility construction," (ALAB-770, slip op. at 21), the Appeal Board remanded for a "full exploration of the significance of the [reinspection] program in terms of whether there is currently reasonable assurance that the Byron facility has been properly constructed" (id. at 27). Within this full exploration, the remand was ordered to focus on

whether the Byron Reinspection Program ("BRP") "has now provided the requisite degree of confidence that the Hatfield and Hunter quality assurance inspectors were competent and, thus, can be presumed to have uncovered any construction defects of possible safety consequence" (id. at 28).

2c. In other words, the basic issue on remand was whether the now completed reinspection program justifies a finding that the "ascertained quality assurance failings [were] either cured or [were] overcome to the extent necessary to reach an informed judgment that the facility has been properly constructed" (id. at 9). For the reasons summarized in paragraph 166 below, we find that it does not, i.e., that the reinspection program has not sufficiently cured or overcome the quality assurance failings identified in our Initial Decision. Consequently we cannot conclude that an operating license for Byron is now appropriate.

3. In the first set of hearings on the quality assurance issue in March and April, 1983, we did not consider an item of non-compliance found in the March, 1982 NRC Construction Assessment Team inspection regarding the certification practice for quality control inspectors by contractors at Byron. Our attention was drawn to this matter before the additional hearings we held in August 1983 as a result of granting Intervenors' motion to reopen the hearing record. At that time, testimony was adduced on (1) the training and certification of a former QC inspector of the Hatfield Electric Company ("Hatfield"), (2) the very recently completed program of recertifying inspectors to revised criteria based on ANSI N45.2.6-1978, and (3) the structure and preliminary results of a reinspection program designed to show that inspectors who conducted inspections prior to the revised certification procedures were adequately qualified. On the basis of the evidence before us with respect to this last issue we denied the operating license application expressing reservations about the reinspection program. (I.D. ¶s D 435-438.) ~~itself and the quality of the work of two site contractors, Hatfield and Hunter Corporation ("Hunter"). (I.D. ¶s D-429-441.)~~

4. When the evidentiary record was closed the reinspection program was still in progress, and a final report on its results was not published until February 1984, followed by a supplemental report in June 1984. In our initial decision we expressed several reservations regarding the adequacy of the Byron quality control inspector reinspection pro-

gram ("BRP"), none of which we thought had been eliminated by evidence presented at the August 1983 hearing. We noted that it had not been established that the program used a statistically significant and reliable sample. (I.D., ¶ D-382-4, 436) We also expressed concern about documentation deficiencies which were discovered during a CECo audit of the BRP. (I.D., ¶D-379-382, 438) These concerns, together with the fact that the testimony of the Region III Staff indicated that it was not satisfied completely with some aspects of the program's structures and that it would not be able to judge the success of the BRP until its results were known, caused us to deny the operating license application.

5. Applicant appealed and, following briefing and oral argument, the Appeal Board remanded this proceeding to the Licensing Board with instructions to receive further evidence on the BRP as it applied to Hatfield and Hunter and to render a supplemental initial decision. The Appeal Board agreed that the record was insufficient to warrant issuance of an operating license, but held that further hearings should be conducted to allow a full exploration of the BRP to determine whether there is reasonable assurance that Byron has been properly constructed. (Memorandum and Order, dated May 7, 1984, ALAB-770, 19 NRC ___ (Slip Opinion at 27, 28)) (See ¶ 2b above.)

6. Additionally, the Appeal Board noted the recent disclosure of deficient welds on cable pan hangers supplied to the

both CECo's quality assurance oversight of SCC (see ¶ 166d below) and

site by Systems Control Corporation ("SCC") and that CECo had apparently not fully met commitments to perform source inspections of SCC equipment. These matters raised questions concerning the overall adequacy of equipment supplied by SCC. To resolve ~~this~~ those questions the Appeal Board determined that further exploration of ~~this~~ these issues on the evidentiary record was warranted. (ALAB-770, slip opinion at 31, 32)

7. Finally, the Appeal Board stated that the Licensing Board would have discretion to include within the scope of the reopened evidentiary record any other question which it deemed relevant to the ultimate question whether reasonable assurance exists that the Byron facility has been properly constructed. (ALAB-770, slip opinion at 35, note 72.) Thereafter, we sought the advice of the parties on the proper exercise of this discretion. (Transcript of Conference Call, May 9, 1984, at 8032.)

8. Applicant reviewed the Board's initial decision and in a letter dated May 9, 1984, identified various issues as those it perceived to be of concern to the Board and as to which the Board might require an evidentiary showing. These issues included the issue of the Region III Staff's acceptance of the BRP; the basis for the determination of inaccessible and non-recreatable inspection attributes in the BRP; the relationship of deficiencies identified during the BRP to a trend analysis; the number of Hatfield inspectors requiring recertification and retraining at the inception of the BRP; Hunter documentation

practices regarding discrepant conditions identified during the BRP; further evidence regarding possible fraudulent practices by contractors in the certification of quality control and quality assurance personnel; the disposition of allegations open as of the close of the record in August 1983; Applicant's general control of its site contractors; and supplemental evidence regarding Hunter "tabling" practices and any pattern of nonconformances by Hatfield.

9. As we ruled subsequently, Applicant's list was accurate and fairly complete. However, the Board added the issue of whether CECo's commitment to repair any defects identified during the BRP had been effectively satisfied. (Memorandum and Order Following Prehearing Conference at 4, dated June 8, 1984.)*/ The Intervenors proposed several additional issues of their own. Applicant objected to Intervenors proposal on the ground that it presented issues not relevant and material to the issues remanded by the Appeal Board for further consideration. These conflicting views were fully exchanged during a prehearing conference conducted on May 30 and 31, 1984.

10. On June 8, 1984, we issued an order setting the scope of the reopened hearing. Beyond the issues discussed above we ruled that certain of the matters proposed by Intervenors

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*/ We observe that the Appeal Board characterized this issue as whether "all identified discrepant conditions . . . [have] been properly resolved". (ALAB-770, slip op. at 29.) As discussed in Section IX, infra, repair was not the only basis on which discrepancies were dispositioned.

should be litigated. We ruled that the NRC Staff should present evidence on certain worker allegations which the Staff had expected would be resolved by the BRP. For one allegation, that electrical cables were overstressed by excessive pulling during installation by Hatfield, we requested a full evidentiary presentation on the cause and safety significance of the alleged episodes and their relationship to the BRP. Finally, we ruled that Pittsburgh Testing Laboratory ("PTL") should be added as one of the contractors to be considered with respect to the BRP. In this regard, we advised the parties that we expected a general showing of the scope of PTL's work and a discussion of whether the BRP has provided reasonable assurance that PTL's work presents no safety problems.

11. Hearings commenced on July 23, 1984. To address the issues in the reopened hearing, Applicant presented the testimony of 22 witnesses in four segments. The first segment described the formulation and implementation of the BRP and its results with respect to the qualification of the Hatfield, Hunter and PTL QC inspectors. The second and third segments of the testimony addressed the questions of the significance of the discrepancies discovered during the BRP and the adequacy of the Hatfield and Hunter work. Finally, evidence was presented concerning other issues, namely, CECO's oversight of SCC and the adequacy of the hardware furnished by Systems Control Corp., the use by Hunter of a "tabling" practice and the adequacy of cable installed by

Intervenors proffered the testimony of two other witnesses, one an expert in reliability engineering and the other an Authorized Nuclear Inspector at Byron, both of whose testimony the Board declined to receive.

Hatfield that had been subjected to excessive stress or over-tensioning.

12. The NRC Staff submitted two witness panels who addressed these same issues. In addition, Mr. Keppler, administrator of NRC's Region III, provided an overview and insight with respect to the Region's judgment concerning the adequacy of the BRP. Mr. William Forney, an NRC employee who was formerly senior resident inspector at Byron also testified. An affidavit prepared by him which described his differences with the testimony of an NRC Staff witness panel with respect to the conclusions to be drawn from the results of the BRP was received into evidence as his direct testimony. Intervenors presented three witnesses. One witness questioned the adequacy of the engineering evaluations performed by Sargent & Lundy of the discrepancies discovered during the BRP. The remaining two witnesses challenged the adequacy of various assumptions used by Edison in the formation of the BRP and the applicability of statistical principles to the results of that program.

13. All testimony was presented during the course of 3 weeks of hearings held in July and August of this year. The record was closed on August 24. All parties filed findings of fact and conclusions of law in support of their respective positions.

14. On the basis of the extensive testimony presented during the July and August hearing, and after careful considera-

The Board also declined to receive portions of Intervenors' engineer's testimony concerning design issues, and portions of intervenors' statistician's testimony concerning higher reliability requirements for inspections of greater safety significance.

tion of the proposed findings and conclusions submitted by the parties, we conclude that Applicant has ~~now~~ not prevailed on Intervenor Contention 1A on quality assurance.*/ The basis for this determination follows.

II. APPLICABLE LAW

15. An operating license for a nuclear power plant may be issued at such time as the NRC renders the findings required by 10 C.F.R. § 50.57(a). The Commission, subject to the immediate effectiveness provisionf of 10 C.F.R. § 2.764, has vested the Director of Nuclear Reactor Regulation with the authority to make the findings under section 50.57(a). 10 C.F.R. § 2.760(a). Our authority is limited to deciding matters in controversy among the parties. 10 C.F.R. § 2.104(c) and § 2.760(a). It was in the context of this regulatory regime that Contention 1A was decided against the Applicant.

16. We were unable to make these findings in our Initial Decision of January 13, 1984 in large part because of outstanding questions raised by an item of noncompliance contained in NRC Staff Inspection Report 82-05. Specifically, noncompliance 82-05-19 questioned the qualifications of contractor QC inspectors certified under procedures which the Staff deemed defective. The

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*/ The specific findings of fact and conclusions of law contained in our initial decision which are altered by this supplemental intitial decision are set forth in Section XVIII, infra.

Appeal Board agreed that the record previously before us was insufficient to support the issuance of an operating license, but remanded the record to us

> to permit a full exploration of the significance of the [reinspection] program in terms of whether there is currently reasonable assurance that the Byron facility has been properly constructed. Stated otherwise, the focus of the inquiry should be upon whether, as formulated and executed, the reinspection program has now provided the requisite degree of confidence that the Hatfield and Hunter quality assurance inspectors were competent and, thus, can be presumed to have uncovered any construction defects of possible safety consequence.

(Memorandum and Order, dated May 7, 1984, ALAB-770, 19 NRC _____ Slip Opinion at 27, 28)

17. Further, subsequent to our initial decision new information regarding another item of noncompliance resurrected questions we had deemed closed in our initial decision. (I.D., ¶ D-442; ¶s 204 - 263, infra.) Noncompliance 80-04-01, contained in a December 30, 1980 inspection report, asserted that Applicant had failed to take prompt and effective corrective action with respect to deficient equipment supplied to the Byron Station by Systems Control Corporation ("SCC"). While we had been willing to delegate the closure of this item of noncompliance to the NRC Staff, the Appeal Board, as a result of the new information, directed that we hold further hearings on this issue as well.

18. Notices of violations regarding items of noncompliance which are found during the course of NRC Staff inspection

activities constitute an enforcement action prescribed by the Commission's regulations. (10 C.F.R. Part 2, Appendix C, IV. A. "Notice of Violation.") The relationship between the resolution of NRC Staff enforcement actions and the finding we are required to make under 10 C.F.R. 50.57(a) is found in 10 C.F.R. Part 2, Appendix C "General Policy and Procedure for NRC Enforcement Actions." The introduction to that Appendix states that the purpose of the NRC enforcement program is to promote and protect the health and safety of the public by, among other things, "ensuring compliance with NRC regulations and license conditions."

19. The basic issues in the reopened hearing, therefore, included but were not limited to ~~involved~~ the adequacy of corrective actions taken by the Applicant to close out these items of noncompliance to the satisfaction of the NRC Staff. The closing of Noncompliance 82-05-19 involved re-certification of QC inspectors for, inter alia, Hatfield and Hunter, and a demonstration by way of the BRP that even prior to their recertification, the inspectors were competent. As discussed in the body of this decision, the BRP also provided one basis for determining work quality of those two contractors. Full and proper resolution of this item of noncompliance could satisfy ~~satisfied~~ the concerns we expressed in our Initial Decision. (See I.D. at 5.)

20. With regard to the issue of the adequacy of equipment supplied by SCC, Noncompliance 80-04-01 has not been closed.

However, the testimony of the NRC Staff and Applicant indicates that only one discrete issue remains to be resolved. A program for resolution of the one outstanding issue by way of a 100% inspection of certain components, is in progress and the NRC Staff expressed confidence that this program will satisfy their concerns.

21. It is within our authority to delegate an issue to the NRC Staff when it is clear that the NRC Staff can adequately resolve the issue. (See generally our discussion in the Initial Decision, ¶'s D-419 - 427 and cases cited therein.) The nature of the program for resolution of the outstanding SCC issue, as discussed below, presents an appropriate case for delegation to the NRC Staff and we so ruled at the close of the hearings. (Tr. 11,169-71.)

III. THE INCEPTION OF THE BYRON REINSPECTION PROGRAM

22. A special inspection was conducted at Byron during the Spring of 1982 by an NRC Construction Assessment Team ("CAT"). The CAT findings were published in IE Report Nos. 50-454/82-05 and 50-455/82-04. One of the findings (noncompliance 82-05-19) questioned the adequacy of the on-site contractors' programs for certifying QC inspectors. The CAT inspectors found deficiencies in (i) the contractors' evaluations of initial inspector capabilities, (ii) the documentation of initial certification, and (iii) the criteria used to establish inspector quali-

fication. (Applicant's Exhibit 8; Del George, prepared testimony at 6, ff. Tr. 8406.) Although there was no finding that these deficiencies had compromised the quality of construction, the NRC Region III Staff adopted the position that the site contractors' QC inspector qualification programs had to be upgraded and that the quality of the inspections already completed required verification. (Del George, prepared testimony at 5, ff. Tr. 9406.)

23. In response to the Staff's criticisms, Edison initiated a recertification program between June and September 1982, to review in accordance with the guidelines of ANSI N45.2.6-1978, and to revise where necessary, contractors' QC inspector certification procedures. These upgraded procedures were used to certify inspectors beginning on September 30, 1982. This action solved the Staff's concern with respect to the qualification of QC inspectors after September 30, 1982; however, it did not provide assurance that the inspectors who performed QC inspections prior to that time were qualified. The BRP was constituted to address this latter concern. (Hansel, prepared testimony at 4, ff. Tr. 8901; Del George, prepared testimony at 7-10, ff. Tr. 8406; Connaughton, Staff prepared testimony at 16, ff. Tr. 9510.)*/

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*/ A full discussion of the recertification program is contained in paragraphs D-385 through D-393 of our initial decision.

24. To verify the effectiveness of inspector qualification and certification practices used by site contractors between January 1976 and September 1982, the BRP was structured to reinspect the original QC inspections and to analyze any discrepancies (differences between the results of the original inspections and the reinspections) to determine their significance. The data would then be used to draw inferences about the qualification of the total inspector population on a contractor-by-contractor basis. Thus, the original purpose of the BRP was not to directly validate work quality at Byron. Given the concerns about work quality raised in our initial decision, however, both Applicant and the Staff determined that the BRP data could also be used as one basis for determining the quality of the construction work. (Del George, prepared testimony at 6, 7, ff. Tr. 8406; Little, Staff prepared testimony at 4, ff. Tr. 9510.)

25. The NRC Staff's characterization of the purpose of the BRP is stated differently than the description we have just articulated. The Region III panel testified that the primary purpose of the BRP was to determine whether QC inspectors had overlooked significant safety-related hardware deficiencies. (Little, Staff prepared testimony at 4,ff. Tr. 9510; Tr. 9577.) However, Mr. Little also agreed, on behalf of the panel, that determining whether QC inspectors had overlooked

is not clear the extent to which

significant deficiences was equivalent to determining whether they were competent. (Keppler, Tr. 10,134; Little, Tr. 9582-83.) Indeed, William Forney, former Region III senior resident inspector at Byron, testified for the Staff in August 1983 that the purpose of the BRP was "to determine whether or not [the contractors] have used qualified inspectors."*/ (Forney, Tr. 7991.) (But see ¶ 99 below.) In sum, it ~~appears that~~ any difference between the purpose of BRP as stated by CECo and the NRC Staff is a matter of semantics rather than substance.

IV. THE STRUCTURE OF THE PROGRAM

26. The BRP was formulated to address the qualification of QC inspectors who performed inspections for 8 on-site construction contractors during the period January 1976 through September 1982. In general, the adequacy of the original inspection results was determined by reinspection using qualified QC inspectors. Inspectors were selected for reinspection by a

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*/ We note that Mr. Forney's most recent testimony contradicts this characterization. Mr. Forney testified at the reopened hearing that in his opinion, the fact that inspectors have not failed to discover significant deficiencies is not necessarily a demonstration of their competence. His reasoning appears to be that the Byron plant is so well constructed that there may not be very many significant discrepancies to discover. (Forney, Tr. 10,063-64, 10,082.) In any event, Mr. Forney himself characterizes his disagreement as "miniscule" in importance. (Forney, Tr. 10,068.) We will come back to an evaluation of Mr. Forney's position in the work quality portion of this decision.

is discussed in ¶ 99 below.

identifiable, reinspectable

sampling technique and the first 90-days of their work was reinspected. The subject matter of the inspections was grouped into two work categories called "subjective" and "objective" attributes." If the reinspector agreed with at least 95% of the original inspector's calls for objective attributes or 90% for subjective attributes, the inspector was deemed qualified. The work of any inspector who initially failed to pass either acceptance criterion was subjected to an expanded inspection process; wherein the inspector either passed based on a reinspection of a second 90-day period, or if the inspector still failed, all of his work was reinspected. These program elements will be discussed in detail below.

identifiable, reinspectable

Insert Intervenors' Proposed FOF 26A, 26B, and 26C, following this page, to here

a. Selection Of Contractors

27. The first element of the BRP was the selection of site contractors whose QC inspectors would be subjected to reinspection. Mr. Del George explained that eight of the 19 contractors who had performed or were performing safety-related work at Byron were subjected to reinspection. The work inspected by these eight contractors accounted for approximately 93 percent of the safety-related work at Byron. (Del George, prepared testimony at 8, 9, ff. Tr. 8406.)

28. Of the eleven contractors not subjected to reinspection, three were excluded because they were not subject to ANSI N45.2.6-1978. In other words, the qualification of their QC

INTERVENORS' PROPOSED PARAGRAPH 26A

26A. CECo did not apply sufficient expertise to develop the BRP appropriately. Mr. Louis Del George had lead responsibility for managing the development of the BRP and the final decision for CECo respecting the BRP's content. (Del George, Tr. 8466, 8471.) This was the first time that Mr. Del George had had such lead responsibility for a reinspection program (Del George, Tr. 8467-69, 8476). Moreover, his previous reinspection experiences were focused on work quality, rather than inspector performance (Del George, Tr. 8467-70).

INTERVENORS' PROPOSED PARAGRAPH 26B

26B. The BRP was developed by CECo without regard to statistical validity. Mr. Louis Del George had lead responsibility for managing the development of the BRP. However, Mr. Del George is not a statistician, has had virtually no statistical training and did not consult with a statistician in developing the BRP. (Del George, Tr. 8466-67). CECo concedes that the BRP was not developed to a specified statistical sampling plan. (Del George, Tr. 8467.)

INTERVENORS' PROPOSED PARAGRAPH 26C

26C. CECo did not develop a sampling plan to demonstrate work quality based on the BRP (Del George, Tr. 8467.) Nevertheless, Mr. Del George assumed that if inspector performance were adequate, then the work quality was sound. (Del George, Tr. 8488, 8494.) However, many of the sampling elements in the BRP as developed by Mr. Del George, such as the 95%/90% acceptance criteria and reliance on the first three months of inspector performance had never been applied in reinspection programs at other nuclear power plants. (Del George, Tr. 8472-73.)

inspectors was not in question. Three other contractors were already undergoing extensive reinspection of their work, making it unnecessary to address the question of their QC inspector qualification. Five contractors were excluded from the BRP because their work was neither accessible nor recreatable for purposes of reinspection. (Del George, prepared testimony at 10, 11, ff. Tr. 8406; Del George, Tr. 8724-28.)

29. The selection of contractors included in the BRP was not a material issue in this proceeding. It appears that of the contractors who performed on-site construction work, the significant ones were captured in the program. Their work represented 93% of the safety-related work at Byron. In any event, these remanded proceedings were limited to Hatfield, Hunter and PTL, and these contractors were included in the BRP.

b. Selection Of Inspectors

30. The second element of the BRP was the selection of inspectors for reinspection. The inspection work of the original QC inspectors of Hatfield, Hunter and PTL was reinspected on a sampling basis. (Del George, prepared testimony at 11, ff. Tr. 8406.) Edison and the NRC Staff agreed that a 100 percent reinspection effort was not necessary since a properly structured sampling plan permits sound judgments to be drawn concerning the total population based on the sample results. (Hansel, prepared testimony at 10, ff. Tr. 8901; Del George,

plan permits sound judgments to be drawn concerning the total population. Whether CECo's program was properly structured, however, is another question, discussed at ¶'s 178-85 below.

Tr. 8482-3; Little, Staff prepared testimony at 4, ff. Tr. 9510.) We do not disagree that a properly structured sampling

31. The names of inspectors for Hatfield, Hunter and PTL were compiled on rosters and listed chronologically by date of certification. The fifth and every fifth inspector thereafter on the roster was included in the BRP. In addition, the NRC Staff senior resident inspector, Mr. Forney, reviewed the sample and added both the first inspector certified and two to four additional names to each contractor's group of inspectors. This selection method resulted in 27%, 26% and 27% of Hatfield, Hunter and PTL QC inspectors, respectively, being included in the program. (Del George, prepared testimony at 30, 31, 33, ff. Tr. 8406.)

32. The table contained in Mr. Del George's testimony shows that Applicant claims to have made certain the inspectors selected were not only sufficient in number but represented the range of inspection activities for the entire six year span of interest. The table also shows that inspectors were chosen from each year of work activity. (Del George, prepared testimony at 13, ff. Tr. 8406.)

To have a chance of being included in the Reinspection Program

33. ~~To qualify to have his work reinspected~~ an inspector had to perform at least 50 reinspectable inspections during the period subject to reinspection. In the case of PTL, an inspector who conducted 25 or more could be included inspections ~~were determined to be acceptable~~ because of the limited

CECo introduced no evidence to show that inspectors who performed fewer than the minimum number of inspections would be likely to perform as well as inspectors who stayed on the job longer.

number of inspections for the typical inspector. Where reinspection was initiated for the original inspector but it was subsequently learned that the "minimum quantity" was not available, all reinspections actually performed for the original inspector were nevertheless included in the BRP data base. (Del George, prepared testimony at 16, 17, ff. Tr. 8406.)

34. The Staff concluded that the sample size of inspectors whose work was reinspected was sufficiently large and provided an adequate basis for evaluating the qualifications of inspectors whose work was not reinspected. The Staff emphasized the adequacy of the selection methodology, including the two to four inspectors added for each contractor by the resident inspector. (Little, Staff prepared testimony at 4, 5, ff. Tr. 9510.)

~~35. The inspector sampling scheme was the result of an~~ engineering judgment that for a small population of inspectors, a sample size in excess of 20 percent would provide a reliable indicator of the quality of the total population of the Hatfield, Hunter and PTL inspectors, provided the sample covered the entire range of interest from January 1976 through September 1982. The engineering judgment of both CECo and Staff personnel which led to the selection of the sample of inspectors whose work was reinspected is responsive to our concerns ~~regarding the statistical significance and reliability of the~~

[Intervenors' proposed ¶¶ 34a and 35 follow this page.]

INTERVENORS' PROPOSED PARAGRAPH 34A

34A. Neither the staff, nor the Applicant, however, tested the assumption that the staff had added the worst inspectors to the list. What little data is available in the record (covering Hunter weld inspections) shows that the overall discrepancy r. e for inspectors added by the NRC was less than the overall discrepancy rate for the inspectors chosen by taking every fifth inspector. The NRC selected inspectors had an overall discrepancy rate of 1.5% (9 out of 594) (for these elements), less than half of the discrepancy rate of 3.3% (103 out of 3134) for those not chosen by the NRC. (Ericksen, prepared testimony Attachment D. Supp., ff. Tr. 11, 045.) Applicant and staff have failed to show that the deviation from random selection of inspectors was conservative. In fact, available data indicates that the NRC's additions may have introduced a non-conservative bias in the results.

INTERVENORS' PROPOSED PARAGRAPH 35

35. In our initial decision, we made clear that we were concerned about several unexplained aspects of the reinspection program for Hatfield. In particular we expressed concern as to whether the size of the sample reinspected was large enough to provide a statistically significant and reliable sample and whether the sample was adequate to provide assurance that inaccessible and non-recreatable inspections were adequate. (Initial Decision, D-436, D-437.)

The evidence now makes clear that the inspector sampling scheme was the result of an engineering judgment that for a small population of inspectors, a sample size in excess of 20% would provide a reliable indicator of the quality of the total population of the Hatfield, Hunter and PTL inspectors, provided the sample covered the entire range of interest from January 1976 through September 1982. (Little, Tr. 9817-19.)

This bare contention by staff and CECo that "engineering judgment" justifies their conclusions that the sample was adequate is similar to the argument presented in the recent Comanche Peak decision involving design quality assurance. */ In Comanche Peak the applicant

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*/ Texas Utilities Generating Company (Comanche Peak Steam Electric Station Units 1 and 2), LBP-83-81, 18 NRC 1410 (1983) (footnote omitted).

urged the Board to put substantially more weight on the expert testimony offered by its engineering witnesses and the staff's engineering witnesses than on evidence introduced by intervenors. The applicant and the staff also urged the Board to accept conclusions based on "engineering judgment." The Board rejected this argument, stating in pertinent part:

> [W]e do not consider it satisfactory to present engineering judgment without any explanation. Engineers should be able to explain the reasons for their judgments. An inability to provide an explanation beyond the bald statement of "engineering judgment," erodes this Board's confidence in the validity of the statement.

(18 NRC at 1420.)

Here, too, mere invocation of engineering judgment cannot justify inferences that inspectors were qualified and work quality was adequate. As we made clear in our initial decision, we were concerned that no one had determined that the reinspection of 25% of Hatfield inspectors was a statistically significant sample or that statistically reliable sampling had been conducted to provide assurance that inaccessible and non-recreatable inspections were adequate. (I.D. D-436 and 437.) Moreover, the applicant's initial reliance on statistics belies its subsequent claim -- made only after its statistical witness Dr. Singh faltered -- that statistics is unimportant in evaluating the adequacy

of the reinspection program. Finally, we recognize that whenever one generalizes from a sample to a population, one is making a statistical statement. (Ericksen, Tr. 11, 074.) In the absence of a probability sample, an engineer can make estimates on the basis of assumptions but the assumptions should be clearly stated with justifications. (Ericksen, Tr. 1073.) Here, the Applicant clearly failed to set forth its assumptions or justifications. Instead, it relied on bald general assertions of engineering judgment, even on points as to which available data does not support its assumptions.

For example, as cited in ¶34A above, CECo claims that its engineering judgment is reinforced by the nature of the selection process used by the NRC staff to add inspectors to the program. Because Mr. Forney selected inspectors whose qualifications he believed to be questionable, CECo argues that the sample of inspectors was biased to include the inspectors who would most likely be determined to be unqualified. (Little, Tr. 9817-19.)

However, the Applicant and staff presented no evidence to support this assumption, and what little data exists in the record is to the contrary (¶34A above).

(Intervenors' Proposed ¶ 35, p. 3)

inspector sample expressed in our initial decision, even though there was not a rigorous application of mathematical statistical theory to the inspector selection process. It would appear, therefore, that a sufficient and representative number of inspectors was captured by the sampling process to provide confidence that inferences could be drawn with respect to the qualification of the Hatfield, Hunter and PTL inspectors not captured in the BRP. This judgment is reinforced by the nature of the selection process used by the NRC Staff to add inspectors to the program. Based on his judgment, Mr. Forney selected inspectors whose qualifications he believed to be questionable; and as a result, the list of inspectors to be reinspected was biased to include the inspectors who would most likely be determined to be unqualified. (Little, Tr. 9817-19.)

86. Intervenors did not present any evidence which directly challenged the sample selection process for inspectors other than two general assertions by Professor Ericksen, an expert statistician. The first assertion is that at any time a sample is selected and one wishes to make a generalization to the total population, that person is making a statistical statement. (Ericksen, Tr. 10,964.) Second, in his prepared testimony Dr. Ericksen asserted it is proper statistically to make generalization only to all population elements which had a known, non-zero chance of being selected into the sample. (Ericksen, prepared testimony at 8, ff. Tr. 11,045.) This type

[Intervenors' proposed ¶ 36 follows this page:]

INTERVENORS' PROPOSED PARAGRAPH 36

36. In his testimony, Intervenors' witness Professor Ericksen, an expert statistician, emphasized the statistical flaws in CECo's inferences regarding work quality. He did not focus on flaws in CECo's inferences regarding inspector qualifications. Nonetheless, he identified problems with the statistical reliability of CECo's inferences regarding inspector qualifications. He testified that the inferences were questionable because inspectors who did less than a certain amount of work were excluded from the sample and because CECo did not test its assumption that the NRC staff added inferior inspectors to the sample. (Ericksen, Tr. 11,083.) Dr. Ericksen further explained that generalizations to a population from a sample are straightforward if one utilizes a probability sample, a sample drawn from a population in which all elements have a known non-zero chance of being selected. (Ericksen, prepared testimony at 8, ff. Tr. 11,046 and Ericksen, Tr. 11,073.)

In the absence of such a probability sample, Dr. Ericksen testified, generalizations can still be made based on assumptions reflecting some model or view of the real world. The assumptions in that model or view should be stated clearly with justification. If data exists which are inconsistent with the assumption, the

assumption needs to be changed and the generalization must be revised. (Ericksen, Tr. 11,073.) He testified that neither a probability sample, nor a clear statement of assumptions, underlay CECo's generalizations regarding inspector qualifications. (Id. and prepared testimony at 8, ff. Tr. 11,045.) We agree.

Dr. Frankel was not sure whether he would use available data to test the accuracy of the engineer's assumptions. (Frankel, Tr. 11, 137.) We agree with Dr. Ericksen that it is appropriate and useful to test such assumptions, particularly where the data is available.

~~of sample is known as a probability sample. (Ericksen, Tr. 11,072.) Dr. Ericksen concluded that since certain inspectors had "no chance" of being included in the sample, there was an inadequate statistical basis from which to draw inferences about these inspectors. (Ericksen, prepared testimony at 8, ff. Tr. 11,045.)~~

37. Dr. Martin Frankel, an expert statistician testifying on behalf of Applicant agreed that the inspector sample does not qualify as a "probability sample", mainly because of the addition of designated inspectors whose qualifications were considered suspect by the NRC Staff. (Frankel, prepared testimony at 7-8, ff. Tr. 11,120.) Although the sample of inspectors does not meet the criteria for a probability sample, Dr. Frankel believes that inferences to the total population of inspectors can be drawn if supported by the judgments of individuals with appropriate substantive knowledge. (Frankel, prepared testimony at 7-8, ff. Tr. 11,120.) ~~We agree.~~ The feature of the sampling scheme for inspectors which causes it to not constitute a probability sample is the addition of inspectors to the sample by the NRC resident inspector. (The staff's assertion that these additions to the sample were designed to include in the BRP inspectors whose qualifications were suspect should have been tested.) In fact, ~~It would be contrary to common sense to reject inferences drawn from the results of the BRP by experienced engineers employed by Applicant and Staff, as well as by independent consultants based on a ritual~~ available data suggests that they may not have been (¶34a above). We do not have adequate assurance

that the inspector sample was in fact

~~istic application of statistical theory. We accept the validi-~~

conservatively biased, and we

~~ty of the inspector sample in the BRP and~~ conclude that the

results do not form an adequate basis for reliable inferences to the qualifications of inspectors whose work was not reinspected.

c. Selection Of Inspector Work To Be Reinspected

38. The third element of the BRP involved the selection of the part of each inspector's work which would be reinspected. This work was categorized into discrete work activities called attributes. All safety-related work attributes that ~~were reinspected if they~~ were ~~both~~ recreatable, ~~and~~ accessible, An attribute was considered recreatable if it could be traced to a specific inspector and the condition or state originally inspected was capable of reinspection at a later time. An attribute was accessible for reinspection if extensive dismantling was not required for the reinspection to be performed. However, attributes were deemed accessible if reinspection could be accomplished through the erection of scaffolding or through the removal of paint, insulation or fireproofing. (Del George, prepared testimony at 17-19, ff. Tr. 8406.)

insert Intervenors proposed ¶38a, following this page, to here →

39. Approximately 80 percent of Hatfield's total inspections performed at Byron (up to the date its revised certification procedures were implemented) were reinspectable. For Hunter, this figure was approximately 70 percent. (Tuetken, prepared testimony at 25, 26, ff. Tr. 8408.) Somewhat less

and identifiable to a sampled inspector had a chance of being included in the BRP, but not all such attributes were in fact reinspected.

INTERVENORS' PROPOSED PARAGRAPH 38A

38A. For Hatfield, all welds for which the original inspector could not be identified were excluded from the program. (Ericksen, prefiled testimony, Table 1, p. 1, Tr. 11,045.) This may have been a nonconservative bias, since one can reasonably question whether those welds for which there was no adequate record identifying the welder are likely to be of less reliable quality than fully documented welds for which the welder can be identified.

than 50 percent of the inspections performed by PTL prior to the implementation of its revised certification procedures were reinspectable. (Tuetken, prepared testimony at 25, 26, ff. Tr. 8408.) This is because PTL performed mainly concrete and soil inspections, which are not recreatable. (Tuetken, Tr. 8664.) It is undisputed that placement of work in either an inaccessible or nonrecreatable category was supported by proper documentation which showed appropriate reasons why a certain inspector's work could not be reinspected. (Hansel, prepared testimony at 17, ff. Tr. 8901; Hansel, Tr. 8982.)

40. Finally, some attributes for work to be reinspected were not captured in the BRP. This was the case for 2 of 11 Hatfield inspection attributes and 5 of 48 Hunter inspection elements. The two Hatfield attributes involving component support and equipment final inspection (cable pan covers and cable pan identification) were not reinspected because this work had not been initiated before September 1982. (Del George, prepared testimony at 17, 18, ff. Tr. 8406.)

Insert Intervenors' Proposed ¶ 40a, following this page, to here →

~~41. The first 90 days of each selected inspector's work~~ was reinspected. (Hansel prepared testimony at 11, ff. Tr. 8901; Del George, Tr. 8490.) Both Edison and the NRC Staff agree that the first 90 days of work is an appropriate period to evaluate to determine inspector qualification. If training has been inadequate to produce a qualified inspector, the first 90 days covers the time when an inspector is most likely to

[Intervenors' Proposed ¶¶ 41-49 B appear following page 26:]

INTERVENORS' PROPOSED PARAGRAPH 40a

Applicant's witness Del George claimed to have evaluated the nature of non-reinspectable work but in his prepared testimony he was mistaken in his analysis of what items were and were not reinspected. For example, he reported that piping and component support temporary attachment, piping component inspection and whip restraint component inspection were reinspected (Del George, prepared testimony, Attachment B, page 11 of 14). After intervenors informed the Applicant of numerous data errors, however, the Applicant stated that portions of these items were non-recreatable and thus were not reinspected. (Ericksen prefiled testimony, Amended Attachment B, page 6.)

make mistakes as a result of that inadequate training. Therefore, in the judgment of CECo and the Staff, a conservative bias was factored into this element of the BRP. (Hansel, prepared testimony at 11, 12, ff. Tr. 8901; Hansel, Tr. 8948; Del George, Tr. 8790-91; Little, Staff prepared testimony at 5, ff. Tr. 9510; Little, Tr. 9646.)

42. This judgment is disputed by Intervenors' witness Dr. Dev. S. Kochhar, a human factors expert from the University of Michigan. According to Dr. Kochhar, inspector performance can be expected to attain its highest proficiency level in the period immediately following completion of training. He testified that in general newly trained inspectors perform better initially because the novelty of the job causes them to be more attentive. This "initial arousal" wears off as novelty and sensory stimulation decline over time. According to Dr. Kochhar, the level of performance effectiveness also declines. Thus, in Dr. Kochhar's opinion, reinspection of only the first 90 days of inspectors' work is likely to have caused a nonconservative bias in the BRP results. The better course, according to Dr. Kochhar, would have been to reinspect the work of inspectors over the full range of their tenure at Byron. (Kochhar, prepared testimony at 7-10, ff. Tr. 10,538.)

43. We have discerned a fundamental problem with the application of Dr. Kochhar's analysis to Byron. Dr. Kochhar's testimony misperceives the very purpose of the BRP, which was

to determine whether the training and certification procedures used by contractors before 1982 were producing qualified inspectors. When confronted with this purpose on cross-examination, Dr. Kochhar agreed that it was necessary to reinspect a period of an inspector's work prior to the time his experience on the job might mask any lack of adequate training. (Kochhar, Tr. 10,571.) In the Board's view, it is obvious that the period of interest is the first few months of an inspector's job performance. The question becomes therefore, whether Dr. Kochhar's testimony persuades us whether the first 90 days as opposed to a longer period is appropriate.

44. Dr. Kochhar admitted that his analysis applied, for the most part, only to the inspection of subjective attributes, that is, visual weld inspections. (Kochhar, Tr. 10,542-43.) For objective attributes, where measuring devices are used, the human factors issues addressed in Dr. Kochhar's testimony are of less concern.*/ (Kochhar, Tr. 10,543.) In this regard, Dr. Kochhar admitted that the only inspection procedures he reviewed at Byron were visual weld inspection procedures. He did not review inspection procedures for any objective inspection attributes. (Kochhar, Tr. 10,553.)

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*/ Indeed, rebuttal testimony by James Buchanan, former Hatfield QA/QC manager, and Malcolm Somsag, Hunter QA supervisor, makes plain that objective inspections involve the application and repeated use of standard measurements and other easily verifiable criteria. (Buchanan, prepared testimony at 5-6, ff. Tr. 11,174; Somsag, prepared testimony at 5-6, ff. Tr. 11,172.)

48. Dr. Kochhar further admitted that his experience with inspection activities has been limited, primarily, to assembly line or batch manufacturing operations involving a Firestone Tire and Rubber Company assembly line operation where inspectors inspected three or four major attributes on tires which passed by at a controlled rate. (Kochhar, Tr. 10,548.) Dr. Kochhar's laboratory experiments involved television monitors on which simulated products moved across the screen at controlled rates. The subject inspectors were required to identify any faults or defects in the products as they moved across the screen. (Kochhar, Tr. 10,550.)

49. Thus, aside from his review of the EEP, Dr. Kochhar has no experience at all with nuclear plant inspection activities. (Kochhar, Tr. 10,547.) Nevertheless, Dr. Kochhar asserts that his Firestone and laboratory results are applicable to Byron QC inspection activities. (Tr. 10,547-48.) Surprisingly, Dr. Kochhar makes this assertion without having evaluated the actual duties of the Byron QC inspectors. (Kochhar, Tr. 10,589.) He was aware that the work of QC inspectors was "somewhat varied", that they looked at different kinds of welds, that welds were located in various locations throughout the plant, and that access to some welds was difficult. (Kochhar, Tr. 10,589-91.) Nevertheless, Dr. Kochhar simply assumed that their tasks like those which were the subject of his experience would require subjective judgments based on pre-

determined criteria. (Kochhar, Tr. 10,589.) On examination by the Board, he agreed that the varied duties of the QC inspectors might tend to break up the tedium that inspectors on assembly lines ordinarily experience. (Kochhar, Tr. 10,591.)

47. Dr. Kochhar also testified that none of his experiments lasted more than 2 or 3 days. (Kochhar, Tr. 10,558.) He is not aware of any studies which have examined this job performance phenomenon over an extended period of time. (Kochhar, Tr. 10,558.) He testified that his predictions concerning long-term job performance are based on a simple analogy to daily performance. (Kochhar, Tr. 10,568, 10,592.) Yet Dr. Kochhar also testified that, based on what he has read in the literature, it is likely that the predicted downturn in inspector performance would begin after only a couple of days. (Kochhar, Tr. 10,562.) Given this, it is logical to assume that any downturn in inspector performance at Byron would have occurred within an inspector's first 90 days. This obviously belies his argument that more than three months of an inspector's work should have been reinspected in order to overcome the initial arousal effect.

48. Finally, Dr. Kochhar was unable to quantify the effect of the alleged nonconservative bias on the results of the BRP. Nor was he able to say when, if ever, an inspector who was initially performing his tasks competently would become incompetent. (Kochhar, Tr. 10,595.) He testified as follows:

INTERVENORS' PROPOSED PARAGRAPHS 41 THROUGH 49B

41. Only the first 90 days of each selected inspector's work was reinspected. (Hansel prepared testimony at 11, ff. Tr. 8901; Del George, Tr. 8490.) Both Edison and the NRC Staff agree that the first 90 days of work is an appropriate period to evaluate to determine inspector qualification. They reason that if the training has been inadequate to produce a qualified inspector, the first 90 days cover the time when an inspector is most likely to make mistakes as a result of that inadequate training. Therefore, CECo and the Staff assume that a conservative bias was factored into this element of the BRP. (Hansel, prepared testimony at 11, 12, ff. Tr. 8901; Hansel, Tr. 8948; Del George, Tr. 8790-91; Little, Staff prepared testimony at 5, ff. Tr. 9510; Little, Tr. 9646.) However, CECo and the Staff are not aware of any studies or previous reinspection programs that support this view. (Del George, Tr. 8472). They admit that they know of no nuclear power plant or other construction reinspection program that similarly relied upon an inspector's first 90 days of work. (Del George, Tr. 8472.)

42. Intervenors' witness Dr. Dev S. Kochhar, an expert on human factors affecting engineering systems and design, from the University of Michigan, disagrees with this view. He has engaged in extensive research and industrial consultation activities on how human factors affect quality control inspection. Dr. Kochhar testified that

inspector performance can be expected to attain its highest proficiency level in the period immediately following completion of training. In general, newly trained inspectors perform better initially because the novelty of the job causes them to be more attentive. As novelty and sensory stimulation decline over time, the level of performance effectiveness also declines. The reason for this pattern of performance is the repetitive, dull and unstimulating nature of the inspection task. Thus reinspection of only the first 90 days of the inspectors' work is likely to cause a nonconservative bias in the BRP results. The better course, according to Dr. Kochhar, would have been to reinspect the work of inspectors over the full range of their tenure a. Byron. (Kochhar, prepared testimony at 7-10, ff. Tr. 10,538.) The question becomes therefore, whether Dr. Kochhar's testimony persuades us that reinspections directed only to the first 90 days are appropriate.

43. We recognize, as Dr. Kochhar acknowledges, that there are no dispositive longitudinal or other studies that clearly establish a pattern of inspector performance. (Kochhar, Tr. 10,569). However, CECo and the Staff provide no empirical basis whatsoever to justify their reliance on reinspections of only the first 90 days of inspection performance. To the contrary, Intervenors have presented the expert testimony of Dr. Kochhar

who has extensively researched and reviewed studies of quality control inspections. (Kochhar, prepared testimony at 2, Attachment A, ff. Tr. 10,538.) These studies involve both stationary and roving inspectors principally at manufacturing facilities. (Kochhar, Tr. 10,597-98).

44. Dr. Kochhar reviewed the BRP, and we are persuaded that his experience with human factors affecting quality control inspections at industrial facilities is applicable to nuclear plant inspection. We recognize that Dr. Kochhar's direct experience with nuclear plant inspections is limited. (Kochhar, Tr. 10,547). However, the human factors relating to quality control inspections have common elements in both environments. The inspection task undertaken is characterized by the same monotony, in which the worker repeatedly undertakes the same decision-making task -- an item is viewed, measured and then determined to be acceptable or unacceptable (a binary decision) in accordance with specified criteria. Regardless of the environment or the particular pace of work, the operational task of inspection is the same. (Kochhar, prepared testimony at 4-5 ff. Tr. 10,538).

45. Similarly, there are no substantial differences between the tasks being performed by the individual under examination in the laboratory and the inspector at Byron. The individuals are performing a mundane task in which essentially the same

type of binary decision is to be made based on certain criteria. Knowledge of the human factors affecting inspector performance obtained from laboratory experiments can then be applied to workplace settings. (Kochhar, Tr. 10,559-60, prepared testimony at 6-7, ff. Tr. 10,538). We are convinced that general patterns of inspector performance identified in laboratory experiments are pertinent to the BRP.

46. Dr. Kochhar acknowledges that his human factors analysis applies predominantly to the inspection of subjective attributes, that is, visual weld inspections. (Kochhar, Tr. 10,542-43.) Still, for objective attributes, where measuring devices are used, there is some element of subjectivity. (Kochhar, Tr. 10,542-3.) We are persuaded that Dr. Kochhar's human factors analysis is applicable to the BRP, especially to the subjective visual weld inspections. (Kochhar, Tr. 10,591.)

47. Dr. Kochhar described the pattern of inspector performance that has been found in various human factors studies. We are aware that none of Dr. Kochhar's laboratory experiments lasted more than 2 or 3 days. (Kochhar, Tr. 10,558.), and that there are not any studies in this field which have examined these job performance phenomena over an extended period of time. (Kochhar, Tr. 10,560.) However, Dr. Kochhar identified a significant pattern of daily performance, in which performance begins high and then tapers off, that would be repeated over time (Kochhar, Tr. 10,567.) This pattern of

inspector performance when viewed over a long period of time reflects a fairly well-maintained consistency of performance in the initial stages. When fatigue and monotony begin to set in, "the curve" of performance decreases until gradually it begins to flatten out or settle. Overall, the pattern reflects that performance is good initially, and then over a period of time, it decreases and then flattens out. (Kochhar, Tr. 10,566.)

This pattern would not show Byron inspector performance declining in the first two days following the conclusion of training. (Kochhar, Tr. 10,566-67). Instead, the trend for Byron inspectors would reflect better performance in their first 90 days following training than in later periods. (Kochhar, Tr. 10,568).

48. This phenomenon of quality control inspector performance tedium and decline has been recognized by industry, not just revealed in laboratory experiments. Industry often compensates for this problem by rotating inspectors to different, unrelated jobs. (Kochhar, Tr. 10,602). At Byron, inspectors performed only inspection tasks.

49. We are persuaded that inspector performance is likely to attain its highest level of proficiency in the period following completion of training and then decline over time reaching a plateau. Thus by limiting inspectors to only the first 90

days of inspector performance most likely biased the BRP results in a non-conservative manner, rather than conservative manner as suggested by CECo and the Staff. CECo's and the Staff's assumption is misplaced. We agree with Dr. Kochhar that the BRP would have more accurately examined inspector performance and qualifications if the reinspections had tested inspector performance over an extended range of the work period. (Kochhar, prepared testimony at 9-10, ff. Tr. 10,538.)

49A. Dr. Kochhar acknowledges that unless inspector performance is examined over a longer period of time, the precise degree of the bias cannot be quantified. (Kochhar, Tr. 10,601). Nonetheless, we can conclude that the bias of relying on the first 90 days of inspector performance was opposite to that assumed by CECo and the Staff. We agree with Dr. Kochhar that this phenomenon most probably led to a higher percentage of inspector work found to be acceptable (i.e., confirming) by the BRP than would otherwise have been justified by the circumstances. BRP is thus flawed and reliable conclusions about its results can only be made after this non-conservative bias is taken into account. (Kochhar, prepared testimony at 13, ff. Tr. 10,538).

49B. Therefore, we find that CECo's and the Staff's reliance on

reinspections of the first 90 days of inspector performance was arbitrary and oversimplified. While the selection of this period was understandable for purposes of validating inspector training and pre-employment qualifications, it is nonconservative for purposes of generalizations concerning the levels of inspector performance over time at Byron, and for purposes of any inferences concerning work quality made on the basis of the BRP sample.

A. Yes, well what I'm saying is that I don't think anybody could quantify that bias. The fact is that if you had taken a period of time that was longer and then sampled, it may have been more reflective of the actual working span.

* * *

Q. Dr. Kochhar, just so we are clear on this, you don't know -- as you sit here today -- whether the reinspection results have been overstated by a half a percent or 20 percent because of the selection of the first 90 days?

A. That's correct. I do not know.

(Kochhar Tr. 10,601, 10,603, 10,604.)

49. Thus, it appears that Dr. Kochhar's theory, which is limited to subjective attributes and based on limited relevant experience, would have its impact, if at all, in the first 90-days of an inspector's job performance. Consequently we are not persuaded that Applicants choice of the first 90-days was inappropriate. Indeed, we find that reinspection of an inspector's first three months of work was appropriate to determine whether the inspector was adequately qualified following his initial training.

d. Inspector Qualification Acceptance Criteria

50. In order to evaluate the performance, and thus the qualifications, of the original inspectors, it was necessary to establish appropriate acceptance criteria. To facilitate the establishment of such criteria, the reinspection of QC inspections was divided into two attribute categories: objective and

subjective. (Hansel, prepared testimony at 13, ff. Tr. 8901; Del George, prepared testimony at 19, 20, ff. Tr. 8406.)

51. An attribute is subjective if its inspection requires qualitative interpretation by the inspector. Visual weld examination was the only subjective attribute in the BRP. An attribute was classified as objective if its inspection was not significantly affected by qualitative interpretation. (Del George, prepared testimony at 19, 20, ff. Tr. 8406.) The types of inspections included in this category, such as dimensions that should not change and verification of materials and shape, are repeatable and require very little exercise of judgment by the inspector. (Hansel, prepared testimony at 13, ff. Tr. 8901; Del George, preapred testimony at 18, 20, ff. Tr. 8406.) Nonetheless, inspection of objective attributes involves an element of subjective judgment. (Kachhar, Tr. 10,542-43)

52. For inspections involving objective attributes, the acceptance level was set at 95 percent, which means that ~~95~~ the reinspector agrees with the original inspector's findings in 95% of the reinspected inspections. ~~percent of the inspected work had to be found acceptable to qualify the original inspector.~~ (Hansel, prepared testimony at 13, ff. Tr. 8901; Del George, prepared testimony at 19, 20, ff. Tr. 8406.)

53. Both Applicant and NRC Staff witnesses testified that the 95 percent acceptance level for objective attributes was reasonably conservative and recognized that unintentional human error precludes total agreement. (Del George, prepared testi-

mony at 23, ff. Tr. 8406; Little, Staff prepared testimony at 8, ff. Tr. 9510.) The level was acceptable in our judgment. ~~We agree.~~

54. For inspections involving subjective attributes, the acceptance level was set at 90 percent. (Hansel, prepared testimony at 13, ff. Tr. 8901; Del George, prepared testimony at 23-25, ff. Tr. 8406.) The 90 percent acceptance level for subjective attributes recognized the likelihood for reasonable disagreement between inspectors and reinspectors where judgmental decisionmaking was involved in the inspection. (Del George, prepared testimony at 24, ff. Tr. 8406; See also, Little, Tr. 9560, 9574.) (Edison's expert) (incorrectly) (that) ~~As~~ John Hansel testified the inspection agreement rate on a piece of hardware can range from 20 percent for a very complex piece to 80 percent for a very simple piece. (Hansel, Tr. 8942.) Mr. Hansel ranked visual weld inspections in the 70 to 80 percent agreement range. (Hansel, Tr. 8943.) ~~Thus,~~ Nonetheless we find that the subjective attribute rate of 90 percent used in the BRP is acceptable, (albeit not demonstrably conservative) (Hansel, Tr. 8943.)

55. If an acceptance criterion was not met for the first 3 months of an inspector's job performance, inspections during the second three months of the individual's inspection tenure were reinspected for the attributes for which the inspector failed the acceptance criterion. If the results of the second three month period did not meet the acceptance criterion, the inspector was judged to be unqualified. In this event, 100 percent of the inspections performed by that inspector of the

In fact, the data on which Mr. Hansel erroneously relied were defect detection rates, not inspector agreement rates. (See Harris and Chaney p. 76, ff. Tr. 9321, and Tr. 9327-30.)

As explained by Mr. Forney and discussed in ¶ 99 below, the two are quite different.

type found to fail the acceptance criterion were reinspected. In addition, the original inspector sample population for the particular contractor involved was expanded by as much as 50 percent for the attribute in question, depending on the number of inspectors still available for inclusion in the program. Applicant's selection of inspectors added to the sample was made from an overall list of inspectors certified in the specific area where the unqualified inspector was identified. (Del George, prepared testimony at 26, 27, ff. Tr. 8406.)

56. If an inspector had no inspections beyond three months and did not meet an acceptance criterion, the next inspector certified chronologically was substituted and his first three months of work was reinspected. The qualification of the original inspector in such a case was considered indeterminate, but his results were retained in the program data base, and all observed discrepancies were evaluated for design significance. (Del George, prepared testimony at 27, ff. Tr. 8406.)

57. The Board finds that the mechanisms used to expand the reinspection process in the event that inspectors failed to pass the applicable acceptance criterion were reasonable. Furthermore, we agree it was prudent to include the results of all reinspections in the BRP, including those of the inspectors characterized as indeterminate.

V. IMPLEMENTATION OF THE PROGRAM

a. Meetings With Contractors

58. Implementation of the BRP began in February 1983. At that time Applicant's representatives met with the contractors whose work was to be reinspected.

59. We note that the contractors whose inspectors were the subject of the BRP had no input into the formation of the program. According to Mr. Tuetken, the only contact between Applicant and the contractors prior to NRC Staff approval occurred when Mr. Tuetken asked the contractors whether it was possible to produce a listing of inspectors by certification date. (Tuetken, Tr. 8845.) No details of the reinspection plan were released to the contractors until after NRC Staff modification and approval of Applicant's proposal for a reinspection program on February 3, 1983. (Tuetken, Tr. 8764.) Subsequently, at its initial meeting with the contractors, the purpose and nature of the reinspection activities to be performed, an outline of the program and criteria for reinspection were discussed. The basic instructions given to the contractors were (i) the reinspections were to be conducted employing the acceptance criteria used at the time of the original inspections; (ii) individuals involved in the reinspection of work could not be the same inspectors who performed the original inspection, and (iii) the need for removal of fireproofing, paint and insulation did not render an item inaccessible for

Contractors were also instructed that the total BRP was to be completed by July 1, 1983 (Tuetken, Tr. 8607-08), even though Mr. Tuetken originally testified at his deposition that no timetable could be set before the volume of work was determined (id., Tr. 8606).

purposes of reinspection. (Tuetken, prepared testimony at 4, 5, ff. Tr. 8408.)

60. As the BRP proceeded, weekly meetings were held between the participating contractors and the CECo project construction department to discuss and resolve questions concerning the ongoing program, establish methods for recording results, and determine action to be taken on discrepancies observed in the reinspection effort. A series of written interpretations regarding implementation of the BRP were created, as necessary and disseminated to all contractors for their guidance. (Tuetken, prepared testimony at 5, ff. Tr. 8408; Shewski, prepared testimony at 4, ff. Tr. 8423. See Attachment A to Teutken, prepared testimony at 5, ff. Tr. 8408.)

b. Physical Reinspection Activities

61. Physical reinspection activities began in the middle of March 1983. (Tuetken, prepared testimony at 6, ff. Tr. 8408.)*/ The BRP was performed by reinspectors who were prop-

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*/ The Appeal Board noted that the reinspection program only covered inspectors certified up to September 1982 and the recertification program was not completed until early 1983. It therefore questioned whether Applicant had ensured that inspectors certified between those dates were capable of performing their tasks. (ALAB-770, slip opinion at 29.) To address this concern, Mr. Tuetken explained that the reinspection program examined the first three months of work performed by inspectors right up to the date the revised certification procedures were implemented. The first three months of work of at least a small number of inspectors who were certified during the summer of 1982 were included in the BRP and this three month period extended beyond September, 1982. (Tuetken, prepared testimony at 18, ff. 8408.)

erly recertified to ANSI N45.2.6 (1978) before commencing reinspections.*/ (Del George, prepared testimony at 20, 21, ff. Tr. 8406; Tuetken, prepared testimony at 16, 17, ff. Tr. 8408.) The proper certification of the reinspectors was confirmed on the basis of extensive overview inspections by Applicant's project construction and quality assurance departments and the NRC Staff. (Del George, Tr. 8789; Ward, Tr. 9691-92.)

62. Reirspections were performed to the same or more stringent criteria than had been used in the original inspection. (Del George, prepared testimony at 21, ff. Tr. 8406.) This introduces a ~~further~~ conservatism, since the reinspectors, having been trained to 1983 standards, were required to apply less stringent earlier criteria. Mr. Tuetken testified that in many cases it was simply not possible to ignore the influence of the current standards. (Tuetken, Tr. 8706-07.)

63. More than 80,000 man-hours of actual reinspections were performed, and more than 160,000 additional man-hours were spent in construction, clerical, and administrative support

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*/ In our Initial Decision, we identified a concern about the number of Hatfield inspectors that required recertification and/or retraining at the inception of the BRP. (I.D. ¶D-436.) In response, Mr. Connaughton explained that as of September 30, 1982, Hatfield employed 46 inspectors who required additional training, testing, and/or documentation to comply with the new QC inspector certification requirements. Mr. Connaughton also explained that there is no particular significance to the number of Hatfield inspectors requiring recertification inasmuch as all of them were included in the population considered in the BRP. (Connaughton, prepared testimony at 18-19, ff. Tr. 9510.)

but Mr. Hansel did not personally interview any of the reinspectors who participated in the BRP (Tr. 8905).

work related to the BRP. More than 202,000 inspection points were reinspected. (Tuetken, prepared testimony at 19, ff. Tr. 8408; Behnke, prepared testimony at 14, ff. Tr. 9336.)

64. Each contractor used its own QC inspectors as reinspectors. (Del George, prepared testimony at 21, ff. Tr. 8406; Hansel, Tr. 8928.) However, steps were taken to ensure that no inspector reinspected his own work. (Hansel, prepared testimony at 15, ff. Tr. 8901; 8917.) Supervisors assigned work to reinspectors only after verifying that the inspector performing the reinspection was not the original inspector. (Tuetken, prepared testimony at 20, ff. Tr. 8408.)

65. In ~~some~~ most cases, a reinspector knew whose work he was reinspecting. (Tuetken, id. at 21.) ~~(Hansel, Tr. 8934-35.) However,~~ A sample audit by Mr. Hansel found no evidence or patterns indicating the presence of a buddy system or any attempt to alter the results. (Hansel, prepared testimony at 16, ff. Tr. 8901; Del George, Tr. 8480; See also, Little, Tr. 9854-57.) ~~There was no~~ Consequently his failure to find evidence that reinspectors were concerned and/or influenced by the potential economic consequences to their employer of adverse program results is entitled to little weight. The same is true of ~~To the contrary,~~ the reinspectors were ~~judged by Mr. Hansel to be~~ professionals concerned with their personal reputations and ~~Mr. Hansel testified~~ that they ~~reinspectors~~ would not be likely to jeopardize their own reputations for the sake of the contractor. (Hansel, Tr. 8928-33.)

his conclusions that

66. Independent third-party reviews were conducted by Level III inspectors of all visual weld inspections which were found discrepant. (Tuetken, prepared testimony at 19, 20, ff. Tr. 8408.) Third-party reviewers examined 3,136 weld discrepancies identified by Hatfield reinspectors, and determined that 1,150 of these should have been accepted by the reinspectors rather than rejected. The third-party reviewers examined 121 weld discrepancies identified by Hunter and determined that 12 should have been accepted rather than rejected. For PTL the third-party reviewers examined 999 weld discrepancies identified by reinspectors, concluding that 94 should actually have been accepted. (CECo contends that These third-party review results confirm that the reinspectors of Hunter, Hatfield, and PTL generally evaluated weld inspections consistently and conservatively. (Tuetken, prepared testimony at 30, ff. Tr. 8408.) This judgment was (concurred in ~~confirmed~~) by the NRC Region III Staff. (Ward, Staff prepared testimony at 10-11, ff. Tr. 9510; Ward, Tr. 9691-92, 9776; Del George, prepared testimony at 25, ff. Tr. 8406.)

67. Mr. Ward, the Region's welding expert, testified that he found no instance where a reinspector had missed a deficiency. Indeed, in his opinion, in many cases the reinspectors were overly conservative, classifying welds as unacceptable even though they were in fact acceptable under the AWS Code. (Ward, Tr. 9774-76; Ward, Staff prepared testimony at 10-12, ff. Tr. 9510; See also Little, Staff prepared testimony at

on having inspected only about 1% - 330 - of the more than 31,000 Hatfield, Hunter and PTL welds that were reinspected. (Ward, Tr. 9911.)

14-16, ff. Tr. 9510.) Mr. Ward estimated that reinspections were overly conservative in about 10 percent of the cases. (Ward, Tr. 9868.) However, Mr. Ward based this judgment,

68. To verify the accuracy of the reinspections, Edison directed PTL to perform a special unit concept inspection to determine whether PTL's inspectors would independently arrive at the same results as the contractors' QC inspectors who were performing the reinspections. (Tuetken, prepared testimony at 19, 20, ff. Tr. 8408.) PTL performed a sample reinspection of the items inspected during the reinspection program. PTL randomly selected QC inspectors and activities for reinspection, PTL inspectors were able to reproduce the reinspection results for Hatfield and Hunter at a very high rate (See Shewski, prepared test at 21, ff. Tr. 8423.) ~~providing an addi-~~ However, PTL inspectors do not inspire confidence. PTL had a cumulative ~~tional level of confidence that the reinspections by Hatfield and Hunter were reliable and conservative (Shewski, prepared test at 5, ff. Tr. 8423).~~ average of 85.3% for all its inspectors whose subjective work was reinspected, and 77% for its inspectors who were reinspected in the expanded sample period. (Del George, Tr. 8504

69. The special unit concept inspection also verified that the reinspection personnel for Hatfield and Hunter were not involved in the reinspection of work that they had originally inspected. ~~In addition, the reproducibility of the results by PTL, whose inspection personnel had no connection with Hatfield and Hunter employees, demonstrated that the reinspectors did not bias their results in favor of the inspectors whose work they were reinspecting. (Shewski, prepared testimony at 22, ff. Tr. 8423; Tuetken, prepared testimony at 21, ff. Tr. 8408.)~~

prepared testimony at Attachment E, p. 6, ff. Tr. 8406.)

70. Despite this evidence of conservatism, Dr. Kochhar testified for Intervenors that knowledge by the reinspectors of the identities of the original inspectors could have biased the reinspection results nonconservatively, that is, in favor of conforming reinspections. Dr. Kocchar testified that the reinspection effort should have been undertaken by individuals with no previous involvement at the site to minimize any bias (Kocchar, prepared testimony at 11, ff. Tr. 10938.) However, on cross-examination Dr. Kochhar admitted that he could not state whether such knowledge did in fact lead to nonconservative bias in this particular inspection setting. Nor would he even attempt to quantify the amount of bias which may have been introduced. (Kochhar, Tr. 10,604-05, 10,612.) Moreover, consistent with the Staff testimony, Dr. Kochhar admitted that such bias, even if it was introduced, might just as well have led to stricter reinspection rather than leniency. (Kochhar, Tr. 10,605.) We conclude that there simply is no evidence that reinspectors' knowledge of the identities of some original inspectors nonconservatively biased the results of the BRP.

71. It is also significant that in many instances the reinspectors simply did not know the inspectors whose work they were reinspecting. For Hatfield, almost the entire population of inspectors had turned over by the time of the BRP. Of the five Hatfield original inspectors who remained, only one was included in the program sample. (Hansel, Tr. 8926-27.) For

[Intervenors Proposed ¶¶ 70-76:A follow page 39:] →

Hunter, only the identification number of the original inspector was provided to the reinspector. (Hansel, Tr. 8927.) Obviously, a person is much less likely to remember a number than to recognize initials. Finally, for PTL, offsite PTL inspectors were brought in to perform the reinspections. (Hansel, Tr. 8927.)

72. In most instances the reinspectors knew the results of the original inspections. (Hansel, Tr. 8933-5; Kochhar, prepared testimony at 12, ff. Tr. 10,538) The reason for this is easy to understand. The reinspection program was set up so that the only inspections which were reinspected were those where the items inspected had been found originally to conform to requirements.*/

73. Dr. Kochhar proposed that this knowledge of the original results introduces another source of possible bias. In his opinion, the fact that in most instances the reinspectors knew the results of the original inspections could have resulted in a "mimic" effect where reinspectors conform their results to the original inspection results. (Kochhar, prepared testimony at 12, ff. Tr. 10,538.) Dr. Kochhar testified that this phenomenon is based on the "general human tendency to avoid deviation from a prior determination." (Kochhar, prepared

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*/ The single exception is with respect to "as-builts", where the reinspector was simply asked to measure the dimensions of certain components as-built. In these cases, the reinspectors' measurements were compared with the measurements of the original inspectors. (Kochhar, Tr. 10,619.)

testimony at 12, ff. Tr. 10, 538.) Dr. Kochhar further testified, however, that he had never personally observed this phenomenon in any of his laboratory experiments; rather his testimony regarding this theory is based on his review of the literature. (Kochhar, Tr. 10,620.)

74. As with Dr. Kochhar's earlier theories, we are not persuaded that a mimic effect played a significant factor in the results of the BRP. First, by program definition, the only inspections which were subject to reinspection were those where the items inspected had been found originally to conform to requirements. (Kochhar, Tr. 10,618.) Thus, the original inspection results can be viewed as a constant, the original inspector always having found the items to meet requirements. We find, as a matter of common sense, that the mimic effect is less likely to operate in conjunction with such a constant.

75. Moreover, and of even more importance, Dr. Kochhar's theory is inconsistent with the actual evidence which the results of the BRP produced. Dr. Kochhar conceded that if the inspectors were very thorough and rigid in their reinspection, the mimic effect would be lessened. (Kochhar, Tr. 10,621-22.) Such thoroughness and rigidity in fact took place. The Staff testified that weld reinspectors were often overly conservative, even to the point of being "gun shy", in their assessment of earlier inspection results. (Ward, Tr. 9776, 9790; See also Kochhar, Tr. 10,625.)

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70. Dr. Kochhar testified for Intervenors that knowledge by the reinspectors of the identities of the original inspectors could have biased the reinspection results nonconservatively, that is, in favor of conforming reinspections. Even though the precise amount of bias could not be quantified (Kochhar, Tr. 10,605), it was important. (Kochhar, Tr. 10,610.) Dr. Kochhar testified that the reinspection effort should have been undertaken by individuals with no previous involvement at the site in order to minimize any bias. (Kochhar, prepared testimony at 11, ff. Tr. 10,538.)

70A. According to Dr. Kochhar, workplace dynamics and social associations can influence the reinspector's decision-making criteria. The BRP assigned site contractors responsibility to reinspect their own inspections. Some procedures in the BRP may have mitigated these biases: reinspectors were not permitted to verify their own inspections, and PTL conducted a limited number of over-inspections. Nonetheless, even though some Hatfield, Hunter and PTL inspectors were no longer on-site during the reinspections, a large number of original inspectors were on-site at the critical time, and these inspectors and reinspectors may have continued personal associations with the off-site inspectors. (Kochhar, prepared testimony at 11, ff. Tr. 10,538). The key factor is not whether the individual remains on the site, but

whether there was any personal association between the inspector and reinspector. (Kochhar, Tr. 10,608.)

70B. We recognize the common sense logic of Dr. Kochhar's testimony that in order to have the maximum confidence in the validity of the reinspection results, the reinspector should be "independent" of the original inspector. Not only should the inspector's name be concealed, but to minimize bias the reinspector should have no previous involvement at the site, and thus no economic incentive to demonstrate a high level of work quality. That reinspectors were employed by site contractors, and received their initial instructions and general supervision from these same contractors, also may have led to bias of the reinspection results. NRC regulations may permit site contractors to do both inspections and reinspections, but nevertheless the reinspectors' knowledge of the inspectors' names led to bias. We acknowledge that, in practice, it might be difficult to undertake a completely independent reinspection program, but preventing the reinspectors from knowing the names of the original inspectors would lessen the potential for a non-conservative bias resulting from reinspectors being more lenient. (Kochhar, prepared testimony, at 12, ff. Tr. 10,538.)

71. We are persuaded by Dr. Kochhar that a reinspector's knowledge

of the identity of the inspector introduces a bias that, in most cases, would be lenient and thus tend to overstate an inspector's results. (Kochhar, Tr. 10,607.) This bias is important, and pertinent to nuclear power plant inspections. (Kochhar, Tr. 10,610-11.)

72. We find that in most cases, the reinspectors knew the identities of the inspectors whose work they examined. This tended to generally overstate the BRP results by leading to a higher percentage of conforming reinspections than otherwise would have been justified under the circumstances. Reliable conclusions about the BRP results can be made only after this human factor bias is taken into account. This non-conservative bias undermines our confidence that the BRP was appropriate to determine whether an inspector was adequately qualified following his initial training.

73. In most instances the reinspectors knew the results of the original inspections. (Hansel, Tr. 8933-5; Kochhar, prepared testimony at 12, ff. Tr. 10,538) The reason for this is easy to understand. The reinspection program was set up so that the only inspections which were reinspected were those where the items inspected had been found originally to conform to requirements.*/ However, it is neither typical nor

*/ The single exception is with respect to "as-builts," where the reinspector was simply asked to measure the dimensions of certain components as-built. In these cases, the reinspectors' measurements were compared with the measurements of the original inspectors. (Kochhar, Tr.10,619.)

desirable industry practice to permit the reinspector to know the original inspection results. (Kochhar prepared testimony at 12, ff. Tr. 10,538.)

74. Dr. Kochhar testified that this knowledge of the original results introduces another source of possible bias. Based on his human factors studies, the fact that in most instances the reinspectors knew the results of the original inspections could have resulted in a "mimic" effect where reinspectors conform their results to the original inspection results. (Kochhar, prepared testimony at 12, ff. Tr. 10,538.) Dr. Kochhar testified that this phenomenon is based on the "general human tendency to avoid deviation from a prior determination." (Kochhar, prepared testimony, at 12, ff. Tr. 10,538.) Dr. Kochhar further testified, however, that he had never personally examined this phenomenon in any of his laboratory experiments; rather his testimony regarding this theory is based on his review of the studies undertaken by others. (Kochhar, Tr. 10,620.)

75. Dr. Kochhar conceded that if the inspectors were very thorough and rigid in their reinspections, the mimic effect would be lessened, and the bias could be somewhat offset. (Kochhar, Tr. 10,621-22.) The Staff testified that weld reinspectors may have been sometimes overly conservative in their

assessment of earlier inspection results. (Ward, Tr. 9776, 9790; See also Kochhar, Tr. 10,625.)

76. We are persuaded by Dr. Kochhar that the reinspector's knowledge, in most cases, of inspection results biased the BRP results and most probably led to a higher percentage of conforming reinspections. Thus the percentage of the original inspectors' work found to be acceptable by the reinspectors would be higher than otherwise would have been justified by the circumstances. Reliable conclusions about the BRP results can be made only after the bias from this human factor, even though it cannot be precisely quantified, is taken into account.

76A. Overall, we find that the cumulative effect of these three particular human factors identified by Dr. Kochhar as present in the structure and implementation of the BRP -- reliance on reinspections of the inspectors' first three months of job performance; that, in most cases, the reinspectors knew the names of the original inspectors; and that, in most cases, the reinspectors knew the original inspection results -- biased the program results, and most probably led to a higher percentage of conforming reinspections. The percentage of the original inspectors' work found to be acceptable by the reinspectors thus would be higher than otherwise would have been justified by the circumstances. Reliable conclusions about

the BRP results can be made only after the biases from these human factors are taken into account. These non-conservative biases undermine our confidence that the BRP was appropriate to determine whether an inspector was adequately qualified following his initial training.

(Intervenors' Proposed ¶¶ 70-76A, p. 6)

76. Finally, John Hansel testified that the reinspectors knew their work would receive a great deal of attention. They knew particularly that they themselves might be reinspected, by the NRC Staff, by a CECo auditor or by someone like Mr. Hansel. In Mr. Hansel's judgment, the reinspectors were strongly motivated to perform their jobs properly, even stringently, not to mimic the results of the earlier inspections. (Hansel, Tr. 8939-40.)

c. Termination Of Allen Koca

77. In our June 8 Order setting forth the scope of the reopened proceedings, we denied Intervenor's request to make the circumstances surrounding the termination of Allen Koca, former Hatfield QA supervisor, a mandatory issue to be addressed. However, Intervenors had been granted the right to discover information concerning Mr. Koca's termination (Tr. 8156-61.) and we stated that the parties themselves should determine its relevance, if any, to the BRP. (Memorandum and Order Following Prehearing Conference, dated June 8, 1984, at 6.) In the interest of a complete record, Edison and the Staff presented undisputed testimony concerning Mr. Koca.

78. First, Mr. Koca's release from Hatfield in October 1983 was not related in any way to his work on the BRP. (Tuetken, prepared testimony at 8, ff. Tr. 8408; See also Hayes, Tr. 9965.) Second, Mr. Koca's role in the BRP was limited to supervising the Hatfield QA clerical staff review of

certification records to identify the roster of inspectors based on certification dates. Thereafter, his role consisted solely of supervising the clerical staff members who were responsible for searching the inspection record files to identify each individual inspection performed by the selected inspectors during their first 90 days. (Tuetken, prepared testimony at 7, ff. Tr. 8408.)

79. Finally, Mr. Koca's work on the BRP was satisfactory, as demonstrated by audits performed by the CECo Site QA Department in June 1983 (Audit 6-83-66) and August 1983 (Audit 6-83-124). These audits confirmed that Hatfield had properly prepared the chronological listing of inspectors from which the reinspection sample was selected, and had properly established the population of inspections for each selected inspector. (Tuetken, prepared testimony at 8, ff. Tr. 8408.)

VI. OVERSIGHT OF PROGRAM IMPLEMENTATION

a. CECo QA Audits And Surveillances

80. CECo's quality assurance department conducted three audits and four surveillances of the BRP. Two of the audits dealt with the activities of all site contractors, including Hatfield and Hunter. The third audit involved only Hatfield. Additional surveillances were performed to close out all audit findings and observations. These audits and surveillances were described in detail in the testimony of Walter Shewski. Mr.

Shewski testified that all findings, observations or other concerns raised as a result of these audits and surveillances have been closed by Applicant on the basis of acceptable corrective actions. (Shewski, prepared testimony at 5-20, ff. Tr. 8423.) We discuss the specifics of the audits in the following paragraphs.

81. Audit 6-83-66 was conducted between June 21, 1983 and July 6, 1983 and examined the following areas for each of the seven contractors involved in the BRP:

-- Reinspection sample size of inspectors and inspection items.

-- Items determined to be inaccessible.

-- Third party review of potentially unacceptable subjective type inspections.

-- Dispositions of nonconforming conditions discovered during the BRP.

-- Adequate documentation of the reinspection program as implemented by the contractors.

-- Qualifications of inspection personnel performing reinspection.

Audit 6-83-66 resulted in a single finding. Part A of that finding applied to Hunter, Part B to Hatfield and Part C to PTL. (Shewski, prepared testimony at 8, Attachment E, ff. Tr. 8423.)

82. Part A of the audit finding identified two problems with potential consequences on the analysis of the BRP results. The first problem involved the use of field problem

sheets by Hunter rather than discrepancy reports. A subsequent quality assurance surveillance (number 5189) verified that discrepancy reports had in fact been initiated for the particular discrepancies as required by Hunter's procedures. (Shewski, prepared testimony at 9, Attachment F, ff. Tr. 8423.) The second problem involved the reinspection of bolted connections by Hunter. This item was dispositioned by a letter from Sargent & Lundy which stated that the particular bolt values would relax over time and thus could not be reproduced for purposes of the reinspection program. (Shewski, prepared testimony at 9, ff. Tr. 8423.)

83. Part B of the audit finding determined that Hatfield was using field problem sheets to resolve discrepancies identified during reinspection for conduit and termination attributes. A subsequent quality assurance surveillance (5202 R1) found that Hatfield NCR number 674 was written to disposition a deficient item discovered during the reinspection process which had previously been the subject of a field problem sheet. (Shewski, prepared testimony at 10, ff. Tr. 8423).

84. Part C determined that PTL had not yet transmitted inspection reports generated during the BRP to the appropriate contractors. These inspection reports described discrepant conditions in work performed by other contractors, but inspected by PTL. PTL was working on the premise that reports with nonconforming conditions would be reported to the contrac-

tors upon completion of the BRP. Upon being advised during the audit to immediately transmit nonconforming reports to the appropriate contractors after concurrence by the independent third party inspector, PTL began and continued transmitting such reports as they were prepared. No further corrective action was required. (Shewski, prepared testimony at 10, ff. Tr. 8423.)

85. The second audit, 6-83-93, was conducted between November 14 and November 17, 1983 and examined the following areas for each of the seven contractors involved in the BRP:

-- Accuracy of BRP results as reported to the NRC in the Interim Report.

-- The design basis for the engineering evaluation of visual weld inspection discrepancies as described in the Interim Report.

-- Qualifications of the third party inspectors.

-- Documentation of third party inspections.

-- Basis for project construction department "Interpretations" regarding the BRP.

-- Correction of deficiencies identified as a result of the BRP.

(Shewski, prepared testimony at 14, Attachment N, ff. Tr. 8423.)

86. Audit 6-83-93 identified no findings or observations applicable to Hatfield or Hunter. It did, however, result in one finding applicable to PTL. Following implementation of a project construction department interpretation of the BRP, PTL

had changed the deficient status of some welds which previously had received third party concurrences on rejectability without allowing the independent third party inspector to concur or disagree with the changes. Corrective action for this Finding involved the resubmittal to the third party inspector of the particular reports which changed the deficient status of the rejected welds for reasons other than those addressed by the Interpretation. In addition, the contractors were advised that such second inspections should not be performed without allowing the third party to concur or disagree. This corrective action was documented in CECo surveillance 5696. (Shewski, prepared testimony at 15, Attachment O, ff. Tr. 8423.)

87. The third CECo quality assurance audit, 6-83-124, was directed solely at Hatfield and was conducted between August 24 and September 1, 1983. Its purpose was to verify proper implementation of the BRP by Hatfield. The audit examined welding and Hatfield reinspection methodology for welding. Specifically, field and record reviews were performed to determine that Hatfield had adequate traceability of weld travelers to installations in the field. The reviews were accomplished by retrieving weld travelers from Hatfield for a particular component and then going into the field to determine which weld travelers corresponded to which weld on the component. Since welders identify welds on a component with a unique identification number assigned to them traceability of weld traveler to

weld could be made. In addition, this audit reviewed the method Hatfield used to identify hangers which had been reworked or renumbered so that a reinspection could be performed if required. This was done by reviewing the inspection history of a component to determine the completeness of inspection as well as identification of the most current inspection. Finally, the audit was performed to verify that Hatfield was properly inspecting combination cable pan hanger welds (hangers shared with the HVAC contractor). This was performed through identification of combination hangers, and review of installation and inspection documentation to support the installation. (Shewski, prepared testimony at 16-18, Attachment P, ff. Tr. 8423.)

88. Audit 6-83-124 resulted in two findings. The first finding was that in some cases the weld traveler cards did not adequately identify the weld in the field for inspection. The second finding was that not all combination hanger inspections had been documented to indicate conclusively that the inspection was completed. (Shewski, prepared testimony at 18, ff. Tr. 8423.)

89. Hatfield's corrective action for the first finding was to correlate the weld traveler inspection data to design drawing cable pan hanger data using computer data base management techniques to demonstrate traceability of inspection. This use of the computerized data base identified the welders

and inspectors who worked on and inspected the component as well as components not inspected. For those components for which no correlation existed between component and inspection data, it was assumed that no weld inspection had ever occurred. An inspection was initiated to complete the documentation and any necessary repairs. This corrective action was documented in CECo QA surveillance 5275. (Shewski, prepared testimony at 19, Attachment Q, ff. Tr. 8423.)

90. Hatfield's corrective action for the second finding involved the identification of all combination hangers for which inspection accountability was indeterminate. The hangers identified were considered as never having been inspected. An inspection was performed and, where required, rework was performed. This corrective action was documented in CECo surveillance 5274. (Shewski, prepared testimony at 19, Attachment R, ff. Tr. 8423.)

91. The audit finding in Audit 6-83-66 regarding the use of field problem sheets by Hatfield and Hunter was one of the matters discussed in our initial decision as indicating continuing documentation problems on the part of Hatfield and Hunter. (I.D. ¶D-444.) In the remanded hearing we had the opportunity to place that audit finding in the context both of the overall evolution of documentation requirements for Hatfield and Hunter (see infra ¶'s 301 - 306) and oversight of the BRP by the CECo Quality Assurance Department. While we do

not condone the use of the field problem sheets ~~we~~ it now appears ~~do not believe~~ that their adverse effect on ~~they undermined~~ the reliability of the results of the BRP may have been corrected. Moreover, CECo's overall quality assurance effort, including the special audit of Hatfield (¶'s 87 - 90) and the special unit concept inspection of the BRP by PTL adds to our confidence that the program was conducted in accordance with the program description, that there were no alterations of the results and that the reported results are accurate, subject to the inaccuracies discussed in ¶ 184a below.

b. NRC Staff Overview

~~92. Staff oversight of the implementation of the BRP has~~ been extensive. Mr. Ward testified that he and another Staff inspector visually examined approximately 500 welds which had been previously examined by Hatfield, Hunter or PTL inspectors and which had been subject to the BRP (Ward, Staff prepared testimony, at 10, Enclosure 1 at 37, ff Tr. 9510). The Staff inspectors examined the welds to determine that they had in fact been reinspected and that the reinspector had not overlooked a discrepancy. Mr. Ward testified that he also examined the documentation of welds generated by the BRP as well as the documentation generated by the original weld inspection. he also held discussions with supervisors and lead weld inspectors. (Ward, Staff prepared testimony at 10, 11, enclosures 1, 2, ff. Tr. 9510.)

93. Mr. Ward testified that during his oversight inspections ~~he found no case of a reinspector missing a deficiency~~.

[Intervenors' Proposed ¶¶ 92-94 follows this page:]

INTERVENORS' PROPOSED PARAGRAPHS 92-94

92. Staff oversight of the implementation of the BRP has been extensive, but inconsistent and overstated. Mr. Ward testified that he and another staff inspector visually examined approximately 330 welds which had been previously examined by Hatfield, Hunter or PTL inspectors and which had been subject to the BRP (Ward, Tr. 9639, 9911.) The staff inspectors examined the welds to determine that they had in fact been reinspected and that the reinspector had not overlooked a discrepancy. On the basis of his review, Mr. Ward concluded that "it is my opinion that Byron is probably the safest plant there is because of all this reinspection ...." Yet Mr. Ward acknowledged that he did not think that there was any need to conduct the BRP, and that his expertise was limited to welds. (Ward, Tr. 9910.) Then Mr. Ward conceded that his statement was based on having inspected only those 330 Hunter, Hatfield and PTL welds, less than a 1% sample of the 36,000 welds that were subject to the BRP and even a smaller percentage of the many Byron plant welds. We find that Mr. Ward's assertions are overstated in light of his limited review. (Ward, Tr. 9639, 9911.)

To the contrary, Mr. Ward concluded that in many cases the reinspection results were overly conservative because reinspectors were classifying welds and attributes as unacceptable even though, in Mr. Ward's judgment, they were in fact acceptable under the applicable welding code. Nor did Mr. Ward find any instance of a reinspection not being conducted correctly. Finally, Mr. Ward found no deficiencies in the documentation generated by the BRP or by the original inspections. (Ward, Staff prepared testimony at 11, ff. Tr. 9510.)

94. For other then welding attributes, Staff oversight of Hatfield and Hunter included the review of inspection reports, nonconformance reports, deficiency reports, and the observation of work activities, including inprocess inspections. (Ward, Love, Staff prepared testimony at 11, enclosure 3, ff. Tr. 9510.)

95. The Staff also monitored Applicant's oversight of the BRP by reviewing audit and surveillance reports and by interviews with CECo personnel. (Love, Staff prepared testimony at 11, 12, ff. Tr. 9510.)

VII. METHOD OF EVALUATING RESULTS OF BRP

96. The original inspection record and the reinspection record were compared and evaluated to determine whether any discrepancy between the two records existed. (Del George, prepared testimony at 20, 21, ff. Tr. 8406.)

97. Acceptable items were defined as those for which the reinspector agreed with the condition recorded on the original inspection record. Without that agreement, the item was graded as unacceptable. (Del George, prepared testimony at 21, ff. Tr. 8406.)

98. All observed discrepancies were recorded and tabulated and subsequently compared to the BRP acceptance criteria. These discrepancies were counted against the original inspector whether or not the observed discrepancy was later demonstrated to be a valid discrepancy when compared to current design or installation parameters and tolerances. (Del George, prepared testimony at 22, ff. Tr. 8406.)

Insert Intervenors' Proposed ¶ 99, following this page, to here →

VIII. RESULTS OF THE REINSPECTION PROGRAM AS THEY RELATE TO INSPECTOR QUALIFICATION

~~99. The BRP results for Hatfield, Hunter and PTL inspectors demonstrated with very few exceptions, that the sampled inspectors were qualified. All Hatfield, Hunter and PTL inspectors passed the 95% acceptance criteria for objective attributes during their first three months of inspections. (Del George, prepared testimony at 27, 28, ff. Tr. 8406; see also Hansel, prepared testimony at 22, ff. Tr. 8991.)~~

100. For the subjective attribute (visual weld inspection), Hatfield and Hunter each had one inspector whose first three months of work failed to meet the 90% acceptance criteria. PTL had two such inspectors. Because these individuals

INTERVENORS' PROPOSED PARAGRAPH 99

99. The BRP results fall short of establishing that contractor quality control inspectors at Byron were qualified and may thus be presumed to have detected safety significant construction defects.

Overall, the universe of inspectors covered by the BRP included 356 inspectors. Of these, 110 were sampled. Of these, at least 18 did not achieve program acceptance levels either in their first three months or thereafter. (BRP February, 1984 Report at ES-3 and Exhibit V-2.) (Two more inspectors did not pass the acceptance criteria in their first three months, but passed after their second three months. (BRP Report, Ex. V-2.)

In other words, approximately 16% of the sampled inspectors did not achieve either 90% on visual weld inspections or 95% on inspections of objective attributes. This fact alone weakens any inference that all 356 inspectors were qualified, and that none of them overlooked safety significant deficiencies.

More fundamentally, even if a higher percentage of inspectors had achieved program acceptance levels, the program as defined did not generate data from which one can reliably infer inspector qualifications. This point was made in the testimony of two experienced NRC staff members, including the principal author of the original NRC inspection findings questioning the qualifications of Byron quality control inspectors.

INTERVENORS' PROPOSED PARAGRAPH 99

That inspector, Mr. Forney, testified:

> ... My belief is that the data base that's available does not provide conclusively that an inspector is capable. There are other things that could be taken into consideration.
>
> For example, if you're going to qualify an individual and you're going to give him the capability demonstration test, you give him a sample of demonstration pieces with known problems, which would have a hign percentage of problems involved, and you determine the individual's ability to discern the relative effects.
>
> The Reinspection Program, in my mind, - because I believe that the work out there is generally of good quality - skews the data base in such a direction that most often in my mind, an inspector is merely looking at work that is already good. So it's difficult, then, to say whether he's determining good or bad.
>
> (Tr. 10, 063.)

Asked whether he was suggesting, "that it's really more important to focus on what proportion of the defects were detected by the original inspector, rather than the data which was actually used to score the results of the Reinspection Program," Mr. Forney replied,

> I included that as one of the things that I would include in the population if I were going to post facto try and determine the capability. I would possibly want to be interested in did this inspector ever identify anything and cause it to be corrected.
>
> The Reinspection Program wasn't designed to take that type of look and factor it into the program.
>
> (Tr. 10, 064-065.)

INTERVENORS' PROPOSED PARAGRAPH 99

As an illustration, Mr. Forney pointed out,

> For example, if you had 100 widgetts or whatever and 10 of them were bad, one position could be that you have 90 percent confidence in that inspector's ability to discern the quality of the work. Another person might take the view that if those are the only 10 - or you don't know that those are the only 10 bad widgetts that were in the sample, that you have a 0 confidence in that inspector's ability.
>
> And another person might take the position that would say, I would like to know something about the population of widgetts that that inspector ever caused to be fixed, and then integrate that knowledge together to come up with some perspective of your belief in an inspector's capability.
>
> (Tr. 10, 065-066.)

Despite the importance of the inspectors' defect detection rates in his view, neither Mr. Forney nor any other member of his panel was "aware of any data generated by the Reinspection Program that would enable one to examine what proportion of the defects initially confronted by the original inspector he detected" (Tr. 10, 071), and CECo produced no evidence of such data at the hearing.

Mr. Forney was not the only NRC staff member to hold the foregoing views. In February, 1984, panel member Hayes had written an internal NRC memorandum questioning

whether inspector capabilities could be inferred from the BRP results. Although he had described the memorandum as a devil's advocate position, when asked whether what he "actually believed" was "approximately the same then as what Mr. Forney has just described now," he answered:

A. Yes, I believe so.

Q: And you hold those same views today?

A: Yes ....

(Tr. 10, 071.)

We find the logic of the position argued by Mr. Forney (and concurred in by Mr. Hayes) to be persuasive on the issue of inspector qualifications. If one believes -- as Mr. Forney does and as CECo vigorously asserts -- that the quality of the work in the BRP sample was good, then the agreement rate between the original inspector and the reinspector tells one little about the capabilities of the original inspector.

Applying Mr. Forney's illustration directly to the BRP, consider an inspector who "scores", say, 95% on visual weld examinations. What this tells one is that the reinspector agreed with the original inspector in 95 out of 100 cases. But what does it tell one about the capabilities of the original inspector, assuming that the reinspector is capable? If there were 10 defective welds in the population of 100 welds examined, it tells

one that the original inspector detected only five out of the 10 defective welds. Had the BRP been graded on this basis, the original inspector would have "scored," not 95% as reported by CECo, but only 50%.

That, in turn, would offer weak support, if any, for CECo's contention that Byron has been safely constructed. Would anyone be comforted to know that of all the discrepant welds at Byron, the original quality control inspectors detected only 50%?

Mr. Forney is not troubled by the logical difficulty in inferring inspector capabilities from the BRP data, because he believes on other grounds that Byron is safely built. He thus characterizes his argument on this issue as a "miniscule point." (Tr. 10, 064.)

However, whether Mr. Forney's point is miniscule or not depends on the degree to which one agrees with him that there are, in fact, sufficient grounds other than an inference of inspector capabilities for finding reasonable assurance that Byron is built safely. As discussed in ¶166 below, this Board finds the other grounds asserted by CECo to be overstated as well. Consequently, we view Mr. Forney's argument as a significant critique of CECo's contention that one can reasonably infer, from the BRP data, that the inspectors were capable, and thus can be

presumed to have detected any safety signficant defects in the 90-95% of Hatfield and Hunter work at Byron which was not reinspected. (See ¶166 c below.)

had no further work, their qualifications could not be assessed further and under the terms of the BRP were considered indeterminate. The reinspection results for these inspectors were retained in the BRP data base. A substitution was made for each of these inspectors and each substitute's reinspected work was determined to meet program acceptance criteria. (Del George, prepared testimony at 28, ff. Tr. 8406.)

101. The performance of one PTL inspector did not meet the 90% subjective acceptance criterion for either his first or second three-month period. Therefore, all of this inspector's remaining work was reinspected. In addition, PTL was subjected to an inspector sample expansion which captured the first three months of work for visual welding inspection of all remaining inspectors whose work was accessible. Each of the four additional inspectors passed the 90% acceptance criterion. (Del George, prepared testimony at 28, ff. Tr. 8406; Shewski, prepared testimony at 24, ff. Tr. 8423; Little, Staff prepared testimony at 9, 10, ff. Tr. 9510.) (But see ¶ 68 above.)

102. Both Edison and (some of) the Staff have concluded that the number of inspectors whose work was reinspected, the amount and type of work reinspected, and the requirement for sample expansion provides a valid basis to draw positive conclusions about the qualifications of the overall population of inspectors, and specifically those for Hatfield, Hunter and PTL. (Del George, prepared testimony 29-53, ff Tr. 8406; Hansel, prepared testi-

However, for the reasons stated in ¶99 above, we disagree.

mony at 23, ff. Tr. 8901; Little, Staff prepared testimony at 4, ff. Tr 9510; Connaughton, Tr. 9876.) As Mr. Del George emphasized, the fundamental objective of the BRP was to verify by reinspection the adequacy of the qualification and certification practices for contractor QC inspectors. He concluded, ~~as we do,~~ that the BRP demonstrated the effectiveness of those practices for a representative sample of inspectors from which it can be inferred that the same practices were effective as applied to the remaining inspectors and, therefore, as to all inspection work performed by the entire inspector population. (Del George, prepared testimony at 33, ff. Tr. 8406.)

103. The fact that certain inspections were inaccessible or not recreatable does not affect the inference concerning inspector qualifications ~~these conclusions~~, since, as Mr. Del George pointed out, the qualification and certification programs for inaccessible and non-recreatable attributes were the same as those verified by the BRP. (Del George, prepared testimony at 22, ff. Tr. 8406.) Indeed, Messrs. Buchanan and Somsag testified that Hatfield and Hunter QC inspectors were selected and trained in the same manner regardless of the types of inspections they were to perform. (Buchanan, prepared rebuttal testimony at 3, 4, ff. Tr. 11,174; Somsag, prepared testimony at 2-5, ff. Tr. 11,172.) The requirements imposed for prior experience, job training, and performance demonstration have the same general scope and technical content for each of these attributes. In addition, the attributes not rein-

except for the inaccuracies discussed in ¶ 184a below

spected are similar in many respects to those captured for reinspection. (Del George, prepared testimony at 33-35, ff. Tr. 8406; Muffet, Tr. 9871; see generally, Muffet, Staff prepared testimony at 21-23, ff. Tr. 9510.)

104. We have previously found that the sample selection process for inspectors whose work was to be reinspected was not statistically sound ~~appropriate~~ (¶ 37, supra); that the choice of the first 90 days of an inspectors tenure on the site was a proper time period for checking the validity of an inspector's training and initial qualification (¶ 49B, supra; but non-conservative for other purposes (id.)); the acceptance criteria for establishing whether an inspector was qualified, based on the results of the reinspection are ~~appropriate and~~ acceptable but not demonstrably conservative (¶'s 53, ~~57~~ 54, supra) the results of the BRP are accurate and reliable, (¶ 91, supra), and there was ~~extensive~~ extensive oversight of the entire BRP by CECo's QA department and the NRC Regional Staff (¶'s 80 - 90, supra). Based on the results of the BRP, and for the reasons discussed in ¶ 99 above, the Board ~~finds~~ is unable to find that Applicant has provided reasonable assurance that the Hatfield, Hunter and PTL inspectors who performed inspections at Byron, beginning with the construction of safety-related work in 1976 through September 1982, were qualified, even though their certifications were not in strict accordance with ANSI N45.2.6 (1978).

IX. SARGENT & LUNDY DISCREPANCY EVALUATIONS

105. On July 26 and 27, 1984, Applicant presented testimony on the engineering evaluation of discrepancies performed by Sargent & Lundy. Applicant presented a panel comprised of John M. McLaughlin, Partner and Manager of the Structural Department at Sargent & Lundy; Ernest B. Branch, Associate and Director of Mechanical Design at Sargent & Lundy; Richard X. French, Partner and Manager of the Electrical Department at Sargent & Lundy; and Anand K. Singh, Associate and Assistant Head of the Structural Analytical Division at Sargent & Lundy. On July 30 and 31, 1984, the NRC Staff presented the testimony of William Little, Branch Chief in the Division of Reactor Safety, NRC Region III; Kavin D. Ward, Ray Love and James Muffett, Reactor Inspectors in the Division of Reactor Safety, NRC Region III; and Kevin Connaughton, Resident Inspector at Byron. On August 22, 1984, Intervenors presented the testimony of Charles C. Stokes, an engineering consultant with P/S Associates. In response to questions raised by Mr. Stokes relating to Sargent & Lundy's engineering evaluation of discrepancies, Applicant presented the rebuttal testimony of Bryan A. Erler, Associate and Director of the Structural Division at Sargent & Lundy; Robert W. Hooks, Assistant Division Head of the Structural Engineering Division at Sargent & Lundy; Dennis DeMoss, Mechanical Project Engineer in the Project Management division

at Sargent & Lundy; and Ernest B. Branch, who was part of the original panel.

106. Sargent & Lundy performed an engineering evaluation of discrepancies in work performed by Hatfield involving hardware installation and work performed by Hunter involving hardware installation and related documention, which were categorized as objective attributes. A total of 63,085 reinspections of Hatfield objective attributes was performed as part of the Reinspection Program out of which 2,153 discrepancies were identified. Another 3,896 reinspections of Hatfield objective attributes were performed under a supplemental reinspection program and 158 discrepancies were identified. A total of 71,510 reinspections of Hunter objective attributes was performed under the Reinspection Program out of which 689 discrepancies were identified. (French, prepared testimony at 4,6, 12, ff. Tr. 9044; Branch, prepared testimony at 5-7, ff. Tr. 9051.) As we will explain below, ~~evaluations~~ 1,244 of the (per Furse letter 9.17.) Hatfield discrepancies and 614 of the Hunter discrepancies were determined upon evaluation either not to exceed design parameters or tolerances or to involve inconsequential documentation items and were, therefore, not "valid" discrepancies, (as that term was used by CECo in the BRP.) (¶'s 112 and 122, infra.)

107. Sargent & Lundy also performed an engineering evaluation of visual weld discrepancies on welds produced by Hatfield covered by the American Welding Society ("AWS") standard and welds produced by Hunter covered by AWS and the American

Society of Mechanical Engineers ("ASME") Code. The ASME Code governs welding for piping and pressure vessels and the AWS Code governs all other welding. A total of 27,538 Hatfield AWS welds were subjected to reinspection during the original program, out of which 1,986 discrepancies were identified. A total of 3,725 Hunter welds were reinspected (27% AWS welds, 73% ASME welds), out of which 109 discrepancies were identified, 60 AWS and 49 ASME. (McLaughlin, Prepared Testimony at 3-5, 7, 14, ff. Tr. 9047; Branch, prepared testimony at 6, 10-11, ff. Tr. 9051.)

a. Objective Attributes -- Hatfield Discrepancies

108. Hatfield installed all the components, materials and equipment associated with the electrical systems at Byron, including the installation of electrical equipment, cable tray and conduit and the pulling and terminating of cable. Hatfield also installed concrete expansion anchors that were initially inspected and reinspected by PTL. This work was divided into the following objective attributes for reinspection: conduit installation, cable termination, cable-tray and cable-tray hanger installation, equipment modification, conduit as-built reconciliation, A-325 bolting, and concrete expansion anchors. (Visual weld inspection, discussed infra, was separately characterized as a subjective Hatfield attribute.) (French, prepared testimony at 5, ff. Tr. 9044; Summary of Objective Discrepancy Evaluation--Hatfield, ff. Tr. 9239.)

109. The 63,085 reinspections of Hatfield objective attributes performed as part of the reinspection program included 2,840 reinspections of concrete expansion anchors inspected by PTL. */ Of the 2,153 discrepancies identified, 38 were associated with concrete expansion anchors. Most of the discrepancies were associated with conduit as-built reconciliation. These discrepancies consisted primarily of differences between the installed locations of conduit, conduit supports and junction boxes and the locations shown on the installation drawings. (French, prepared testimony at 6-8, ff. Tr. 9044.)

110. For the 2,153 observed discrepancies, 1,713 evaluations were performed. The number of evaluations was less than the total number of discrepancies because some evaluations covered more than one discrepancy. The discrepancies were first compared with current design parameters and tolerances. This involved a comparison of installed component locations and dimensions with the corresponding locations, dimensions, and tolerances shown on the design drawings. The discrepancies found to be outside of design tolerances were evaluated either by engineering judgment or by engineering calculations. (French, prepared testimony at 6. ff. Tr. 9044)

111. Engineering judgment evaluations were performed in two ways, by either a review of the component design function

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*/ As indicated supra, PTL only provided inspection services; it did not perform any construction work at the Byron site.

to determine whether the function of the component was affected by the discrepancy, or a comparison of the discrepancy to the current design to determine whether the discrepancy had design significance. Engineering calculations were used to resolve the remaining discrepancies. (French, prepared testimony at 6, ff. Tr. 9044.)

112. Of the 1,713 evaluations, 1,244 found the discrepancies to be within current design parameters and tolerances. The reason the reinspectors identified these as discrepancies was that the acceptance tolerances established for the Reinspection Program were more stringent than the tolerances indicated on the installation drawings. (French, prepared testimony at 7, ff. Tr. 9044.) ~~Obviously, these so-called discrepancies were not real discrepancies; rather they were the product of a conservatively-structured reinspection program.~~ It is not clear, however, how many of these discrepancies should have been detected by the original inspectors based on their instructions at the time.

113. Eighty evaluations of discrepancies were deemed acceptable by engineering judgment. Approximately two-thirds of these evaluations involved a review of the component design function to determine whether the function was impaired by the existence of the discrepancy. None of these discrepancies impaired component design function. The balance of these evaluations involved a comparison of the discrepancy to current design requirements to determine significance. None of the discrepancies was significant. (French, prepared testimony at 7, ff. Tr. 9044)

114. The remaining 389 evaluations were conducted by reviewing the conduit support, junction box loading, and mounting detail design calculations. The variations in support locations and associated variations in loads were ~~recalculated and~~ found to be acceptable. (French, prepared testimony at 7-8, ff. 9044)

115. The detailed engineering evaluation of the discrepancies in Hatfield objective attributes demonstrated that none of the evaluated discrepancies had design significance and, therefore, no safety significance. (French, prepared testimony at 8 ff. 9044.) Apparently because of shortcomings in the original BRP, identified by the NRC staff and others,

116. ~~A~~ supplemental program was established for the reinspection of certain Hatfield attributes, namely, equipment setting, equipment modification, A-325 bolt installation and conduit-support bolting. (See ¶129 below.) ~~This program was established, among other reasons, to provide further assurance that work in these areas was properly done.~~ (French, prepared testimony at 9, ff. Tr. 9044.)

117. With respect to equipment setting 778 inspections associated with 50 pieces of electrical equipment identified 34 discrepancies. The majority of the discrepancies consisted of equipment anchoring details with weld length and weld spacing deviations. An evaluation of the discrepancies determined that none had design significance. (French, prepared testimony at 9, ff. 9044.) With respect to equipment modification, a 100%

wiring inspection performed on 1,850 elements associated with 50 pieces of safety-related equipment identified 44 discrepancies. The discrepancies were minor wiring variations that did not affect the functioning of the equipment. An evaluation of the discrepancies determined that none had design significance. (French, prepared testimony at 10, ff. Tr. 9044.) With respect to A-325 bolting, which was used in the assembly of cable-tray riser supports, inspection of 295 bolts on 50 supports identified 46 discrepancies. The discrepancies represented bolts with torque less than the acceptance criteria. The design of the associated connections was reviewed and it was determined that the connections were structurally sound despite the lack of complete bolt torque. Therefore, the discrepancies were determined to have no design significance. In any event, all A-325 bolted connections were retorqued because of the unsatisfactory discrepancy rate. (French, prepared testimony at 10-11, ff. Tr. 9044. Tr. 9232-34.)

118. With respect to the supplemental reinspection of conduit-support bolting, inspection of 1,008 conduit-support bolts on 305 supports identified 34 discrepancies. The discrepancies were evaluated and determined to have no design significance. (French, prepared testimony at 11, ff. Tr. 9044.) However, two missing conduit clamps were detected during the inspection and, because a missing clamp at a critical location could have design significance, a walk-down was performed of all 8,532

critical clamp locations. Ten locations were found with missing bolts or clamps. Based on these results, a walkdown of the remaining accessible conduit clamps and bolts was conducted. An evaluation of the 10 cases showed that the discrepant conditions had no design significance. The last of these evaluations to be completed involved a missing clamp on a six or seven foot run of conduit in a hard to reach location. Due to the presence of another conduit and a large piece of steel in the area, even without the clamp, the conduit could only move a fraction of an inch. Sargent & Lundy's evaluation demonstrated that the conduit could not be pulled out during a seismic event and that there was no design significance. (French, prepared testimony at 11-12, ff. Tr. 9044. Tr. 9282-85.)*/

119. Including the supplemental reinspections discussed in paragraphs 116-118, 66,981 reinspections of Hatfield objective discrepancies were performed. Although 2,311 discrepancies

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*/ The design significance of another discrepancy was debated during the cross-examination of the Region III Staff Panel. This discrepancy involved the miswiring of a damper that without correction would not have closed automatically under certain accident conditions. ~~However, it was conclusively established~~ that the discrepancy lacked significance since operation of the damper on a manual basis, an acceptable alternative to automatic operation, was not impaired. Moreover, although the discrepancy had been missed by the original inspector, by the time of the BRP, it had already been discovered and repaired during system turnover testing. ~~This corrective action presents a good example of the successful operation of the in-depth mechanisms that are in place at Byron to assure work quality and safety.~~ (Tr. 9732-47.) Nonetheless, given the history of manual operations in operating plants such as TMI and the imperfect nature of any testing system, we cannot agree that this discrepancy was utterly devoid of safety significance.

CECO contends

were identified, none of the evaluated discrepancies had design significance. (French, prepared testimony at 12, ff. Tr. 9044.) Accordingly, the quality of the foregoing reinspected Hatfield work is adequate. (French, prepared testimony at 12 ff. Tr. 9044. Tr. 9273-74.)

b. Objective Attributes -- Hunter Discrepancies

120. Hunter was responsible for the installation of nearly all the mechanical systems at Byron. This work included installation of mechanical equipment and interconnective process piping and supports, and the supply of miscellaneous piping and welding materials. As noted supra, the Hunter work fell into three attributes: hardware installation, related documentation, characterized as objective attributes, and welding, characterized as a subjective attribute. Each objective attribute consisted of a number of elements. For example, the documentation attribute was subdivided into such inspection points as work process sheets, weld material regulation sheets, field inspection reports and discrepancy reports. (Branch, prepared testimony at 5-6, ff. Tr. 9051; Summary of Objective Discrepancy Evaluation--Hunter, ff. Tr. 9265.)

121. A total of 69,624 reinspections of Hunter objective attributes was performed as part of the Reinspection Program. Another 1,886 Hunter installations of concrete expansion anchors were inspected by PTL. Thus, there were 71,510 total reinspections of Hunter objective attributes. Of this amount,

a total of 689 discrepancies were reported. The 689 discrepancies involved 441 documentation and 248 hardware discrepancies. Five of these discrepancies were associated with concrete expansion anchors inspected by PTL. (Branch, prepared testimony at 6-7, ff. Tr. 9051.)

122. Sargent & Lundy evaluated all 689 discrepancies. The evaluations were performed by the same procedure as described for the discrepancies associated with the Hatfield objective attributes. (Branch, prepared testimony at 7-9, ff. Tr. 9051.) A total of 614 discrepancies in Hunter objective attributes was evaluated by comparison to the design parameters and tolerances. This included all 441 documentation discrepancies and 173 hardware discrepancies. Discrepancies evaluated typically included cosmetic flaws, minor dimensional errors, and documentation errors. The dimensional errors consisted primarily of minor as-built piping and pipe support dimensional errors or incomplete as-built information. Documentation errors consisted primarily of minor data-entry errors and omissions on work reports and process sheets. These discrepancies were evaluated by reviewing corroborating information on the affected documents and other independent documents. The evaluation showed that all hardware discrepancies were within the current design parameters and tolerances. All documentation discrepancies were deemed acceptable based upon reviewing other corroborating documentation. (Branch, prepared testimony at 8,

term was defined in the SRP.

ff. Tr. 9051.) Again, this class of discrepancies, like similar ones for Hatfield, contains discrepancies which are either ~~extremely~~ inconsequential or in conformance with current design requirements, and as such they ~~cannot be~~ were not considered "valid," or that

123. A total of 54 hardware discrepancies was evaluated by engineering judgment. Discrepancies evaluated included dimensional errors and omissions for piping, pipe supports and pipe whip restraints; hardware substitutions; minor configuration changes; and minor mechanical joint bolting deviations. None of these discrepancies impaired component design functions or had design significance. (Branch, prepared testimony at 8, ff. Tr. 9051.)

124. A total of 21 hardware discrepancies was evaluated using detailed engineering calculations. Discrepancies evaluated included three as-built pipe support dimensions, four concrete expansion anchors, three pipe whip restraints, and 11 small-bore pipe bends with excessive ovality. These elements were originally established by engineering calculation and a new calculation was necessary in order to account for the identified discrepancy. For example, with respect to pipe ovality, which is a measure of the pipe roundness at the point of bending, the 11 pipe bends exhibited average ovality values of 10.5%, which is in excess of the 8% limit of ASME, Boiler and Pressure Vessel Code -- Section III, Nuclear Power Plant Components -- Division I (1974 Ed. Summer, 1975 Addenda). Accord-

ingly, calculations were performed verifying the acceptability of the pipe-wall thickness and flow-area reductions allowed by the ASME Code. Stress intensification effects were evaluated as negligible because all of the pipe bends are five pipe diameters in radius. (Branch, prepared testimony at 9, ff. Tr. 9051)

125. The detailed engineering evaluation of the 689 discrepancies in Hunter objective attributes demonstrated that none of the discrepancies had any design significance and, hence, no safety significance. (Branch, prepared testimony at 10, ff. Tr. 9051.) Accordingly, the quality of the foregoing reinspected Hunter work is adequate. (Branch, prepared testimony at 14, ff. Tr. 9051; Tr. 9277-78.)

126. The Board finds that, based upon the Sargent & Lundy evaluations of discrepancies in the Hatfield and Hunter objective attributes, none of the discrepancies had design significance and, accordingly no safety significance, except for the discrepancy discussed in ¶ 118 note above.

c. Subjective Attribute AWS Welding -- Hatfield Discrepancies

127. The Hatfield AWS welding covered by the Reinspection Program included the welding of conduit supports, junction-box supports, cable-tray supports, cable-tray holddown welds, and auxiliary steel for electrical supports. (McLaughlin, prepared testimony at 5, ff. Tr. 9047.)

128. Of the 27,538 AWS Hatfield welds that were subjected to reinspection during the original program, 1,986 welds were

identified with various discrepant conditions. A total of 169 welds was taken from this group for analysis by Sargent & Lundy. An additional 187 discrepant welds was included as a part of the sample to be analyzed by Sargent & Lundy when, in response to NRC questions, additional inspections were made of welds not initially covered by the Reinspection Program. Thus, a total sample of 356 Hatfield discrepant welds was analyzed by Sargent & Lundy. (McLaughlin, prepared testimony at 7, ff. Tr. 9047.)

129. Of the 356 Hatfield weld discrepancies analyzed by Sargent & Lundy, 50 were selected at random, 50 were selected by a third-party inspector on the basis of being the worst welds from a visual ~~weld~~ discrepancy viewpoint, and the remaining 256 discrepancies involved welds at some of the most highly-stressed connections, where the design margin was least. (McLaughlin, prepared testimony at 7-8, 17, ff. Tr. 9047.) Thus, the sample of 356 Hatfield weld discrepancies analyzed by Sargent & Lundy was biased to examine a sampling of the most highly stressed welds in the Reinspection Program, where the greatest potential existed for exceeding design margins. (McLaughlin, prepared testimony at 8, 16-17, ff. Tr. 9047.) However, Mr. McLaughlin acknowledged

130. A review of weld maps for the 356 discrepant Hatfield welds indicated that five of the discrepant welds involved arc strikes, spatter and convexity. Arc strikes and spatter are cosmetic discrepancies which would create a strength problem

that there were highly stressed welds captured in the BRP which were not evaluated by Sargent & Lundy. (Tr. 9142)

only if there were a large number in a given weld. The weld maps indicated that arc strikes and spatter were minimal. Convexity is of no consequence when, as in this case, the welds on the structures under consideration are not subject to fatigue loading. Thus, these five weld discrepancies do not reduce the load-carrying capacity of the weld and, therefore, have no structural impact. (McLaughlin, prepared testimony at 10, ff. Tr. 9047.)

131. A detailed engineering evaluation based on the weld maps was conducted with respect to the remaining 351 discrepant welds to determine (i) the effect of the discrepancy on the strength of the weld and (ii) because the discrepant welds were among the several welds joining steel members and components, the effect of strength reductions on these joints or connections. It was determined that 162 welds had strength reductions of less than 10% and 186 discrepant welds had strength reductions equal to or greater than 10%, including strength reductions of up to 95%. (McLaughlin, Tr. 9156.) Three welds had cracks. Irrespective of the actual strength reduction, the discrepant portion of the weld was entirely disregarded for evaluation purposes. For example, if the weld map indicated that 1-1/2" of porosity existed in a 10" weld, Sargent & Lundy recalculated the capacity of the connection on the basis of only 8-1/2" of weld. This is a conservative calculation in that there is probably no reduction at all in the capacity of the connection for this 1-1/2" of porosity. In the case of

welds with cracks, no credit was given in the evaluation for the presence of the weld. (McLaughlin, prepared testimony at 10-11, ff. Tr. 9047.)

132. After the weld strength reductions were determined, an evaluation of the connections' ability to withstand the expected loads or forces was performed. The forces on the connections are made up of two major loadings. The first is the dead weight or static load of the cables and the tray. The second is the seismic load on the connection. With respect to the static load, Sargent & Lundy reviewed the cable loadings to confirm that the loads on the cables were less than that assumed in the original design. Because maximum or bounding loads were used in the original design of the cable tray and conduit system, the actual loads are expected to be less than design loads. In each case, where Sargent & Lundy calculated the actual load, it found that load to be less than the original design load. (McLaughlin, prepared testimony at 11-12, ff. Tr. 9047.) The neighboring welds to one of the three cracks, which involved a cable-tray hold-down weld, bore a slight additional load (still within the Code allowable) as a result of the crack. These welds were inspected by Sargent & Lundy. The inspection revealed that none of the neighboring welds was discrepant. (Erler, prepared rebuttal testimony at 5-6, ff. Tr. 11,158.)

Insert Intervenors' Proposed ¶ 132a, following this page, to here

133. Sargent & Lundy next reexamined the seismic loading and performed a seismic analysis representative of the Byron

INTERVENORS' PROPOSED PARAGRAPH 132A

132A. In general, however, the evaluation of the neighboring welds' ability to withstand the expected loads was a theoretical evaluation, because, according to Mr. McLaughlin, the neighboring welds were not reinspected for discrepancies, unless they happened to be captured in the BRP. (McLaughlin, Tr. 9154-56.) Thus, it was possible that the neighboring welds contained defects that were assumed not to exist in the calculations. This approach contrasts unfavorably with the calculation of load redistribution effects done by Mr. Kostal with respect to SCC welds for purposes of his testimony in this case. (Kostal, Tr. 10,238-240.)

site which reduced the load from that determined initially. The seismic loading used in the original design of the cable tray and conduit system was based on a response spectra design method, a very conservative design method used in the nuclear industry. The reevaluation of the seismic loading on connections was based on a time-history seismic analysis, which as indicated is a more refined and accurate determination of the seismic loading. (McLaughlin, prepared testimony at 11-12, ff. Tr. 9047.)

134. Due to the recurring nature of two types of discrepancies, additional investigation was performed by Sargent & Lundy to determine their significance. The first recurring discrepancy involved a fit-up gap between the horizontal and vertical cable-tray members. Strength tests performed by Sargent & Lundy demonstrated that even though the AWS Code required that the strength of this connection be reduced, there was no actual reduction in the joint capacity. The second recurring discrepancy involved the use of a partial penetration weld rather than a fillet weld as called for in the design. Laboratory testing by Sargent & Lundy demonstrated that the as-built partial penetration weld had less than a 10% reduction in capacity when compared to the original design. (McLaughlin, prepared testimony at 12-14, ff. Tr. 9047.)

135. The detailed evaluations described above were conducted on all 356 discrepant Hatfield welds. The results of

these evaluations demonstrated that none of the discrepancies exceeded design margin and, accordingly, none had design or safety significance. Accordingly, the quality of this reinspected work is adequate. (McLaughlin, prepared testimony at 12, ff. Tr. 9047.)

d. Subjective Attribute AWS and ASME Welding -- Hunter Discrepancies

136. The Hunter AWS welding covered by the Reinspection Program included pipe supports and pipe restraints. (McLaughlin, prepared testimony at 6, ff. Tr. 9047.) The Hunter ASME welding covered by the Reinspection Program included large-bore butt welds, socket and fillet welds, NF support welds, and pipe penetrations and reinforcing saddles. (Branch, prepared testimony at 11, ff. Tr. 9051.) Of the 3,725 welds produced by Hunter that were reinspected (27% AWS welds, 73% ASME welds), 109 discrepancies were observed. One hundred percent of these 109 discrepant welds were evaluated by Sargent & Lundy. As noted above, this included 60 AWS welds and 49 ASME welds. (McLaughlin, prepared testimony at 5, 14, ff. Tr. 9047; Branch, prepared testimony at 6, 10-11, ff. Tr. 9051.)

137. The 60 discrepant Hunter AWS welds were evaluated by the same procedure as described for the Hatfield discrepancies. Nineteen of the welds fell into the no-structural impact category encompassing arc strikes, weld spatter and convexity, which do not reduce the load-carrying capacity of the weld. Eighteen of the welds had a capacity reduction of less than

10%. The remaining 23 welds had a capacity reduction of 10% or more. (McLaughlin, prepared testimony at 14-15, ff. Tr. 9047.)

138. The detailed engineering evaluation of the 60 discrepant Hunter AWS welds indicated that none of the discrepancies exceeded design margin and, accordingly, none had design or safety significance. Accordingly, the quality of this reinspected work is adequate. (McLaughlin, prepared testimony at 15, ff. Tr. 9047.)

139. The evaluations of AWS weld discrepancies by Sargent & Lundy were performed pursuant to the 1983 edition of the AWS D1.1 Structural Welding Code while the welding itself was performed pursuant to earlier editions of the Code. Mr. Stokes questions this procedure on the premise that differences among the Code editions could result in more lenient standards for the evaluation performed by Sargent & Lundy. (Stokes, prepared testimony at 19-20, ff. Tr. 10,770.) Contrary to Mr. Stokes' assertion, the Board finds that this practice is appropriate. Excluding the year 1978, a revised version of the AWS Code has been published every year from 1975 to the present. The design requirements have not changed significantly since the issuance of AWS D1.1-75, which was the Code in effect at the time of initial construction. The allowable stresses are the same. The few changes that have been made with respect to calculation of stresses have all been more restrictive with regard to weld capacity. These stricter weld design require-

ments in no way require less demanding calculations for evaluating a discrepancy. If anything, it is conservative to use the latest edition of AWS D1.1 for evaluation of discrepancies. (Erler, prepared rebuttal testimony at 9-10, ff. Tr. 11,158.)

140. The 49 discrepant Hunter ASME welds were evaluated to ASME Section III Code design criteria using three methods to determine whether the Code was met and whether the discrepant welds had design significance. The initial method involved comparing the weld discrepancy with the current design parameters and tolerances and the ASME Code to determine if it was acceptable on that basis. For example, in some cases, such as with surface porosity, the visual welding reinspection criteria were overly stringent and exceeded code acceptance criteria. These reported discrepancies were determined to meet the code design criteria and were, therefore, judged to be acceptable. If it was not possible to disposition a discrepancy using the first approach, the second method involved evaluation by engineering judgment based on a comparison of the effect of a weld discrepancy to design margins or the component design function. The final method of resolution of the weld discrepancy was an evaluation by detailed engineering calculation. (Branch, prepared testimony at 11-12, ff. Tr. 9051.)

141. Three discrepancies were reported involving large-bore piping butt welds. Two were within current design param-

eters and tolerances. The third was compared to design margins and determined to be acceptable by engineering judgment. (Branch, prepared testimony at 12, ff. Tr. 9051.)

142. A total of 30 discrepancies involving socket and fillet welds was reported. Three were within current design parameters and tolerances; four were compared to design margins and determined to be acceptable by engineering judgment; and 23 were evaluated by engineering calculation and met ASME Code design criteria. The majority of the calculations involved a simple arithmetic computation of the code-required fillet weld size. (Branch, prepared testimony at 13, ff. Tr. 9051.)

143. A total of 14 discrepancies involving NF support welds was reported. One was within current design parameters and tolerances and 13 were reviewed by calculation and met ASME Code design criteria. The majority of the calculations involved recalculating the designed weld with consideration of the discrepancy accounted for. All welds were found to meet ASME Code design criteria. (Branch, prepared testimony at 13, ff. Tr. 9051.)

144. A total of two discrepancies involving welds with pipe penetration and reinforcing saddles was reported. Both were reviewed by engineering calculation and found to meet ASME Code design criteria. Both welds were compared to actual design requirements and neither of the discrepancies was determined to have design significance. (Branch, prepared testimony at 13-14, ff. Tr. 9051.)

145. Intervenors' expert alleged that two ASME welds were impermissibly accepted by Sargent & Lundy because of the imprecision in the gauges used in measuring weld undercut. Specifically, Mr. Stokes stated that the 1/64-in. accuracy of the gauges supplied for measuring the welds was in violation of some ASME Code section allegedly requiring "machine shop type accuracy to the thousandths." (Stokes, prepared testimony at 24-25, ff. Tr. 10,770.) The ASME Code does not expressly state a tolerance for the measurement of undercut; it does not require "machine shop type accuracy to the thousandths" to determine Code compliance, as alleged by Mr. Stokes. The acceptance criterion for undercut is stated in ASME Section III, paragraph ND-4424 as a common fraction, 1/32 inch, which means that the Code intended the value to be treated as an approximate, fractional dimension. Whenever the Code intends exact precision, an acceptance value is stated as a decimal value. (Branch, prepared rebuttal testimony at 3, ff. Tr. 11,158.)

146. An acceptance criterion stated in terms of 1/32 inch has an acceptance level within 1/64 inch, that is, the Code is met if the measurement for undercut is 3/64 inch or less. The undercut measurements of the two welds referred to by Mr. Stokes were .041 and .037 inch. Inasmuch as these values fall below 3/64 inch, the Code requirement has been met. (Branch, prepared rebuttal testimony at 3 ff. Tr. 11,158.)

147. In any event, Sargent & Lundy did not rely solely on this Code interpretation to disposition these discrepancies. A

calculation was done to establish the effect of the reported undercut on code minimum wall thickness requirements and code stress criteria. The calculation was performed to answer two questions. First, was the depth of undercut sufficient to encroach on code-required minimum pipe wall thickness? Second, was the stress intensification introduced by the undercut sufficient to cause code allowable stresses for moment loading to be exceeded? The calculation was conservatively biased in that it assumed that the undercut extended completely around the total weld circumference when it actually extended around only a portion of the weld circumference. In addition, the stress intensification factor for the undercut was multiplied by the intensification used in the original analysis for the weld joint instead of treating the effects separately. (Branch, prepared rebuttal testimony at 3-4, ff. Tr. 11,158)

148. The pipe wall thickness calculation showed that the wall thickness remaining after deducting the maximum undercut and the manufacturing tolerance was about 27 times the code-required minimum wall. This is not surprising because the service pressure for the system is 150 psi and schedule 80 pipe was selected to provide adequate mechanical strength for a power plant environment. The stress intensification calculation showed that even when considering the maximum undercut to conservatively extend all the way around the circumference of the weld, and multiplying the fillet weld intensification by

the undercut intensification, code-allowable stresses for the applicable loading conditions, including seismic load, were not exceeded. (Branch, prepared rebuttal testimoony at 4-5, ff. Tr. 11, 158)

149. In the case of all 49 ASME discrepant welds, the weld connections met Code design criteria. The Sargent & Lundy evaluations of the Hunter ASME weld discrepancies demonstrate that, as was true with respect to the Hunter AWS weld discrepancies, as well as the Hatfield weld discrepancies, none of the discrepancies had design significance and, hence, no safety significance. Accordingly, the quality of this reinspected work is adequate. (Branch, prepared testimony at 14, ff. Tr. 9051.)

150. The Board finds that, based upon the Sargent & Lundy evaluations of the Hatfield AWS discrepant welds and the Hunter AWS and ASME discrepant welds, none of the discrepancies had design significance and, accordingly, no safety significance.

e. Matters Raised By Intervenors' Witness, Mr. Stokes

151. The portion of Mr. Stokes' testimony that was admitted into evidence essentially consists of a call for an independent review of discrepancies based on an alleged lack of objectivity and impartiality on the part of Sargent & Lundy. We will now address the specific concerns raised by Mr. Stokes that have not already been discussed and his allegations regarding the need for an independent review of discrepancies.

First, Mr. Stokes asserted that pipe supports which were included in Sargent & Lundy's Hunter AWS welding discrepancy evaluations are subject to fatigue loadings and, thus, convexity should have been considered a defect more serious than a cosmetic flaw. (Stokes, prepared testimony at 18, ff. Tr. 10,770.) However, as Mr. Stokes acknowledged, the American Institute of Steel Construction (AISC) Code does not require a reduction in the allowable stress in a weld for fatigue loading until the number of stress cycles exceeds 20,000. (Stokes, Tr. 10,841-42; Erler, prepared rebuttal testimony at 7-8, ff. Tr. 11,158.) Further, Mr. Stokes admitted that he did not have adequate information to determine whether pipe supports at Byron would experience 20,000 cycles of fatigue loading over their lifetime. (Stokes, Tr. 10,842-43.) In fact, the number of stress cycles experienced by pipe supports at Byron is substantially less than 20,000. (Erler, prepared rebuttal testimony at 8, ff. Tr. 11,158.)

152. Mr. Stokes also asserts that waterhammer could cause fatigue loading. (Stokes, prepared testimony at 18-19, ff. Tr. 10,770.) The evidence indicates, however, that waterhammer loading on a piping system is not a loading that could cause a fatigue problem. Waterhammer is a dynamic pulse loading with low frequency of occurrence. Therefore, the number of stress cycles is extremely low and fatigue is not a problem as defined in the AISC Code. (Stokes, prepared testimony at 9, ff. Tr. 10,770; Tr. 10,844-65.)

although he would still have concerns based on the pertinent weld procedures. (See ¶154 below.)

153. The discrepancy evaluations performed by Sargent & Lundy included 30 flare-bevel AWS welds produced by Hatfield and captured by the Reinspection Program. Intervenors' expert expressed concern with flare-bevel welding based upon Attachment 7 to his testimony indicating that Sargent & Lundy may have used invalid assumptions in establishing design parameters for flare-bevel welding. (Stokes, prepared testimony at 16-17, ff. Tr. 10,770.) On cross-examination, Intervenors' expert conceded that if the attachment and the information contained therein were void, he would have no concern with the flare-bevel weld radii at Byron based on that attachment, (Stokes, Tr. 10,792.) As Applicant's witness testified, that attachment has been voided and the information contained therein is not applicable to either Byron or Braidwood. (Hooks, prepared testimony at 3-5, ff. Tr. 11,158.)

154. Intervenors' expert also expressed concern because flare-bevel groove welding was included under a prequalified welding procedure designated as 13AA. (Stokes, Tr. 10,800-01.) Such welding should be produced against a qualified welding procedure, i.e., one that is validated by establishing through a field demonstration that the procedure produces an adequate weld. However, the Hatfield AWS flare-bevel welds captured in the Byron Reinspection Program were produced during the period May, 1978 through September, 1982. During that period, flare-bevel groove welds were, in fact, produced under

qualified procedures 13Q and 13AB. Procedure 13AA, a prequalified welding procedure, was not approved until December 30, 1983, and flare-bevel groove welding was erroneously included in that procedure. This error is being rectified and the procedure for flare-bevel groove welding is being issued as a qualified procedure. (Erler, prepared testimony at 7, ff. Tr. 11,158.)

155. In any event, the 30 flare-bevel welds produced by Hatfield and captured by the Reinspection Program were inspected for a determination of the actual radius. The inspection yielded a radius measurement of at least two times the tube wall thickness (2T) for all tubes except one, which had a radius equal to 1.75 T. The stress of each weld was conservatively evaluated using the AWS formula for effective throat of 5/16 R with the smallest R measurement of 1.75 T. This demonstrated that the AWS allowable stresses were met. (Erler, prepared rebuttal testimony at 6-7, ff. Tr. 11,158) ~~The Board concludes that no legitimate concerns have been raised with respect to flare-bevel welding at the Byron plant.~~

156. Intervenors' expert also alleged that the discrepant ASME welds identified in Attachment 8 to his testimony were not evaluated by Sargent & Lundy. (Stokes, prepared testimony at 17-18, ff. Tr. 10,770.) This allegation is incorrect. With the exception of three welds that were not part of the Rein-

spection Program,*/ all the welds in Attachment 8 to Mr. Stokes' testimony, including the 46 ASME welds, were evaluated by Sargent & Lundy. This can be demonstrated by a comparison of the drawing numbers in Attachment 8 with the component numbers in Sargent & Lundy document ERP-1, which is a summary of Hunter discrepant welds that were evaluated in the reinspection program. A comparison of the two sets of numbers reveals that these are the same welds. (DeMoss, prepared rebuttal testimony at 4, ff. Tr. 11,158; Stokes, Tr. 10,829-34.)

157. Applicant's witnesses were questioned about the fact that some of the Hunter visual weld discrepancies and discrepancies in Hatfield and Hunter objective attributes were repaired prior to evaluation by Sargent & Lundy. The repair of a discrepancy in no way interferred with Sargent & Lundy's engineering evaluation inasmuch as all the information necessary to perform the evaluation was contained in the discrepancy reports. (McLaughlin, French, Branch, Tr. 9278-80; 9293-96.)

158. All discrepancies subject to ASME Code examination acceptance criteria were reparied, even though they were deter-

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*/ These welds, which were alluded to by Dr. Ericksen (Ericksen, Tr. 10,951, 10,958), were initially included in the program because it was believed that they were attributable to Inspector A, an inspector captured in the program. It was subsequently learned that these three welds had been reworked and inspected by a QC inspector other than Inspector A. Thus, the reinspection of these three welds could not be attributed to Inspector A and, accordingly, they were excluded from the program and the statistics shown for Inspector A in Table B-3 in Applicant's Exhibit R-4. (DeMoss, Tr. 11,162-63.) (See ¶ 184a below.)

mined by evaluation not to have design significance. All other discrepancies were either reparied or dispositioned as acceptable "as-is" based on the engineering evaluation results. (Del George, prepared testimony at 36, ff. Tr. 8406.)

159. The Board was initially surprised by the absence of any design significant discrepancies out of all those analyzed by Sargent & Lundy. Sargent & Lundy attributes this result ~~This result is attributable~~ to the extensive margin allegedly incorporated in the Byron design and, as explained by the Sargent & Lundy panel, is an inherent consequence of the design process. Engineers design a structure such that it is sufficiently strong to withstand the expected forces and stresses with spare or extra strength to account for uncertainties and contingencies. This extra strength is called margin. Design margin is that margin imposed by engineers during the design process. For example, connections are designed in groups rather than individually. As a consequence, the force or load-bearing capability for each connection is established on the basis of the most highly-stressed connection. The actual stresses for most connections will be less than those established by the design process. The difference between the two is an example of design margin. Sargent & Lundy contends that the existence of this design margin in the work evaluated by Sargent & Lundy is the primary reason that none of the weld discrepancies was found to be design significant. (McLaughlin, prepared testimony at 8-9, 11-12, ff. Tr. 9047; French, Branch, McLaughlin, Tr. 9254-61.) Inasmuch as the Byron design is not yet an issue in this proceeding, and intervenors' allegations of design defects were excluded, the Board expresses no view on the adequacy of the Byron design.

160. There is a second margin in the structural design of connections. This is the margin that the code writers put into the design process in the form of allowable stresses. The code writers typically attempt to obtain a margin of approximately two when they write the code. This means that a structure designed to a code could carry approximately twice the design load and not fail. (McLaughlin, prepared testimony at 9, ff. Tr. 9047.)

This does not mean that there were no Code violations. (See, e.g., ¶ 124 above.)

161. In Sargent & Lundy's detailed engineering evaluation, the Code allowable was not exceeded for any discrepancy. (McLaughlin; prepared testimony at 9, ff. Tr. 9047; Erler, prepared rebuttal testimony at 4-5, ff. Tr. 11,158; McLaughlin, Tr. 9271-72.) Although Mr. Stokes initially stated that some of Sargent & Lundy's calculations "appeared" to exceed the Code allowable for stress (Stokes, Intervenors' Prepared Testimony at 7, 8, ff. Tr. 10,770), following cross examination Intervenors and Applicant stipulated that after reviewing the calculations and discussing them with Sargent & Lundy personnel based on Sargent & Lundy design criteria, Mr. Stokes found no calculations for work performed by Hatfield or Hunter where the actual stress exceeded the Code allowable. (Tr. 10,936.)

162. There were a few instances where a 10% overstress factor was used by Sargent & Lundy at an intermediate point in the calculative process. The 10% overstress factor refers to a 10% limit where Sargent & Lundy engineers ~~are allowed~~ permits its to use

their knowledge of the margin in the structural analysis to decide, when the calculated stress is less than or equal to 10% greater than allowable, that the calculated stresses have sufficient conservatisms or margin in them to meet the AISC Code stress allowable. (Erler, prepared rebuttal testimony at 4, ff. Tr. 11,158.) However, as Intervenors and Applicant stipulated, in each of these instances, the overstress factor was not relied upon for the ultimate conclusion in the calculation that the actual stress did not exceed the Code allowable. (Tr. 10,936; Erler, prepared rebuttal testimony at 4-5, ff. Tr. 11,158; Tr. 11,159-60.)

163. Intervenors' witness charged that the judgments and assumptions used by Sargent & Lundy in its evaluation of the BRP discrepancies lacked "objectivity and impartiality" and, hence, an independent review was required. (Stokes, prepared testimony at 7, ff. Tr. 10,770.) However, outside of pointing to an alleged inconsistency between Sargent & Lundy's structural engineering group and the mechanical engineering group in the treatment accorded fatigue loading (Stokes, Tr. 10,893), Mr. Stokes could point to no specific instance, including no specific calculations, where Sargent & Lundy demonstrated a lack of "objectivity and impartiality." (Stokes, Tr. 10,885-904.) As Mr. Stokes himself stated, "I'm just saying they [Sargent & Lundy] ignored certain things, but I can't cite one." (Tr. 10,894.) He also stated that his statement was based in part on portions of his testimony which the Board had declined to receive. (Tr. 10,895.)

164. With respect to the alleged inconsistency between the mechanical group and the structural group in their treatment of fatigue loading, Mr. Stokes asserted that if mechanical designs account for fatigue in the piping system, then the structural group should take that into account when designing those respective pipe supports. (Stokes, prepared testimony at 18, ff. Tr. 10,770.) Contrary to Mr. Stokes' assertion, there is no inconsistency in Sargent & Lundy's treatment of fatigue loading for piping and for pipe supports. Due to the nature of loading on a piping system, the requirements may vary depending on the class of the system. For example, the ASME Code requires an explicit calculation of fatigue loading for a Class 1 piping system while Class 2 and 3 piping systems are affected by cyclic loading only if the number of cycles exceeds 7,000 (ASME Section III NC 3611.2). For pipe supports with respect to Class 1, 2 and 3 piping, both ASME and AISC are consistent in not requiring any reduction in allowable stress for less than 20,000 cycles. (Erler, prepared rebuttal testimony at 8, ff. Tr. 11,158.) At Byron, for Class 1 piping systems, the analysis has accounted for the number of cycles as required by the Code. Fatigue loadings were properly neglected for Class 2 and 3 piping systems and for pipe supports because the number of cycles experienced is less than the threshholds established in the Codes for requiring a reduction in the allowable stress limits. (Erler, prepared rebuttal testimony, at 8, ff. Tr.

11,158.) ~~Mr. Stokes apparently failed to understand the differing Code treatment for factoring fatigue loadings in the design of Byron. No inconsistency exists and Mr. Stokes' criticism is rejected.~~

165. The Board finds that the Sargent & Lundy evaluations were performed in accordance with proper engineering standards and that the assumptions used in performing these evaluations were sufficiently conservative. In the words of Mr. Muffett, Sargent & Lundy's program for evaluating the discrepancies was "more than adequate." (Muffett, Tr. 9813.) Accordingly, the Board finds no evidence in this record to support the need for an independent review based upon any alleged lack of objectivity or impartiality on the part of Sargent & Lundy. In addition, in response to the issue added by the Board concerning Applicant's repair of defects, the Board finds that all discrepancies were either repaired or dispositioned as acceptable "as-is" based on engineering evaluation results, thereby resolving this issue. ~~Finally,~~ However, the Board does not find that the absence of any design-significant discrepancies in the BRP sample demonstrates that the pre-September, 1982 inspectors had not overlooked any significant safety-related deficiencies (see, e.g., ¶ 99 above.) ~~thereby reinforcing the conclusion that these inspectors were qualified~~ in work which was not reinspected.

X. QUALITY OF THE WORK

a. Introduction

166. In evaluating work quality, we begin with the Appeal Board observation, previously noted, that for purposes of this proceeding a presumption of work quality follows a showing of inspector competence. (ALAB-770, slip opinion at 28.) This is also consistent with the position taken by Edison and by the Staff. As Mr. Laney testified, the presence of competent inspectors suggests that significant discrepancies are unlikely to go undetected. Indeed, as noted above, this very phraseology was used by the Staff in its description of the purpose of the BRP. (Little, Staff prepared testimony at 4, ff. Tr. 9510.) By removing doubt as to the qualification and capability of the whole body of inspectors, the BRP has provided confidence in the quality of the work that was originally inspected. (Laney, prepared testimony at 18, ff. Tr. 9339; Little, Staff prepared testimony at 4, ff. Tr. 9510.) We have already found the inspectors in question to be qualified. (¶ 104, supra.) Accordingly, in line with the Appeal Board reasoning, this finding, on its own, raises a presumption of the adequacy of Hatfield and Hunter work quality that has not been rebutted.

as noted in ¶¶ 166-166e above,

167. Applicant, however, did not rely solely on the favorable results of the BRP. It presented extensive testimony of seven witnesses who relied on various additional bases for con-

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INTERVENORS' PROPOSED PARAGRAPHS 166, 166a, 166b, 166c AND 166d

166. As we noted at the outset (¶¶2a, b and c above), the ultimate issue is whether the evidence on remand sufficiently cures or overcomes the quality assurance failures identified in our initial decision, such that we can now find that Byron has been properly constructed, i.e., that there is reasonable assurance that the plant can be operated safely. For the reasons summarized in this paragraph, we cannot so find.

From beginning to end in the remanded hearings, CECo has consistently identified the following three major grounds for inferring that the quality of the work at Byron is adequate:

1. One can infer from the Reinspection Program results that the quality control inspectors at Byron were qualified, and thus did not overlook unsafe work.
2. One can infer from the large number of reinspections conducted, and the fact that most discrepancies detected were inconsequential and none were found to be design significant, that the overall quality of work at Byron is adequate.
3. One can infer from CECo's comprehensive QA program that the work quality at Byron is adequate.

(E.g., CECo proposed supplemental initial decision, ¶202.)

We are not persuaded by any of these proferred grounds.

166a. First, we have already found, based mainly on the testimony of NRC staff members Forney and Hayes, that one cannot reasonably infer from the BRP results that quality control inspectors at Byron prior to March, 1983 were qualified. (See ¶99 above.)

As we noted, Mr. Forney thought this point to be of little consequence, and thus his reservations about the pertinent NRC staff testimony to be "miniscule," because he believes that regardless of inspector qualifications, the work at Byron is adequate based on other factors. However, we find those other factors unconvincing as well. Thus, unlike Mr. Forney, we find his point that one cannot reliably infer inspector capabilities from the BRP results to be important.

166b. Turning to those other factors, CECo argues, second, that one can reasonably infer directly from the reinspections conducted in the BRP that the quality of unreinspected work at Byron is adequate. For several reasons, we are not persuaded. As CECo acknowledges (e.g., Del George prepared testimony at 7, ff. Tr. 8406), the BRP was

originally designed only to address the issue of inspector qualifications. Information about work quality was to be only an incidental by-product of the BRP. Had the BRP been intended to demonstrate work quality directly, it should (and presumably would) have been designed differently in several key respects. For example, a BRP designed to demonstrate work quality directly:

- would not have omitted any reinspections whatever of two of the eleven Hatfield attributes that could be reinspected, and three of the twenty-one Hunter elements that could be reinspected (see CECo proposed findings ¶¶172, 173).

- would not have reinspected, in general, only the first three months of an inspector's work. While reinspection of only this initial period was logical for purposes of validating inspectors' training and initial qualifications, use of only this period was nonconservative for purposes of providing a representative sample of all the inspections, because of the tendency of inspectors' performance to decline over time, as testified to by Professor Kochhar. (See ¶42 above.)

- would not have reinspected relatively few inspections in some categories of greater safety significance than those which were heavily reinspected, (e.g., Ericksen, Amended Attachment B, ff. Tr. 11, 045.) This point is one of engineering judgment and simple common sense, as well as formal statistical methodology.

It is thus not surprising that even CECo's work quality expert Mr. Laney testified on cross-examination that he could not, based on the February, 1984 BRP above, infer that the quality of Hatfield and Hunter

work at Byron was adequate. (Tr.9378-79.) He was also uncertain as to what inference, if any, could be drawn even after the BRP's June, 1984 supplement. (Tr.9379 .) Rather, his testimony on work quality relied on the BRP results in conjunction with two CECo documents describing CECo's overall quality assurance program. (Tr. 9379-80.)

Because the BRP was not designed to demonstrate work quality directly, Edison's argument that one can infer work quality directly from it is compelled to rely on the point made by Mr. Laney: that even if the BRP results alone do not show work quality, they do so in combination with other factors. The problem is that these other factors -- the assertion that inspectors were qualified (which is critiqued in ¶99 above) and the assertion that CECo's overall quality assurance program was adequate, (critiqued in ¶166c below) -- are not independently convincing either. Three unpersuasive rationales, even in combination, do not a convincing showing make.

CECo also contends that the sample size -- 5 to 10% of all Hatfield and Hunter inspections -- is so large, and so similar to the unreinspected work, that one can reliably infer directly

from the adequacy of the reinspected to the adequacy of the unreinspected work. (CECo proposed findings, ¶¶175, 176.) This contention overlooks the fact that disproportionate numbers of reinspections focused on documentation inspections of no direct safety consequence. (See Ericksen Amended Attachment B, ff. Tr. 11, 045.) It was thus predictable that discrepancies in these inspections would be found not to have direct safety significance. But, from these facts, this Board cannot confidently infer that comparable proportions of reinspections of other kinds of inspections -- of greater safety significance according to CECo's Mr. Tuetken -- would also show no discrepancies of safety significance. (Tuetken, cross-examination, Tr. 8539-45; Intervenors Ex. R-1, ff. Tr. 11, 033; Ericksen Amended Attachment B, ff. Tr. 11, 045.) Again, this is a matter of judgment and common sense, in addition to being a lesson of statistical science. (See ¶¶178-182 below.)

166c. The third of CECo's three unconvincing grounds for its inference of adequate work quality at Byron is the least persuasive of all: its supposedly effective overall quality assurance program.

True, it appears that CECo may finally have "caught up" with its contractors' problems at Byron, with respect to their current activities. But for all the reasons stated in our initial decision, and based on extensive quality assurance evidence in the 1983

hearings, we found that over the years the CECo quality assurance program has failed to meet CECo's obligation to oversee its contractors, to whom it delegated much of its quality assurance responsibilities. (See ¶2a above.) And as we found in our initial decision, CECo's belated improvement does not retroactively justify confidence that its quality assurance efforts in earlier years provide an independent ground for inferring that contractor work performed during those years was adequate.

True also, CECo's program may have appeared adequate on paper, even in those earlier years. But CECo's paper program, and the protestations of its officers -- on which CECo expert Mr. Laney relied to reach his conclusion that work quality could be inferred from CECo's quality assurance program (Laney, prepared testimony at 23-24, ff. Tr. 9339) -- are not enough. We are not moved by the self-serving generalities offered by Mr. Behnke and other CECo executives on remand. What counts is evidence of performance, and at least two items of evidence on remand reinforce our conclusion in the initial decision that CECo's historical quality assurance performance, as opposed to its paper program, has been inadequate.

First is a clear indication in Mr. Benhke's testimony, on a point not fully appreciated in our initial decision, that "PTL acts as an arm of our

quality assurance department in conducting overview and unit concept inspections at Byron and Braidwood." (Behnke, prepared testimony at 6, ff. Tr. 9336.) Attachment A to Mr. Behnke's prepared testimony shows that a major portion of CECo's entire quality assurance oversight of Hatfield and Hunter over the years has in fact been carried out by PTL, not by CECo. Unfortunately, his CECo and PTL figures are not directly comparable, and Mr. Behnke on cross-examination attempted to downplay the extent of PTL's role. (Tr. 9347.) But for example, during 1982, the last year before the BRP, while CECo's quality assurance department was directly conducting 10 audits and 100 surveillances of Hatfield, PTL performed 713 overview inspections of Hatfield and reviewed 1,398 items in Hatfield Unit Concept Inspections. (Behnke, prepared testimony at Attachment A page 1, ff. Tr. 9336.) During the following year, 13 CECo audits and 355 CECo surveillances of Hatfield were accompanied by 1007 PTL overinspections of Hatfield and 16,846 items reviewed by PTL in Hatfield Unit Concept Inspections. (Id.) The numbers vary from year to year, but CECo has clearly relied heavily on PTL as an "arm" of its quality assurance department.

This fact is of concern because PTL's performance at Byron has been less than examplary, and in some

respects has been worse than that of the contractors it was supposed to oversee on behalf of CECo. In the BRP, PTL's company-wide average performance on visual weld inspections (85%) was not only less than the program's acceptance level for individual inspectors (90%), but also less than the company-wide averages for Hatfield (93%) and Hunter (96%). (Del George, prepared testimony Attachment E at 1, 4 and 6, ff. Tr. 8406.)

Most recently, PTL violated BRP groundrules by attempting to override a third-party-review inspector's finding of a discrepancy. (Shewski, prepared testimony Attachment O, ff. Tr. 8423.) While CECo expert Mr. Hansel presented a hearsay report that the attempted override was not concealed (Tr. 9315-18), an elementary familiarity with BRP groundrules should have alerted a competent quality assurance organization to the unacceptability of such an override effort. The incident thus reinforces the Board's concern over Edison's extensive reliance on a contractor with an unimpressive track record at Byron to oversee the quality assurance programs of other contractors.

Second is CECo's sorry record in supervising SCC at Byron. In our initial decision, "We concluded that the Systems Control Corporation quality assurance program broke down, was unreliable and fraudulent and that Applicant defaulted in its respective oversight

responsibility." (D-442.) However, we nonetheless delegated the SCC matter to the staff for resolution because, we were advised, CECo has arranged for a 100% reinspection of all SCC work. (Id.)

Not so, we now learn. Following our initial decision, the staff advised the Appeal Board of continuing discoveries of deficient welds on SCC cable pan hangers at Byron. (ALAB 770 at 31.) In remanding, the Appeal Board identified the question "why were not the defects uncovered long ago?" (Id. at 31-32.)

In CECo's proposed supplemental initial decision, CECo chose simply to ignore this issue -- broadly stated, CECo's quality assurance oversight of SCC -- and to propose findings on the "Adequacy of Equipment Supplied by SCC," as if that were the only issue. (CECo proposal at 110.) However, the very fact that CECo -- in mid-1984 -- was still finding it necessary to commission batteries of additional engineering analyses of defects in SCC equipment, and to undertake extensive additional reinspections of SCC equipment at Byron (see ¶¶209-262 below), provides further confirmation of the finding in our initial decision that CECo "defaulted" in its quality assurance oversight responsibility with respect to SCC. (D-442.)

In fact, the evidence with respect to CECo quality assurance oversight of SCC presented on remand reveals even less satisfactory CECo performance than shown by the evidence in the 1983 hearings. (See generally, Marcus, prepared testimony and cross-examination, ff. Tr. 10, 319 and Hayes, Connaughton and Muffett, prepared testimony and cross-examination, ff. Tr. 10, 478.)

It is now clear that with respect to the supposed 100% PTL source inspection of SCC equipment shipped after February, 1980, CECo was both internally confused and externally misleading (albeit not intentionally) in its representations to the NRC staff. (Id.; prepared testimony at 2-3, 5-7, and Marcus' explanation on cross-examination of the inaccuracies and ambiguities in that letter, ff. Tr. 10, 320.) Except for local instrument panels, the 100% source inspections, which CECo apparently thought were being conducted and which the NRC staff understandably thought were being conducted, missed some shipments altogether during 1980-81, and covered only samples of shipments after February, 1981. (See CECo proposed supplemental initial decision ¶208 and note thereto.)

(Intervenors' Proposed ¶¶ 166, 166a-166d, p. 10)

Nor was this the only ineffectual CECo remedial response to SCC deficiencies. While CECo procurement practices are not an issue in this proceeding, this Board cannot overlook the facts that in response to the SCC problems, (1) CECo purported to refrain from further purchases of SCC equipment, (2) CECo failed to do so, but continued its purchases through changes to existing orders, and (3) CECo failed to so advise the NRC staff, which discovered the practice only though its own inspection following the disclosure of further discrepant SCC welds in early 1984. (See CECo proposed supplemental ¶212 note.)

In sum, the evidence on remand strengthens rather than detracts from the finding in our initial decision that CECo quality assurance over the years failed effectively to oversee contractors at Byron. Even if CECo has now at last "caught up" with respect to contractors' current activities, CECo quality assurance over the years affords no reliable independent basis for an inference as to the adequacy of the 90% to 95% of Hatfield and Hunter work that was not reinspected in the BRP. If the BRP does not show work quality at Byron, either directly or through proving the competence of inspectors, and it does neither, then it cannot be salvaged for this purpose by reliance upon CECo's inadequate quality assurance oversight of contractors at Byron.

(Intervenors' Proposed ¶¶ 166, 166a-166d, p. 11)

166d. In addition to the foregoing three grounds asserted by CECo in claiming that there is reasonable assurance of adequate work at Byron, CECo also sometimes cites, and the NRC staff relies upon NRC inspection efforts as an additional ground. (E.g., testimony of Mr. Forney and Mr. Keppler, quoted in CECo proposed supplemental initial decision ¶¶200, 201, respectively.) While the NRC staff inspections would indeed provide some additional confirmation of work adequacy if inspectors were shown to be qualified, and if the BRP results demonstrated work quality directly, and if CECo's overall quality assurance program at Byron had been adequate over the years, the NRC staff's effort does not suffice to overcome CECo's shortcomings on each of these three points.

This is true both because of the limited extent and the necessarily non-uniform nature of NRC inspection efforts at Byron. No great evidentiary showing is required to persuade the Board of the NRC's limited inspection resources. One of many examples which could be cited is the fact that despite the obviously high priority of the BRP, the NRC staff welding specialist was able to inspect less than 330 -- or about 1% -- of the more than 31,000 Hatfield and Hunter welds reinspected in the BRP. (CECo proposed supplemental initial decision at ¶¶128, 136; Ward, cross-examination, Tr. 9911.)

NRC inspection efforts are also necessarily non-uniform. They are often undertaken in response to worker allegations which, as we recognized in our initial decision, are "necessarily random." (D-431.) Coupled with the fact that superficially plausible allegations may or may not prove meritorious following extensive investigation, this means that NRC inspection resources necessarily reflect a non-uniform sampling of contractor activities.

(Intervenors' Proposed ¶¶ 166, 166a-166d, p. 13)

INTERVENORS' PROPOSED PARAGRAPH 166e

166e. In short, the evidence on remand has not cured or overcome the quality assurance failings identified in our initial decision. We therefore cannot conclude that there is reasonable assurance that Byron can be operated safely.

cluding that the quality of the Hatfield and Hunter work was adequate. The testimony of these witnesses, that of the NRC Staff and the Intervenors, as well as that of Applicant's rebuttal witness, ~~are advanced~~ is further discussed below.

b. Sargent & Lundy Evaluation Results

168. Based on the engineering evaluation performed by Sargent & Lundy of discrepancies found in the Hatfield and Hunter work reinspected, numerous witnesses concluded that the quality of all Hatfield and Hunter work at the Byron plant is adequate. John M. McLaughlin, Partner and Manager of the Structural Department at Sargent & Lundy, whose testimony was discussed in the previous section, concluded that based on his engineering judgment, the Sargent & Lundy evaluation demonstrates that the quality of all Hatfield and Hunter work performed at the Byron Station is adequate. (McLaughlin, prepared testimony at 16-17, ff. Tr. 9047.) His conclusion is premised on the fact that none of the visual weld discrepancies or discrepancies in objective attributes identified with the Hatfield or Hunter work had design significance. (McLaughlin, prepared testimony at 17, ff. Tr. 9047.) This encompasses an engineering evaluation of over 3,400 discrepancies. (See Section IX, supra.) In reaching this conclusion, Mr. McLaughlin observed that of the 356 Hatfield weld discrepancies analyzed by Sargent & Lundy, 50 were selected at random, 50 were selected by a

However, the Board does not agree with his conclusion, for the reasons stated in ¶¶ 166-166c above, as well as those in ¶¶ 178-85 below.

third-party inspector on the basis of being the worst welds from a weld discrepancy viewpoint, and the remaining 256 discrepancies involved welds at the most highly-stressed connections where the design margin was the least. (McLaughlin, prepared testimony at 7-8, 17, ff. Tr. 9047.) Thus, the sample of 356 Hatfield weld discrepancies analyzed by Sargent & Lundy was biased to examine the most highly-stressed welds in the Reinspection Program, where the greatest potential existed for exceeding design margins. (McLaughlin, prepared testimony at 8, 16-17 ff. Tr. 9047; Laney, prepared testimony at 14-15, ff. Tr. 9339.) Yet, no design-significant discrepancies were found. Mr. McLaughlin's conclusion that the Hatfield and Hunter work is adequate is also based on what he claims are conservative loadings and assumptions used in the design of the Byron plant, and the margins he contends are inherent in that design. (McLaughlin, prepared testimony at 16-17, ff. Tr. 9047.) However, because the Byron

169. Mr. McLaughlin's conclusion on overall work quality was reinforced with respect to Hatfield by Richard X. French, Partner and Manager of the Electrical Department at Sargent & Lundy. Mr. French testified that, based upon the absence of any discrepancies with design significance out of over 60,000 Hatfield objective attributes reinspected, he would conclude that the similar unreinspected Hatfield work was also adequate. (French, Tr. 9305-06.)

design is not yet an issue in these proceedings and intervenors have not been permitted to introduce evidence on that design, the Board expresses no view on the Byron design.

For the reasons stated in ¶168 above, the Board expresses no view on the Byron design; nor is Mr. Laney qualified to do so. (Tr. 9359-60.)

170. Mr. Laney ~~explained~~ expressed the view that the engineering analysis of discrepancies demonstrates that inherent design conservatism renders virtually all the discrepancies inconsequential. ~~This conservatism, combined with an extremely rigorous code definition of weld discrepancies (the AWS Code defines as a discrepancy almost any deviation from a perfect weld even though the Code also states that discrepancies need not actually be defects), results in the generation of reports of many discrepancies that are later found to be acceptable.~~ (Laney, prepared testimony at 10, 19-23, ff. Tr. 9339.) ~~This is readily demonstrated by the Sargent & Lundy evaluations discussed in ¶'s 112 and 122, supra.~~ Mr. Laney concluded that the total absence of any identified design-significant discrepancies provides additional assurance that the work of Hatfield and Hunter is adequate. (Laney, prepared testimony at 23, ff Tr. 9339.)

171. Mr. Del George and Mr. Behnke similarily conclude that Sargent & Lundy's finding of no design-significant discrepancies contributes to a demonstration of the adequacy of the Hatfield and Hunter work. (Del George, prepared testimony at 49, ff. Tr. 8406; Behnke, Applicant Prepared Testimony at 14, ff. Tr. 9336.)

c. Scope Of Work Reinspected

172. Mr. Laney, testifying on behalf of Applicant, also explained how the scope of the reinspection program supported his conclusion that the quality of the Hatfield and Hunter work

However, it appears that Mr. Laney relied on part on inaccurate information. (See ¶ 184a below.)

was adequate. He stated that he assessed the adequacy of the Hatfield and Hunter data in relation to all work performed by Hatfield and Hunter. (Laney, prepared testimony at 11, ff. Tr. 9339.) Specifically, Mr. Laney performed a comparison of the attributes that were inspected with the total of each contractor's attributes. For Hatfield, nine out of 11 attributes that could be reinspected were reinspected. The two that were accessible but not reinspected were cable pan covers, not yet installed, and cable pan identification, a less significant attribute. Ten attributes were either inaccessible or not recreatable. These 10 attributes were, according to Mr. Laney, less significant in size and importance than the nine that were reinspected. In addition, these attributes were installed using the same procedures as attributes that were reinspected. (Laney, prepared testimony at 12, 13 ff. Tr. 9339.)

173. For Hunter, 18 out of 21 work elements (comprising the three Hunter attributes) that could be reinspected were reinspected. (But see ¶ 184a below.) Fourteen work elements were not reinspected either because they were not recreatable or were inaccessible. Seven of the 14 that could not be reinspected were welding-in-process inspection points such as preheat or welding interpass temperature. However, the BRP found Hunter's welding ~~quality~~ (agreement rate between inspectors of) to be good, with less than a three percent discrepancy rate on 3,725 welds and no design-significant discrepancies. The BRP also reinspected Hunter's quality-assurance documentation.

In other words, 90% to 95% of the work of these two contractors was ~~things~~ not reinspected. Nonetheless,

Twenty-five out of 33 documentation elements were reinspected and found satisfactory (Laney, prepared testimony at 13, 14, ff. Tr. 9339.)

174. In addition to the fact that a broad range of attributes was examined, Mr. Laney also noted that over 160,000 reinspections of Hatfield and Hunter work were performed. (Laney, prepared testimony at 27, ff. Tr. 9339.) Eleven percent of all Hatfield inspection months were reinspected in the program and six percent of all Hunter inspection months were reinspected. From this it is reasonable to infer that, overall, some five to ten percent of the total work of these two contractors was reinspected. (Laney, prepared testimony at 14-15, ff. Tr. 9339.) The ~~vast~~ amount and the ~~broad~~ range of Hatfield and Hunter work reinspected ~~provides~~ was relied upon by Mr. Laney as a basis for ~~him~~ ~~Laney to draw~~ conclusions on the work quality of these two contractors. (Laney, prepared testimony at 13-15, ff. Tr. 9339)

175. Next, Mr. Laney testified that the BRP data shows that for Hatfield, of 87,783 inspections made, less than 4,000 discrepancies were found. Only approximately 11% of these needed to be analyzed by calculation to determine their significance. And, as discussed above, none of these Hatfield discrepancies had design significance and none reduced design margins below the level required by conservative design practice. (Laney, prepared testimony at 16, ff. Tr. 9339.) For Hunter, the BRP data shows that of 73,349 inspections performed, less

Nonetheless Mr. Laney concluded that he could not infer adequate work quality from the February, 1984 BRP report and he was unsure whether he could do so even from the June 1984 supplemental report. (Tr. 9378-9379.)

than 800 discrepancies were found. Only approximately 10% of these needed to be analyzed by calculation to determine their significance. As discussed above, none of these Hunter discrepancies had design significance and none reduced design margins below the level required by conservative design practice. (Laney, prepared testimony at 16-17, ff. Tr. 9339.)

176. In short, of the over 160,000 reinspections of Hatfield and Hunter work, fewer than 500 discrepancies were of such a nature as to require an engineering calculation to determine their significance. And, as discussed previously, the evaluations demonstrated that none had design significance. Thus, Mr. Laney concluded that, in addition to the qualification of inspectors, the absence of any discrepancies with design significance combined with the inherent design conservatism, and CECo's QA program, the scope of the reinspected work demonstrates that the quality of all the Hatfield and Hunter work at the Byron plant is adequate.

177. Mr. Del George similarly concluded that the large number of Hatfield and Hunter items reinspected, the relatively small number of discrepancies, and the absence of any design-significant discrepancies (discussed above) provide a basis for his conclusion that the quality of work is adequate. (Del George, prepared testimony at 49, ff. Tr. 8406.) Specifically, Mr. Del George pointed to (1) the inspection of approximately 130,000 Hatfield and Hunter objective attributes and

30,000 Hatfield and Hunter subjective attributes and (2) the diverse data base developed for Hatfield and Hunter, including related indicia of acceptability for inaccessible and not recreatable attributes. (Del George, prepared testimony at 50-51, Attachment E, ff. Tr. 8406.)*/

~~178. All these judgments on work quality were made on the basis of engineering judgment rather than on the basis of the application of mathematical statistical theory.~~ (Del George, Tr. 8518; Little, Staff Prepared Testimony at 4, ff. Tr. 9510.) Notwithstanding the use by these expert witnesses of engineering judgment as the basis for determining that the work quality was adequate, Intervenors presented the testimony of Dr. Ericksen in an effort to demonstrate that, applying mathematical statistical theory, inferences could not be made regarding the entire scope of Hatfield and Hunter work based upon the sample of the work reinspected in the BRP.

179. In assessing the significance of the testimony of ~~Intervenors' statistical expert, Dr. Ericksen, we recognize~~

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*/ In response to a Board concern, Mr. Del George's testimony explained that the results for all attributes were evaluated on a contractor-by-contractor basis to determine whether any trends existed in the observed discrepancies that might warrant further review. Only two such trends were found, one involving reproduction of original visual weld inspection reports by PTL, the other involving a relatively large number of Hatfield visual weld discrepancies associated with sheet steel welds. Both of these trends involved discrepancies that were ~~minor in nature~~ and were caused by factors that have since been remedied. (Del George, prepared testimony at 38-41, ff. Tr. 8406.)

numerous

not design significant

[Intervenors Proposed ¶¶ 178-185 appear following p. 98 below.] →

that he does not purport to be an expert in the design, construction or evaluation of nuclear power plants and that he has no experience as a quality control inspector at a nuclear power plant. (Tr. 11,026-11,045). He is an expert statistician, but he recognizes that the conclusions expressed by knowledgeable professional engineers in this proceeding may in fact not be statistical statements at all, but rather the results of an engineering analysis. (Ericksen, Tr. pp. 11,077-78.) The limited role of a statistician in these circumstances was also recognized by Dr. Frankel, the statistical expert testifying on rebuttal for Applicant, who explained that a sampling statistician is not qualified to draw inferences where a non-probability sample is used, but can only assist the subject matter expert in drawing inferences from that sample and has no role to play when a subject matter expert does not purport to apply mathematical statistical theory at all. (Frankel, prepared testimony at 8. ff. Tr. 11,120.) None of the witnesses presented by Applicant or Staff, except Dr. Singh, purported to rest their conclusions on an application of mathematical statistical theory and Mr. McLaughlin specifically stated that the results of a statistical analysis were immaterial to his conclusions. (McLaughlin, Tr. 9272-74.) Thus, recognizing that mathematical statistical theory plays an extremely minor role in the evaluation of the quality of Hatfield and Hunter's work, we turn to a consideration of Dr. Ericksen's testimony.

180. Dr. Ericksen's basic criticisms focussed on a formula used by Dr. Singh to calculate the reliability for Hatfield and Hunter inspection attributes. That reliability calculation expressed the proportion of work items in a total population which had no discrepancies with design significance and is stated in the formula R = 1 - 2.9955/n where R = reliability at a 95% confidence level and n = number of inspections. (Singh, prepared testimony at 5, ff. Tr. 9055.) Application of the formula resulted in calculated reliabilities in excess of 99% for all but two Hatfield inspection attributes (the two which were lower had small sample sizes and were in excess of 96%) and for both Hunter attributes. (Singh, prepared testimony at 6, ff. Tr. 9055.) Dr. Ericksen testified that use of the reliability formula in Dr. Singh's testimony was valid only if the inspectors within the sample were homogeneous. (Ericksen, prepared testimony at 10-11, ff. Tr. 11,045.) Dr. Ericksen purported to demonstrate that the inspectors were not homogeneous based on a mathematical calculation of "intraclass correlation," a statistical technique for measuring homogeneity. (Ericksen, prepared testimony at 11, ff. Tr. 11,045.) However, Dr. Ericksen's calculations on which he based his conclusion that the inspectors were not homogeneous used data relating to observed discrepancies. Dr. Ericksen admitted that a calculation based on design significant discrepancies would lead to a calculated intraclass correlation of zero and thus a conclusion

that inspectors were homogeneous. (Tr. 11,058) Of course, observed discrepancies are not a measure of the adequacy of Hatfield and Hunter work. It is only the existence of previously undetected design significant discrepancies which would call the adequacy of those contractors work into question and it was the likelihood of undetected design significant discrepancies that Dr. Singh was attempting to estimate. We find, therefore, that this criticismon the use of the reliability formula by Dr. Singh misunderstands the basic purpose of the calculation and does not detract from conclusions expressed by any witness regarding the adequacy of Hatfield and Hunter work.

181. Dr. Ericksen's second criticism of Dr. Singh's application of the reliability formula, that it did not take the effects of "clustering" the sample into account, is based on a similar misreading of the significance of the data collected by the SRP. Dr. Ericksen testified that the calculation of intraclass correlation is used in another calculation which determines to what extent clustering, i.e., the limitation of the sample of work to the inspections of the selected inspectors, affects the reliability of the statistics generated by the formula used by Dr. Singh. (Ericksen, prepared testimony at 15, ff. Tr. 11,045.) This calculation is known as the "design effect". There can be no effect on the reliability of the sample as a result of clustering with respect to design significant discrepancies, for which the intraclass correlation is zero.

(Tr. 11,066) As a result, in calculating design effect, when the inspectors are homogeneous (roh=0 in Erickson's design effect formula) the design effect of using any clustered sample of design significant discrepancies is 1. As a result, the sample size required to generate reliable data as to design significant discrepancies is unaffected by clustering. (Frankel, Tr. 11,124.) Accordingly, Dr. Singh's reliability calculations are reasonable estimates. (Frankel, Tr. 11,124-25.)

182. Dr. Ericksen also criticized Edison's aggregation of inspection elements, claiming that in some cases the sample sizes of individual inspection elements for Hunter were too small to be meaningful for extrapolation of the results to the remaining population. The BRP basically aggregated inspections into two categories, subjective and objective (See ¶50 supra) and Hunter identified only two objective inspection attributes, documentation and hardware. Dr. Ericksen himself acknowledged that such an aggregation might be proper if done under the guidance of a subject matter expert. (Ericksen, Tr. 11,048-9.)

183. The rebuttal testimony of Mr. Somsag established the similarity of all the Hunter hardware inspections and specifically demonstrated that the same inspection parameters, type, size, location and condition applied to a variety of inspection elements, some of which had been identified by Dr. Ericksen as lacking adequate sample size. (Somsag, Rebuttal testimony at 5-6, ff. Tr. 11,178.)

184. Dr. Ericksen's statistical arguments are similar to those which were rejected by the Licensing Board in the recent Shoreham decision.*/ At Shoreham, an independent verification of construction adequacy was conducted by an engineering firm, Torrey Pines Technology. Witnesses for Suffolk County, an intervenor, criticized Torrey Pines for its decision to rely on engineering judgment rather than statistical methodology in the selection of the structures, systems and components which were inspected during the verification. The Board rejected any suggestion that an application of statistical methodology controlled its evaluation of the adequacy of construction at Shoreham, stating in pertinent part:

> [T]here has been no application of statistical methodology to a problem as diverse and complex as the verification of construction of a nuclear power station. . . .
>
> The Commission's Quality Assurance Criteria, 10 C.F.R. Part 50, Appendix B, do not require the use of statistical sampling methodology. Moreover, throughout the nuclear power industry, it is not the practice to utilize statistical methodology in quality assurance auditing programs.

(18 NRC at 619-20.)

185. We do not believe that there has been any showing that Applicant's use of statistics was erroneous. In any event, mathematical statistical theory played little, if any, role in the conclusions reached by the engineering witnesses

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*/ Long Island Lighting Company (Shoreham Nuclear Power Station, Unit 1), LBP-83-57, 18 NRC 445 (1983).

INTERVENORS' PROPOSED PARAGRAPHS 178 THROUGH 185

178A. Applicants have offered numerous broad generalizations concerning the adequacy of the sample selected for the reinspection program and urge us to accept their conclusions concerning the adequacy based on "engineering judgment" alone, arguing that statistics should have little or no effect on our decision. (Del George, Tr. 8518; Little, staff prepared testimony at 4, ff. Tr. 9510.)

178B. As we stated in paragraph 35B, bald assertions of engineering judgment cannot provide an adequate basis on which to rest our decision. See Texas Utilities Generating Company (Comanche Peak Steam Electric Stations, Units 1 and 2) LBP-83-81, 18 NRC 1410 (1983).

178C. In our initial decision we made clear that we were concerned about the lack of determination that a statistically significant sample had been chosen for reinspection. (Initial Decision, D-436.) We also expressed concern that a statistically reliable sampling had been conducted to provide assurance that inaccessible and non-recreatable inspections were adequate. (D-437.) Where, as here, the inspector qualification program was shown to be inadequate and a 100 percent reinspection is neither possible nor practical, statistics can serve a useful role in

justifying inferences concerning the quality of work that was not reinspected. */

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*/ We did not -- and still do not -- take the position that the Quality Assurance Criteria, 10 CFR Part 50, Appendix B requires use of statistical sampling methodology in all quality assurance auditing programs. It is the initial finding that inspector qualification was inadequate that led to the need for a reinspection program. The program is supposed to be used by this Board as a basis for justifying inferences concerning the quality of work that was not reinspected. As such, the reinspection program is different than general quality assurance auditing programs, which are not used as a basis for drawing inferences to the total population. See Long Island Lighting Company (Shoreham Nuclear Power Station, Unit 1), LBP-83-57, 18 NRC 455, 584, 620 (1983). Applicant's reliance on Shoreham as a basis for rejecting use of statistics is therefore inappropriate. In Shoreham, the Board stated, in pertinent part:

> The Board explicitly notes that the audits, including the Torrey Pines study, allow conclusions no more and no less than what they actually did show (more about this in Section II-K.9.c., Torrey Pines, below). For those specific things looked at, they complied or they did not comply with LILCO or NRC requirements. Any conclusion that because, for the sample chosen, no non-compliances were found, no noncompliances for the total population now exist or will exist in the future is totally unjustified. We certainly don't draw that conclusion, nor need we.

Here, in contrast to Shoreham, we do seek to reach a conclusion concerning the quality of the reinspected work of Hatfield, Hunter and PTL.

178D. Applicant's on-again, off-again position on the use of statistics appears somewhat inconsistent. Applicant's initial reliance on statistics belies its subsequent claim -- adopted only when problems with its statistical analysis were revealed -- that statistics play a minor role in evaluating Hunter's and Hatfield's work.

178E. Applicant initially presented the testimony of Dr. Anand K. Singh, Assistant Head of the Structural Analytic Division of Sargent & Lundy to apply principles of statistics and probability theory to the results of Applicant's engineering evaluations. (Singh prepared testimony at 3-4, ff. Tr. 9055.)

The conclusions of this analysis appeared in the prefiled testimony of Mr. McLaughlin (McLaughlin prefiled testimony at 17, ff. Tr. 9047). Mr. McLaughlin disavowed reliance on this testimony only after cross-examination illustrated problems with the statiscical work. (McLaughlin, Tr. 9272-74.) At this time, Mr. French admitted that he looked at Singh's work but stated it was not a significant part of the analysis of the discrepancies. (Id.)

178F. Intervenors' witness, Dr. Eugene P. Ericksen, a statistical expert, provided testimony concerning Edison's use of statistics in reaching conclusions concerning work quality. He explained that where a 100 percent

reinspection is not possible or practical but one wishes to make a judgment about overall work quality, statistics can be used to draw inferences from reinspected work to non-reinspected work. (Ericksen prefiled testimony at 4, ff. Tr. 11,045.)

178G. Dr. Ericksen explained that statistics enable one to make generalizations to the population from which a sample is selected. If one has a probability sample, then generalizations can be based on a rather straightforward mathematical procedure. (Id.)

178H. In the absence of a probability sample, people -- including engineers -- who make generalizations make estimates on the basis of some model or view of the real world. The model or view requires assumptions. The statistician can assist the engineer in determining whether or not these assumptions are supported by the data. (Ericksen, TR. 11,073-074.)

178I. Dr. Singh presented no rebuttal testimony for CECo. Dr. Frankel, the new statistical expert testifying on rebuttal for Applicant, stated that a sampling statistician is not qualified to draw inferences where a non-probability sampel is used, but can only assist the subject matter expert in drawing inferences from the sample. He stated that a statistician has no role to play when a subject matter expert does not purport to apply mathematical statistical theory at all. (Frankel, prepared testimony at 8, ff. Tr. 11,120.)

179. This position defies common sense. We agree that when an engineer makes a generalization he based his conclusion on certain assumptions. If data is available, a statistician can help the engineer to determine whether or not the assumptions are correct. (Ericksen, Tr. 11,074, 11,109-10.) The statistician need not be an expert in the design, construction or evaluation of nuclear power plants or a quality control inspector in order to provide this useful assistance.

180. Through cross-examination of Dr. Singh and the direct testimony of Dr. Ericksen, intervenors identified several problems with the statistical analysis of Dr. Singh and the assumptions that underlay the Applicant's judgments concerning the adequacy of the reinspection program. One serious problem was created by Edison's inappropriate aggregation of data in computing reliabilities. Edison aggregated items based on the untested engineering judgment that tasks were similar for each element in the face of data showing that, in fact, discrepancy rates for the various elements differed significantly. In addition, enough inspections were done of many elements to provide adequate assurance of safety. Moreover, the sample sizes were further devalued by the effect of cluster. Edison never properly determined the reliabilities that Hatfield and Hunter work met design requirements, both because

Edison improperly aggregated data and because Dr. Singh based his calculations on an inappropriate formula. In addition, Dr. Singh did not evaluate reliabilities at a higher than 95 percent confidence level for attributes and elements that were particularly important to plant safety. (See generally, Ericksen, prepared testimony, ff. Tr. 11,045.) For all these reasons the BRP failed to provide adequate assurance that the unreinspected work of Hatfield and Hunter is adequate.

Dr. Ericksen criticized Dr. Singh's use of an inappropriate formula to calculate the reliability for Hatfield and Hunter inspection attributes. Dr. Singh's reliability calculation purported to express the proportion of work items in a total population which had no discrepancies with design significance and was expressed as the formula $R = 1 - 2.9955/n$ where R = reliability at a 95% confidence level and n = number of inspections. (Singh, prepared testimony at 5, ff. Tr. 9055.) Dr. Singh's application of the formula resulted in calculated reliabilities in excess of 99% for eight of the ten Hatfield inspection attributes. (The two other attributes were reported to have reliabilities in excess of 96%.) The 38,603 inspections of Hunter attributes were divided into only two categories, subjective work and objective work. Dr. Singh reported reliabilities in excess of 99% for these aggregated attributes. (Singh, prepared testimony at 6, ff. Tr. 9055.) Dr. Ericksen testified that according to the text from which Dr. Singh derived his

reliability formula, the formula was valid only if the inspectors within the sample were homogeneous and the sample of inspections was randomly chosen. (Ericksen, prepared testimony at 10-11, ff. Tr. 11,045.) Dr. Singh also stated that his analysis assumed that inspectors were homogeneous, that "you don't have one person doing everything wrong and another doing everything right." (Singh, Tr. 9105-06.) Dr. Ericksen demonstrated that the inspectors were not homogeneous through a mathematical calculation of "intraclass correlation" and application of the F-test, two statistical techniques for measuring homogeneity. He demonstrated that inspectors who performed well in one inspection would tend to perform well in others and inspectors who performed badly in one inspection would tend to perform badly in others. (Ericksen, prepared testimony at 11-12, ff. Tr. 11,045.)

Dr. Singh admitted and Dr. Ericksen made clear that Edison did not select a random sample of inspections, but instead inspections were clustered by inspector. (Singh, Tr. 9093-95, Ericksen, prefiled testimony at 10, ff. Tr. 11,045.) Dr. Ericksen further demonstrated that reliabilities will be inflated when not adjusted for cluster. (Ericksen, prepared testimony at 15, ff. Tr. 11,045.) Dr. Ericksen stated that because Edison had such a heavily clustered sample, it was

impossible to apply the reliability equation on which Mr. Singh relied. (Ericksen, Tr. 11,083.) Edison in its findings argued that Dr. Ericksen should have evaluated homogeneity and the effects of cluster using the number of previously undetected design significant discrepancies as inputs to calculations. Dr. Singh, however, assumed homogeneity of discrepancy rates as a basis for his analysis. (Singh, Tr. 9105.) Dr. Frankel did not justify use of design significant discrepancies and further stated that the design effect created by cluster would be indeterminate (Ericksen, Tr. 11,125.) Edison's argument that one should evaluate the effect of cluster using the number of discrepancies with design significance rather than the number of discrepancies equates the likelihood that someone who makes no errors in his work will make an error which is design significant with the likelihood that someone who makes many errors will make an error of design significance. This is not supported by testimony and defies common sense.

181. We, therefore, concur in Dr. Ericksen's criticism and conclude that Dr. Singh's reliability calculations are not reasonable estimates.

182. In reporting reliabilities Edison aggregated Hatfield data in 10 objective attributes and aggregated Hunter data in one objective and one subjective attribute.

(Intervenors' Proposed ¶¶ 178-185, p. 8)

(Singh prepared testimony at 6-8, ff. Tr. 9055.) Dr. Ericksen illustrated and Dr. Singh admitted that the sample size of some individual Hunter elements was too small if one looked at individual elements. (Ericksen prepared testimony at 7-8, ff. Tr. 11,045; Singh Tr. 9111.) Dr. Singh justified reliance on aggregated results by emphasizing the similarities in the requirements for inspecting each element. (Singh, Tr. 9111.) In explaining why he did not review the number of inspectors who inspected and reinspected each element in Ericksen Attachment B, Dr. Singh stated that he relied on his understanding that if a person did well on objective attribute number one, he would do well on attribute three, four and five. Mr. Somsag also offered rebuttal testimony describing purported similarities of all Hunter hardware inspections through discussions of the inspection parameters of type, size, location and condition. (Somsag, rebuttal testimony at 5-6, ff. Tr. 11, 172.) Ericksen Tables 4 and 5 show, however, that for individual inspectors the discrepancy rates varied substantially even when comparing two types of finished weld inspections, and discrepancy rates for one type of element could vary substantially from contractor to contractor. Although Edison engineers may have believed the inspections of all types of elements were the same and hence

performance would be the same for each inspector, the data on reinspections clearly shows some tasks were more difficult for certain people than others. While aggregation might be proper if done under the guidance of a subject matter expert making justifiable assumptions, here the data shows that aggregation was inappropriate. (Ericksen, Tr. 10,962-63, 11,048-49; 11,109-11,110.) Therefore, Edison was not justified in drawing inferences to non-reinspected items nor justified in aggregating data in reporting reliabilities for Hunter work. (Ericksen, Tr. 10,963-64.)

183. The same conclusion can be presumed to apply to Hatfield. Edison failed to provide any disaggregated Hatfield data. (Ericksen, prepared testimony at 8 and Ericksen Attachment C, ff. Tr. 11,045, Ericksen, Tr. 10,965.)

184A. The results of the BRP are also suspect because of Edison changes in data on those results and repeated errors, up to and including the hearings, in providing data requested. (Tr. 9122; Ericksen, prefiled testimony, Table 2, ff. Tr. 11,045; Tr. 10,960.) Such inability to provide correct information undercuts this Board's confidence in the data provided and in the Applicant's ability to keep accurate records concerning BRP results.

(Intervenors' Proposed ¶¶ 178-185, p. 10)

185. We believe that Applicant improperly used statistics in reaching its conclusions. In addition, data illustrated that the engineering judgment concerning the adequacy of the sample was based on incorrect assumptions. The BRP failed to provide adequate support for reliable conclusions concerning Hatfield and Hunter's work. While a large amount of data was collected which showed no design significant discrepancies, the data did not adequately cover all attributes and did not include results from enough inspectors. We conclude that this data does not provide adequate assurance of the quality of Hatfield and Hunter work.

(Intervenors' Proposed ¶¶ 178-185, p. 11)

who appeared before us and we specifically decline to base our conclusions regarding work quality on an application of statistical methodology. The BRP, although not intended to specifically address the adequacy of Hatfield and Hunter's work, collected a large amount of data which showed no design significant discrepancies. Knowledgeable and experienced engineers conclude that this data is useful in reaching conclusions regarding the work of those two contractors which was not reinspected. We will not ignore this data either and it is one basis for our conclusion that the work of Hatfield and Hunter was adequate.

d. Applicant's Overall QA Program

186. In concluding that the quality of work at Byron is adequate, Applicant's witnesses also relied on their familiarity with CECo's overall QA program. We recognize initially that CECo's corporate commitment to safety and the adequacy of the structure of its QA program are no longer issues open to dispute in this proceeding. Indeed, in our initial decision we noted the express failure of Intervenors to file any proposed findings which controverted either CECo's commitment to safety or the adequacy of its corporate structure pertaining to quality assurance. (ID, ¶ D-12.) We went on to find that CECo's quality assurance program (on paper) is fundamentally sound, comprehensive and independent. (ID, ¶ D-13 - D-71, D-80 - D-89.) As discussed below, these initial findings are reinforced by the most

However, see ¶¶ 2a and 166c above.

~~recent testimony of CECo's QA program. Edison's comprehensive QA programs provide a further basis for our conclusion that the quality of Hatfield and Hunter work at Byron is adequate.~~

187. Wallace Behnke, the Vice Chairman of Commonwealth Edison Company and the individual to whom Mr. Shewski reported in the 1980-March, 1984 period testified regarding the scope and coverage of CECo's quality assurance program as it applied to Hatfield and Hunter at Byron. Mr. Behnke has experience with CECo quality assurance activities dating back to 1965. In 1973, when he was elected Executive Vice President, Mr. Behnke revised CECo's quality assurance organization and established a separate quality assurance department which reported directly to him. (Behnke, prepared testimony at 4, ff. Tr. 9336.) Given his position within the Company, Mr. Behnke has had a unique opportunity to view the effectiveness of CECo's QA program as it relates to Hatfield and Hunter work quality at Byron.

188. According to Mr. Behnke, the activities of the CECo QA department have taken place in an overall context of unequivocal corporate management commitment to quality. (Behnke, prepared testimony at 7, ff. Tr. 9336.) CECo's QA program has expanded significantly over the years both in terms of personnel and financial resources committed to the QA function. (Behnke, prepared testimony at 5, ff. Tr 9336.) With Mr. Behnke's knowledge and concurrence the level of supervision of the site quality assurance organizations was increased in

1980. This led to the appointment of QA superintendents at each construction site. 1982 brought the implementation of the Unit Concept Inspections by PTL at Byron and Braidwood. A special and more comprehensive CECo management audit was conducted at Byron and Braidwood in 1983 as well as a number of independent audits. (Behnke, prepared testimony at 6, 7 ff. Tr 9336.)

189. Mr. Behnke was also familiar with Hatfield's and Hunter's work history at Byron. He testified that on three separate occasions Hatfield's activities resulted in senior management attention. In 1980, an NRC inspection of Hatfield's activities at the Byron site led to multiple items of noncompliance and issuance of a stop-work order by the Quality Assurance organization. At Mr. Behnke's suggestion, CECo's president met with the president of Hatfield and communicated directly and forcefully CECo's concerns regarding the quality of Hatfield work. In 1981, an increased audit schedule of Hatfield by the CECo QA department was implemented. In 1982, extensive reinspection of cable pan hangers installed by Hatfield was performed at CECo's request because of incomplete documentation of inspections by Hatfield. Mr. Behnke knew of these matters and concurred in implementation of increased quality assurance attention for their resolution. (Behnke, prepared testimony at 10, 11, ff. Tr. 9336.) To Mr. Behnke's knowledge, Hunter's activities have not necessitated similar intervention. (Behnke, prepared testimony at 10, ff. Tr. 9336.)

As noted in ¶ 166 c above,

190. The tables which comprise Attachment A to Mr. Behnke's testimony show the extent to which CECo's quality assurance program for Hatfield and Hunter relied on PTL. The tables show numerous audits by both contractors personnel and audits and surveillances by Applicant's QA department, as well as numerous overview inspections and unit concept inspections by PTL. When asked to compare the inspection effort performed by CECo's own QA department with that of PTL, Mr. Behnke testified that the bulk or mainline of the effort was by CECo's own QA department, although he describes PTL as an "arm" of CECo QA. (Behnke, Tr. 9346-48.)

191. On the basis of his extensive experience with CECo's QA program and his knowledge of the coverage of that program over the activities of Hatfield and Hunter, Mr. Behnke asserted that the QA program adequately controls the activities of Hatfield and Hunter and provides assurance that the work of these two contractors is adequate. (Behnke, prepared testimony at 12-14, ff. Tr. 9336.) While these conclusions are not based on any detailed evaluation of the various discrepancies in Hatfield and Hunter's work over the years, they rest on the judgment of an experienced senior officer of CECo who has viewed the QA program in its totality over the years. Mr. Behnke specifically recognized that a number of construction discrepancies had been uncovered with respect to Hunter and Hatfield's work, but concluded that discovery of these discrepancies was an indication that the QA program is functioning

effectively. (Behnke, prepared testimony at 12, ff. Tr. 9336.) However, as noted in FF 166C, such self-serving generalizations are entitled to little weight. ~~We note that none of Mr. Behnke's conclusions were challenged on cross examination.~~

192. (So, too, did Mr. Del George's testimony) that his confidence in the Hatfield and Hunter work quality at Byron was based in part on the many independent layers of inspection and review of the work of Hatfield and Hunter. (Del George, prepared testimony at 51, ff. Tr. 8406.) He noted that both Hatfield and Hunter had implemented several reinspection programs, apart from the BRP, over the course of their tenure at Byron. Hatfield reinspections included concrete expansion anchor verification in 1979, cable routing reinspection in 1981, and 100% weld traveler card validation and 100% cable pen hanger configuration and dimension reinspection between 1982 and 1984. Hunter reinspections involved a 100% reinspection of all hangers installed prior to 1980, and of all concrete expansion anchors installed prior to 1979. (Del George, prepared testimony at 52, ff. Tr. 8406.) Similarly, Mr. Laney based his engineering judgment on the adequacy of Hatfield and Hunter work in part on the coverage and effectiveness of CECo's quality assurance program (as described in two CECo papers). (Laney, prepared testimony at 26-27, ff. Tr. 9339.)

193. We recognize that the BRP was never intended to make a definitive and all-inclusive statement regarding the adequacy of the Applicant's QA program. However, because of the widespread QA problems at Byron, the BRP was ~~It is only in the presence of a quality assurance breakdown that a reinspection program can~~

required as an after-the-fact ~~serve as a~~ substitute for a functioning quality assurance program. See, Pacific Gas & Electric Co. (Diablo Canyon Nuclear Power Plant Units 1 and 2), ALAB-763, 19 NRC 571, 582 (1984). ALAB 770 at 19-21; and

~~There is no indication that a quality assurance breakdown took place at Byron.~~ Indeed, the BRP was originally conceived as a response to one Severity Level IV item of noncompliance identified by the Staff in the CAT inspection dealing with inspector qualification. Considering both the record in the remanded proceeding and our findings in our initial decision regarding CECo's QA program, we do not find the program sufficient to provide an appropriate basis for ~~our~~ a conclusion that the work of those contractors is adequate.

194. Following completion of the BRP, two sets of Staff Inspection Reports were issued which relate to Hatfield QC activities. (Del George, prepared testimony at 42, ff. Tr. 8406.)

195. IE Report 454/84-27, 455/84-19 identified two items of non-compliance. The first noncompliance involved failure to incorporate a drawing requirement on cable pan cover installation into an inspection procedure. However, the affected contractor personnel had been trained on the drawing requirement and are believed to have properly implemented it. There is no basis to conclude that inspectors who were trained did not effectively monitor the pan cover installation activities. (Del George, prepared testimony at 43, ff. Tr. 8406.)

196. The second item of noncompliance identified a limited number of discrepant cable pan hangers caused by deficient inspector activity. The majority of the observed discrepancies involved an inspection element only recently applied (fit-up gap) and does not compromise the integrity of previously performed inspections. The valid discrepancies were shown not to be significant. (Del George, prepared testimony at 43-45, ff. Tr. 8406.)

197. IE Report 454/84-09, 455/84-07 identified one apparent item of noncompliance involving a single Hatfield discrepancy report (DR-3382) which dealt with the removal of a cable from a conduit. The discrepancy report inaccurately described the pulling force applied in the removal of that cable, resulting in a deficient engineering evaluation. This event was determined to be an isolated occurrence. (Del George, prepared testimony at 45, ff. Tr. 8406.) This matter is discussed fully, infra, ¶293-297.

198. Taken together, these three items of noncompliance do identify an apparent weakness in translating design requirements into inspection procedures. However these procedural discrepancies have not resulted in major rework on the affected safety-related components. (Del George, prepared testimony at 47, ff. Tr. 8406.) ~~Consequently, our conclusions set forth in ¶ 193 supra on the effectiveness of CESSI's QA program as one basis for supporting the adequacy of Hatfield and Hunter's work remain unchanged.~~

e. NRC Staff Conclusions On Work Quality

199. Mr. Little, on behalf of the NRC Staff, testified that Region III believes that the reinspection of over 160,000 safety-related elements for Hatfield and Hunter, the results of those inspections, and the analysis and disposition of the reinspection findings provide reasonable assurance that the overall quality of the work of those contractors is good. (Little, Staff prepared testimony at 6, ff. Tr. 9510.) When polled by the Board, the members of the Region III Staff panel reinforced this conclusion with their personal views. For example, Mr. Ward testified that with respect to welding Byron is probably the safest plant ever built. (Ward, Tr. 9872, 9910.) Mr. Muffet agreed with Mr. Ward, adding that the Staff review of Byron construction was unusually "critical" in its search for discrepancies. Mr. Muffet concludes that the results of the BRP reinforce the Staff's already positive conclusions about Byron. (Muffet, Tr. 9872.) Messrs. Little, Love and Connaughton each testified that contractor work quality was adequate, even rigorous, and that Byron can be operated safely. These conclusions are based, not only on the results of the BRP, but also on the Region's long and detailed inspection history at Byron. (Little, Tr. 9872-73; Love, Tr. 9875; Connaughton, Tr. 9876-77.) However, see ¶ 166 d above.

200. Moreover, the testimony of William Forney, as it concerns work quality, is entirely consistent with that of the

Region III panel. Mr. Forney testified, vigorously, that the results of the BRP provide assurance that Byron construction quality is adequate. As with the Region III panel, Mr. Forney's conclusions on work quality are based as well on his extensive experience with Byron construction activities. Mr. Forney's point of departure with the testimony of the Staff panel has to do with inferring QC inspector competence from the fact that they did not overlook safety significant deficiencies. (See ¶ 99 above.) As noted therein, ~~Although Mr. Forney's reasoning here is a little vague,~~ one basis for his position appears to be Mr. Forney's very strong belief, based on his experience as the senior resident inspector, that safety-significant discrepancies do not exist at Byron. In Mr. Forney's words:

> [I]t has been Region III's position all along, and . . . mine, that the construction at the Byron plant was good, because we had not discovered obvious hardware problems like we have at other sites. . . .
>
> I feel at this time that the information provided by the reinspection program did, in fact, provide a very large data base to confirm Region III's position that the quality of the Byron site is acceptable and that it is generally good. . . .
>
> And when you couple this with the work . . that the workers do, which I believe to be generally of good quality, the inspection programs [illegible] only does the NRC undertake, but Licensee has inspection programs, they've had reinspection programs, they've had overinspection programs, you have that, coupled with the construction testing before it's turned over to preoperational testing, and when you put those all together and you have the overlap, . . . it's my belief and

> my professional opinion that those together have provided that degree of assurance required by 10 CFR 50, Appendices A and B, as to the requisite safety and health of the public.

(Forney, Tr. 10,044-45). However we do not concur in Mr. Forney's conclusion on this issue. (See ¶¶ 166-166e above.) ~~This being the case, there is simply no reason for Mr. Forney's "miniscule" disagreement with the Staff panel to weigh against our finding that work quality at Byron is adequate. Indeed, Mr. Forney's testimony shows that he believes strongly in the adequacy of Byron work quality.~~

201. James Keppler, the Region III administrator, described his own conclusions and those of the Staff on Byron work quality. His views are perhaps best summed up by the following passage from his testimony:

> I want to take this opportunity to emphasize to the Board that, despite the identification of certain quality assurance problems at the Byron site, my staff and I had, and continue to have, confidence in the quality of completed construction at Byron. This confidence is based on our overall inspection effort and was reinforced by the special team inspection conducted in early 1982. The applicant's reinspection program further reinforced our confidence. Unfortunately, I believe that in the August 1983 hearing we may have failed to convey to this Board our degree of confidence.

(Keppler, prepared testimony at 2, ff. Tr. 10,135).

f. Board Conclusions On Work Quality

202. After thoroughly reviewing the evidence, the Board observes that Applicant has presented numerous bases to support a determination that the quality of the Hatfield and Hunter work at the Byron plant is adequate. We have already found, however, that they are not persuasive. (¶¶166-166e above.)

that Applicant's quality control inspectors were qualified, from which, based on the Appeal Board's observation, an inference of adequate work quality can be made. However, we do not rely on this inference alone. Applicant also presented evidence demonstrating that of all the discrepancies analyzed by Sargent & Lundy, none was found to have design significance. Applicant's evidence also demonstrated that over 160,000 inspections were performed of Hatfield and Hunter work covering a wide range of the work these two contractors performed. Of the approximately 5,000 discrepancies found in all these reinspections, the inherent design conservatisms or margin rendered most of them inconsequential. The fewer than 500 discrepancies that did need to be dispositioned by detailed calculations were all found to be within Code stress allowables and, as noted above, were not design significant. Finally, Applicant's comprehensive QA program adds to our confidence in the adequacy of the Hatfield and Hunter work.

203. Intervenors ~~only really~~ also challenge the overall quality of the Hatfield and Hunter work ~~lies in their assertion that~~ (criticisms of the theory) based upon mathematical statistical inferences ~~could not be made~~ regarding the entire scope of the Hatfield and Hunter work based upon the sample of work reinspected in the Byron Reinspection Program. As noted above, we ~~do not~~ believe that ~~there has been any showing that~~ Applicant's use of statistics was erroneous. ~~In any event, mathematical statisti-~~ (See ¶¶ 178-185 above.)

cal theory played little, if any, role in the conclusions reached by the engineering witnesses. These witnesses made clear that their conclusions were based on engineering judgment. As did the Licensing Board in the recent Shoreham decision when it noted that 10 CFR Part 50, Appendix B, does not require the use of, nor is it the practice in the nuclear industry to utilize, statistical sampling methodology, we specifically decline to base any conclusions regarding work quality on the application of that methodology. We find that the numerous bases presented by Applicant, considered together, demonstrate that the overall quality of the Hatfield and Hunter work at the Byron plant is adequate.

OTHER ISSUES

XI. ADEQUACY OF EQUIPMENT SUPPLIED BY SYSTEMS CONTROL CORPORATION

a. Background

204. Systems Control Corporation ("SCC") is the vendor that supplied safety related electrical equipment to Byron Station, specifically main control panels, local instrument panels, DC fuse panels, cable trays, and cable tray hangers.

205. At the 1983 licensing hearings, evidence was presented of past deficiencies in the implementation of SCC's quality assurance program, some of which led to the assessment of an item of noncompliance by the NRC Staff in an inspection report

dated December 30, 1980. (Intervenors' Exhibit No. 8 - NRC Inspection Report 454/80-01). Based on the evidence of the corrective actions taken with regard to SCC's work, we found that the matter could be resolved by the NRC Staff as a delegable function. Thus, we concluded that there was nothing left to adjudicate with respect to SCC. (I.D., ¶ D-442.) (See ¶ 166c above.)

206. Subsequent to the 1983 licensing hearings, uncorrected weld deficiencies were found on equipment supplied by SCC. It also became apparent that the Applicant had not fully met its commitments with respect to the corrective actions it had taken in response to the December, 1980 item of noncompliance. Through board notifications made by counsel for the Applicant and by the NRC Staff in March and April, 1984, these matters were brought to the attention of the Appeal Board, which then had jurisdiction. (Letter of Michael Miller, dated March 14, 1984; letter of Thomas Novak, NRC Board Notification 84-074, dated April 17, 1984.) Based on this new information, the Appeal Board deemed that the adequacy of the equipment supplied by SCC warranted further exploration in the remanded hearing. (ALAB-770, slip op. at 31-32.) (See ¶ 166 c above.)

207. Evidence presented at the 1983 hearings and the remanded hearings recounted the history and extent of the corrective action program regarding SCC's work. In early 1980, Applicant identified a generic problem with welds on local instrument panels supplied by SCC. At the same time, as the

result of allegations by an SCC, employee, the NRC Staff was conducting an investigation of SCC quality assurance activities (I.D., ¶ D-97-98; Hayes, Connaughton, prepared testimony at 4-5, ff. Tr. 10,478.) To resolve this problem, on February 15, 1980 Applicant implemented an inspection program for local instrument panels. All safety-related local instrument panels shipped prior to that date were inspected at Byron by Pittsburgh Testing Laboratory (PTL) and either repaired and reinspected on site or sent back to SCC for repairs. Local instrument panels initially shipped from SCC after February 15, 1980 were inspected by PTL prior to shipment ("source inspected"). Ultimately, all safety-related local instrument panels were independently inspected by PTL and accepted. (Hayes, Connaughton, prepared testimony at 5, ff. Tr. 10,478.) (See also ¶ 166c above

208. On December 30, 1980, the Staff issued its inspection report concerning its investigation of SCC quality assurance practices and found that Applicant had failed to take timely and effective actions to assure that deficiencies in the SCC quality assurance program and equipment fabrication activities were corrected. (Intervenors' Exhibit No. 8 - NRC Inspection Report 454/80-04..) On January 26, 1981, eleven months after the implementation of the source inspection program described above, Applicant sent a letter to the Director of Inspection and Enforcement for Region III in response to the item of noncompliance. (Hayes, Connaughton, prepared testimony at 5-6 and

Attachment A, ff. Tr. 10,478.) Applicant's January 26, 1981 letter indicated that all safety-related equipment (not just local instrument panels) shipped from SCC since Februar··, 1980 had been source inspected by PTL prior to shipment.*/ (Hayes, Connaughton, prepared testimony at 6, ff. Tr. 10,478.) Subsequently, it was determined that 100 percent source inspections for that eleven month period were performed only for the safety-related local instrument panels. (Hayes, Connaughton, prepared testimony at 6, ff. Tr. 10,478.) Shipments made during that time of other safety-related equipment were only inspected on a sample basis and there were no source inspections for seven main control panels shipped in that period. (Marcus, prepared testimony at 6-7 and Attachment A.) Mr. George F. Marcus, Applicant's Director of Quality Assurance for Engineering and Construction, acknowledged that Applicant failed to fully meet the commitment as stated in the January 26, 1981 letter regarding source inspection of equipment shipped during the period from February, 1980 to January, 1981. (Marcus, prepared testimony at 7-8, ff. Tr. 10,319.) (See ¶ 166 c above.)

209. Nonconformance reports issued by Applicant in late 1983 and early 1984 regarding SCC weld discrepancies led the

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*/ Applicant's Janaury 26, 1981 letter also stated that all future shipments of safety-related equipment would be subject to source inspection. ~~Consistent with that statement~~ Source inspections on a sample of each SCC shipment were performed subsequent to January 26, 1981. (Hayes, Connaughton, prepared testimony at 6, ff. Tr. 10,475.) (See ¶ 166 c above.)

NRC Staff to believe that SCC quality control inspections, as well as Applicant's corrective actions, had not been effective. (Hayes, Connaughton, Muffett, prepared testimony at 8, ff. Tr. 10,478.) Thus, the NRC Staff took the position that Applicant had to demonstrate that all equipment supplied by SCC as built is able to withstand as-built loads in conformance with applicable codes. (Hayes, Connaughton, Muffett, prepared testimony at 8, ff. Tr. 10,478.)

210. Applicant's primary witnesses on this matter were Mr. Bradley F. Maurer and Mr. Kenneth T. Kostal. Together, their testimony described the showing that Applicant has made to the NRC Staff to demonstrate the adequacy of the SCC equipment. Mr. Maurer, a Senior Engineer with the Equipment Qualification Analysis Department of the Water Reactor Division of Westinghouse Electric Corporation, described the inspections and analyses that were performed by Westinghouse to address the structural adequacy of the main control panels. (Maurer, prepared testimony, ff. Tr. 10,158.) Applicant retained Westinghouse in 1982 to evaluate the SCC main control panels. Westinghouse had previously been conducting similar evaluations on the main control panels supplied by Westinghouse which monitor and control the nuclear steam supply functions. (Maurer, prepared testimony at 5-6, ff. Tr. 10,158.)

211. Mr. Kostal, a Partner and Assistant Manager of the Structural Department of Sargent & Lundy, detailed the inspec-

tions and evaluations performed by Sargent & Lundy of the SCC DC fuse panels, cable trays, cable tray hangers, and local instrument panels. (Kostal, prepared testimony, ff. Tr. 10,159.) Sargent & Lundy's conclusions regarding the adequacy of those components which were only inspected on a sample basis are supported by a statistical analysis performed by Dr. Anand K. Singh, a structural engineer and Assistant Head for Sargent & Lundy's Structural Analytical Division. (Singh, prepared testimony, ff. Tr. 10,160.)

212. The NRC Region III Staff presented a panel of three witnesses who described their review and evaluation of the analyses which were performed by Westinghouse and Sargent & Lundy.*/ The panel was comprised of Messrs. K. A. Connanghton, D. W. Hayes, and James Muffet, all of whom have been identified previously in conjunction with their testimony regarding the

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*/ The NRC Staff witnesses also addressed Applicant's procurement practices with respect to SCC. The NRC Staff believed that ¶D-105 of our Initial Decision, which stated that Applicant had barred SCC indefinitely from procurement activities on safety-related puchases, should be qualified to indicate that, although new purchase orders did not issue after January, 1978, Applicant did procure additional safety-related items from SCC through change orders to existing orders. (Connaughton, prepared testimony at 8, ff. Tr. 10,478.) Applicant objected to this testimony as being beyond the scope of the remanded hearings and irrelevant to any of the admitted issues. (Tr. 10,467-69.) Although we agree with Applicant that procurement practices is not an issue and is unimportant to the issue of the adequacy of the SCC equipment, we admitted this testimony into evidence for the limited purpose of clarifying the nature and extent of the practices associated with the purchases. (Tr. 10,475-76.) (See ¶166 c above.)

Reinspection Program. (Hayes, Connaughton, Muffet, prepared testimony, ff. Tr. 10,478.) Except for a few concerns raised by Mr. Stokes which are disposed of below, Intervenors presented no witnesses addressing the adequacy of the SCC work, instead relying on their cross examination of Applicant's and the NRC Staff's witnesses.

213. In addition to the Westinghouse and Sargent & Lundy inspections and evaluations, and the subsequent NRC Staff review thereof, Applicant sponsored the testimony of Mr. Louis D. Johnson, a mechanical engineer and Manager of Projects for Torrey Pines Technology ("Torrey Pines"). (Johnson, prepared testimony, ff. Tr. 10,294.) Torrey Pines conducted a further review of the SCC equipment and components. The purpose of the Torrey Pines review was to provide a third-party opinion on the adequacy of the safety-related SCC hardware at Byron. The personnel used in the Torrey Pines review were either qualified inspectors or engineers experienced in the fields of structural analysis, quality assurance, statistics, mechanical systems, and project management. (Johnson, prepared testimony at 12, ff. Tr. 10,294.)

214. The Torrey Pines review encompassed all of the SCC components: main control panels, DC fuse panels, cable trays, cable tray hangers, and local instrument panels. The Torrey Pines review program included the following tasks for each component: collection of all records pertinent to the accepta-

Mr. Johnson testified to a series of problems in obtaining adequate records concerning SCC equipment, much of which did not exist. (See, e.g., Tr. 10,294 et seq.)

bility of SCC items; a review of records and evaluation of their objectivity; an engineering evaluation of the technical bases used to substantiate the acceptability of SCC items; identification of samples of the SCC work for reinspection; and documentation of any discrepancies found during the Torrey Pines reinspection between an observed condition and a required condition. (Johnson, prepared testimony at 9-12, ff. Tr. 10,294.)

215. The results of the various evaluations demonstrate that, except for one discrete area still under review and delegable to the NRC Staff for final resolution, the SCC work at the Byron Station is adequate to accept design loads without exceeding the code-allowable stresses. Based on this uncontroverted evidence, we conclude that the quality of the SCC work is acceptable. The bases for this conclusion is discussed below.

b. Main Control Panels

216. The main control panels are located in the main control room and house various controls, monitors and instruments necessary for all aspects of operation of the Byron Station. The main control panels comprise the main control board, which is a U-shaped assembly of separate panels. Main control panels also stand alone or in panel line-ups in the main control room apart from the main control board. (Maurer, prepared testimony at 5-6, ff. Tr. 10,158.)

217. To determine the structural adequacy of the main control panels to withstand seismic loadings, Westinghouse performed a detailed computer analysis using finite element modeling techniques. By this method, the structural elements of the main control panel are modeled by mathematical representations and the seismic loadings are determined by using the appropriate response spectra at the elevation of the main control room. Moreover, it was assumed that the welds were adequate to keep the joints in a fixed condition and thus able to transmit loads. The finite element modeling analysis thereby determined the loads and stresses on each structural member. (Maurer, prepared testimony at 7-8, ff. Tr.10,158; Maurer, Tr. 10,169, 10,284.)

218. To assure that the finite element analysis addressed the as-built condition of the control panel welds, Mr. Maurer, accompanied by a Westinghouse Level II welding engineer, visually inspected all of the accessible welds in each of the control panels in the main control room. (Maurer, prepared testimony at 8-9, ff. Tr. 10,158.) The minimum values for weld length and size found as a result of the visual inspection (the "lower bound weld cond[illegible]"), and the maximum seismic loads acting on each type of structural member as determined by the finite element analysis, were then applied in a calculation to determine whether specific welded connections would have sufficient strength to withstand applied loads. (Maurer, prepared

testimony at 10, ff. Tr. 10,158; Maurer, Tr. 10,310-11, 10,165-67, 10,283-84.) The maximum stress calculated was found to be within the allowable stress criteria prescribed by the applicable codes. (Maurer, prepared testimony at 11, ff. Tr. 10,158; Maurer, Tr. 10,284.) In view of the margin of safety present in the construction of the main control panels, Mr. Maurer concluded that the structural integrity of the Byron main control panels, including those supplied by SCC, will be maintained in the event of design basis earthquake for the Byron Site. (Maurer, prepared testimony at 11-13, ff. Tr. 10,158.)

219. NRC Region III Staff witness Mr. Muffett reviewed the Westinghouse analysis of the structural adequacy of the main control panels, and further reviewed correspondence between Sargent & Lundy and Westinghouse regarding the analytical methodology applied. From this review, Mr. Muffett concluded that the Westinghouse analysis demonstrated that stresses in the structural members and welds of the main control panel are within code allowable stresses and accordingly found this equipment acceptable. (Muffett, prepared testimony at 8-9, ff. Tr. 10,478.)

220. Torrey Pines reviewed the seismic analysis performed by Westinghouse of the main control panels and confirmed the validity of that analysis. Further, Torrey Pines conducted its own reinspection of one of the main control panels. This inspection verified that the weld discrepancies found were com-

parable to discrepancies identified on main control panels in previous weld inspections. The Torrey Pines review also found that redundant load paths were present in the structure of the main control panels, and that significant design margins were present in the components of the main control panels. Based on these findings of Torrey Pines, Mr. Johnson concluded that the safety-related main control panels were capable of accepting design loads without exceeding code-allowable stresses. (Johnson, prepared testimony at 13-18, ff. Tr. 10,294.)

221. Intervenors' witness, Mr. Stokes, expressed concern over the reported use of tack welds and Bondo, an auto body repair compound, in the repair of main control board panels. (Stokes, prepared testimony at 22-24 and attachments 12, 13, ff. 10,770.) Specifically, Mr. Stokes questioned this practice when design drawings call for full penetration welds. Further, Mr. Stokes postulated that the Bondo could crack and cause particles to lodge in contact switches. (Stokes, prepared testimony at 23, ff. 10,770.)

222. In rebuttal, Mr. Maurer explained that epoxy resin surface filler such as Bondo was used by both SCC and Westinghouse to repair surface marks or scratches on the main control panels. (Maurer, prepared rebuttal testimony at 2-3, ff. Tr. 11,158.) However, in three instances it was discovered that Bondo was used for other than cosmetic purposes. In three locations on the face of the main control panels, steel plates

had been tack welded and filled with epoxy resin surface filler rather than welded with full penetration welds. (Maurer, prepared rebuttal testimony at 3, ff. Tr. 11,158.) To repair these conditions, the steel plates were welded using full penetration welds. (Maurer, prepared rebuttal testimony at 3, ff. Tr. 11,158.) In addition, a complete inspection of all of the main control panels supplied by Systems Control and Westinghouse was performed and no other instances of tack welded plates with Bondo were found. (Maurer, prepared rebuttal testimony at 3-4, ff. Tr. 11,158.)

223. In the course of their cross examination of the Staff witnesses, Intervenors also raised the question of whether the full penetration welding repair could cause unacceptable warping of the main control panels. (Tr. 10,528-29.) Mr. Maurer explained that the welding of the steel plates was performed using techniques that limited the heat build up, thus, minimizing the potential for warping of the panels. (Maurer, prepared rebuttal testimony at 4, ff. Tr. 11,158; Connaughton, Tr. 10,517-18.) Moreover, the panels were inspected upon completion of the welding and no warpage was found. (Maurer, prepared rebuttal testimony at 4, ff. Tr. 11,158.)

224. Mr. Maurer also explained, in response to Mr. Stokes' other concern, that it is not possible for particles of Bondo to become lodged in a safety-related control switch since those switches are enclosed to protect the contacts from dirt and

debris. (Maurer, prepared rebuttal testimony at 4, ff. Tr. 11,158.)

225. Mr. Stokes also questioned whether SCC had been allowed to write its own acceptance criteria to close out NCR-F-544. This NCR was issued in August, 1980, and it indicated that certain main control panels did not meet the AWS Code. (Stokes, prepared testimony at 24, ff. Tr. 11,158.) Mr. Maurer explained that SCC did not supply the acceptance criteria to close out the nonconformance report. Rather, Westinghouse established the criteria in accordance with AWS D1.1 (Maurer, prepared rebuttal testimony at 5, ff. Tr. 10,770.) The results of the Westinghouse inspection of the welds in the main control panels have already been discussed in this decision, and the conclusion renders moot any concerns raised by the nonconformance report. (Maurer, prepared rebuttal testimony at 5, ff. Tr. 11,158; Maurer, prepared testimony at 8-10, ff. Tr. 10,158; Connaughton, Tr. 10,520.)

c. DC Fuse Panels

226. Four DC fuse panels were supplied to Byron by SCC. These cabinet-type structures are used to house the fuses and relays which protect the DC electrical system. The fuses and relays are mounted to the internal structural steel members of the panels. (Kostal, prepared testimony at 45-46, ff. Tr. 10,159.)

227. In 1981 discrepant welds were found on the SCC DC fuse panels during an inspection by Sargent & Lundy level III

inspectors. Of the 2,170 welds inspected, 986 were found discrepant. In addition stitch welds were missing on one location in one of the panels, Panel No. 2DC10J. These inspection results caused Applicant to question the efficacy of a seismic qualification analysis of the DC fuse panels performed by Wiley Laboratories in 1980. Consequently Sargent & Lundy was requested to requalify these four DC fuse panels by performing a further analysis. (Kostal, prepared testimony at 46-47, ff. Tr. 10,159.)

228. The 1980 Wyle Laboratory seismic qualification test consisted of a resonance test and a "shake table" test performed on one of the DC fuse panels, Panel No. 1DC10J. The latter test simulated the ground motion to be experienced by the DC fuse panels during the design basis earthquake. The panel tested by Wyle contained the discrepancies discovered by Sargent & Lundy in 1981. Consequently, the Sargent & Lundy requalification analysis compared the discrepant weld conditions in the other three panels with the discrepancies in the Wyle-tested panel to determine equivalency. Based on this analysis, two of the non-tested panels were found to have greater effective weld than the Wyle-tested panel, thus those two panels were determined to be equivalent to the tested panel and were therefore considered seismically qualified. (Kostal, prepared testimoney at 48, ff. Tr. 10,159.)

229. The panel with the missing stitch welds, Panel No. 2DC10J, was found in one location to have less effective weld

quantity than the Wyle-tested panel. Sargent & Lundy performed a finite element model computer analysis of that panel to determine whether it was equivalent to the Wyle-tested panel for purposes of seismic qualification. The finite element model incorporated the as-built condition of the panel, including the missing welds. The computer analysis utilizing this model determined that the dynamic characteristics of the panel were similar to the dynamic characteristics found in the Wyle-tested panel. (Kostal, prepared testimony at 48-49, ff. Tr. 10,159.) Thus, Mr. Kostal concluded that panel 2DC10J is equivalent to the Wyle-tested DC fuse panel in terms of seismic qualification. (Kostal, prepared testimony at 49, ff. Tr. 10,159.) Further, Sargent & Lundy determined that all stresses in the members and the weld are well within code-allowables. (Kostal, prepared testimony at 49-50, ff. Tr. 10,159.)

230. The NRC Region III Staff reviewed the Sargent & Lundy analysis of the DC fuse panels and concluded that the structural adequacy of the DC fuse panels had been demonstrated. (Muffett, prepared testimony at 10-11, ff. Tr. 10,478.)

231. Torrey Pines also concluded that the DC fuse panels were adequate for design use. (Johnson, prepared testimony at 20, ff. Tr. 10,294.) Torrey Pines reviewed the seismic qualification testing on the DC fuse panel performed by Wyle Laboratories and independently inspected 47 welds in the DC fuse panels which revealed three nonsignificant discrepancies.

(Johnson, prepared testimony at 20-21, ff. Tr. 10,294.) Based on its inspection and review, Torrey Pines concluded that the non-tested DC fuse panel can be deemed equivalent to the tested panel for the purposes of seismic qualification. (Johnson, prepared testimony at 21, ff. Tr. 10,294.) Torrey Pines also found that the structure of the DC fuse panels has redundant load paths which do not depend on single welds or single weld connections for structural integrity and that there was significant design margin in the construction of the DC fuse panels. (Johnson, prepared testimony at 21, ff. Tr. 10,294.) Torrey Pines also reviewed the finite element model computer analysis performed by Sargent & Lundy on the one panel found by Sargent & Lundy to have a weld quantity less than the Wyle-tested panel. Based on this review, Torrey Pines concluded that Sargent & Lundy properly conducted that analysis, thus validating its conclusion. (Johnson, Tr. 10,299-300.)

d. Cable Trays

232. Cable trays supplied by SCC are used to support and protect electrical cables in the Byron Station. A majority of the cable trays are constructed of sheet metal formed into troughs 12 to 30 inches wide and 4 to 6 inches deep. (Kostal, prepared testimony at 24 and Figure 7, ff. Tr. 10,159.) These flat bottomed trays have V-shaped sheet metal stiffeners stitch welded across their bottom at 5 feet intervals to provide additional support. (Kostal, prepared testimony at 24 and Figure

8, ff. Tr. 10,159.) Cable tray fittings are used to accommodate changes of directions in a cable tray run, to connect cable tray intersections, or to adapt trays of different sizes. (Kostal, prepared testimony at 24 and Figures 2, 7, ff. Tr. 10,159.) Less than three percent of the entire length of cable trays is comprised of ladder-type cable trays and ladder-type tray fittings. Ladder cable trays are constructed by connecting two sheet metal side channels with pipe rungs at approximately 12 inch intervals. (Kostal, prepared testimony at 25 and Figure 10, ff. Tr. 10,159.) T-type ladder tray fittings are used to join intersecting ladder trays and are constructed in a similar manner to straight ladder trays. (Kostal, prepared testimony at 25, ff. Tr. 10,159.) Sargent & Lundy performed engineering evaluation on all these types of cable trays and fittings. (Kostal, prepared testimony at 25, ff. Tr. 10,159.)

Cable Tray Stiffeners

233. Discrepant welds on cable tray stiffeners were identified in July, 1980. To address this issue, a random sample of stiffeners was inspected, encompassing cable trays and fittings from all building floor elevations. (Kostal, prepared testimony at 26, ff. Tr. 10,159.) This inspection, conducted by Pittsburgh Testing Laboratories and verified by Applicant's site quality assurance personnel, found weld in excess of the minimum amount required by design on all of the 227 stiffeners

inspected. (Kostal, prepared testimony at 26-27, ff. Tr. 10,159.) Subsequently, at the request of the NRC Staff, the same stiffeners were reinspected for weld quality. This reinspection found weld discrepancies on each stiffener. The weld discrepancies found included lack of fusion, undersize, craters, undercut, and porosity. (Kostal, prepared testimony at 27, ff. Tr. 10,159). In addition, small linear crack indications approximately 1/4 inch in length were observed. These cracks were determined to be non-propogating. (Kostal, prepared testimony at 27, ff. Tr. 10,159.)

234. Sargent & Lundy's engineering evaluation of the discrepant welds, which conservatively deleted the discrepant portion of the weld from total weld length, determined that all welds were adequate to transfer design loads. (Kostal, prepared testimony at 27, ff. Tr. 10,159.) An additional engineering evaluation of the stiffeners which were found to have the small crack indications conservatively assumed the complete absence of the stiffener from the cable tray. This additional evaluation showed that the complete absence of tray stiffeners is not significant to the design, and cable trays will carry design loads even without stiffeners. (Kostal, prepared testimony at 28-29, ff. Tr. 10,159). Based on these evaluations, Sargent & Lundy concluded that the stiffeners supplied by SCC to Byron are adequate to carry design loads. (Kostal, prepared testimony at 28-29, ff. Tr. 10,159.)

235. The NRC Region III Staff reviewed Sargent & Lundy's analysis of the effect of a missing cable tray stiffener on cable tray design and generally agreed with the conclusion that the stiffeners are not required to carry the design loads. (Muffett, prepared testimony at 14-17, ff. Tr. 10,478.) However, the NRC Staff did observe that the load combination methodology used by Sargent & Lundy did not adhere to the methodology to which the Byron plant is committed pursuant to its FSAR. (Muffett, prepared testimony at 16, ff. Tr. 10,478.) In response to this concern, Sargent & Lundy performed a re-analysis using the appropriate combination methodology. This re-analysis has been received and reviewed by the NRC Staff and found to be acceptable. (Muffett, Tr. 10,479-480.)

236. Based on its review of the Sargent & Lundy analysis of SCC cable trays, Torrey Pines concluded that the Sargent & Lundy evaluation provides a valid demonstration of the adequacy of the SCC cable trays. (Johnson, prepared testimony at 37-38, ff. Tr. 10,294.) Torrey Pines' conclusion regarding the validity of Sargent & Lundy's evaluations is supported by the results of its own inspection of the cable trays. (Johnson, prepared testimony at 38-39, ff. Tr. 10,294.) Further, Sargent & Lundy's conclusion is supported by the results of other cable tray inspections performed over the years, the presence of redundant load paths in the structure of the cable trays, and

the significant design margin in the cable trays. (Johnson, prepared testimony at 39-40, ff. Tr. 10,294.)

Cable Tray Fittings

237. Cable tray fittings were inspected in 1977 as part of an overall response to a nonconformance report regarding SCC welder qualifications and procedures. 99 out of the approximately 1200 fittings then present at Byron were inspected by Industrial Contract Services for the purpose of determining SCC weld quality. Four fittings were found to have side channel weld discrepancies, including lack of fusion, porosity, and a missing weld attaching a corner bent plate to the cable tray side channel. An engineering assessment performed at that time of the weld discrepancies concluded that none of them had design significance. This conclusion was based on the presence of alternate load paths available to transfer loads through the fitting around the discrepant fitting weld. (Kostal, prepared testimony at 29-30, ff. Tr. 10,159.)

238. In June, 1984, an additional engineering evaluation by Sargent & Lundy confirmed that the fitting welds are not required to meet structural load-carrying requirements for any fitting because of the presence of alternate load paths to carry the cable loading through the tray fittings. (Kostal, prepared testimony at 30, ff. Tr. 10,159.) However, the evaluation determined that in one configuration, involving the outside fitting weld of a 90 degree fitting, only one load bearing

redundancy exists, and that is the redundancy offered by the fitting stiffener. (Kostal, prepared testimony at 31, ff. Tr. 10,159.) In order to ensure that either the outside weld or the stiffener weld is present at each 90 degree fitting, all such fittings were inspected. (Kostal, prepared testimony at 31, ff. Tr. 10,159; Kostal, Tr. 10,234-35.) The inspection found that all of the outside fitting welds were present. (Kostal, prepared testimony at 31, ff. Tr. 10,159; Kostal, Tr. 10,234-35.)

239. The NRC Region III Staff reviewed the Sargent & Lundy evaluation of the cable tray fittings and concurred in the conclusion that fitting welds are not required to carry the design loads except where the fitting stiffener weld is missing. (Muffett, prepared testimony at 15-16, ff. Tr. 10,478.) Upon hearing Mr. Kostal's testimony that the inspection had been completed and that all outside fitting welds were found to be in place, Mr. Muffett expressed confidence that the reinspection effort with respect to cable tray fittings had been concluded and indicated satisfactory welding on those fittings. (Muffett, Tr. 10,521.)

Ladder Cable Trays and Fittings

240. A recent inspection of ladder cable trays and fittings supplied by SCC found that a particular weld called a "horizontal weld," prescribed in the design drawings, was generally missing. This weld was one of two welds contemplated

for use to connect the tray rungs to the side channel to the ladder cable tray. The discovery of the missing welds prompted a further inspection to assure the adequacy of the trays. The inspection, which included a random sample of 17 straight sections of ladder tray encompassing 300 weld connections, disclosed several weld discrepancies. No welds were missing (other than the horizontal welds as noted above) and no cracks were observed. (Kostal, prepared testimony at 33, ff. Tr. 10,159.) In addition, 10 randomly selected ladder tray fittings were inspected and it was thereby verified that the welded connections there are similar to those found in the straight sections of ladder trays. (Kostal, prepared testimony at 33, ff. Tr. 10,159.)

241. Sargent & Lundy performed engineering evaluations to determine whether the inspected ladder trays could adequately support the design loads given the missing horizontal welds and the identified weld discrepancies. (Kostal, prepared testimony at 33, ff. Tr. 10,159.) The results of these evaluations showed that the ladder cable trays were structurally adequate, assuming the absence of the horizontal welds, and that none of the weld discrepancies had design significance. (Kostal, prepared testimony at 34, ff. Tr. 10,159.) Thus, the ladder trays and ladder tray fittings supplied by SCC were determined to be of adequate quality. (Kostal, prepared testimony at 34, ff. Tr. 10,159.)

242. The NRC Region III Staff reviewed the Sargent & Lundy analysis of the structural adequacy the ladder cable trays and fittings and, with one reservation, concurred with Sargent & Lundy's conclusion. (Muffett, prepared testimony at 13-14, ff. Tr. 10,478.) The NRC Staff believed that the Sargent & Lundy method for calculating the strength of those weld connections where the pipe rung on a ladder tray fitting intersects the side channel at a 45 degree angle should be refined to take into account the reduction in effective weld throat at such intersections. (Muffett, prepared testimony at 14, ff. Tr. 10,478.) In response to the NRC Staff's concern, Sargent & Lundy performed recalculations incorporating the suggested refinement. The NRC Staff has received and reviewed the re-analysis and found it acceptable. (Muffett, Tr. 10,479.)

243. Torrey Pines also conducted a review of the Sargent & Lundy analysis of the ladder cable trays and fittings supplied by SCC. Based on that review, Torrey Pines confirmed that the as-built condition of the ladder cable trays and fittings is adequate to accept design loads. (Johnson, Tr. 10,302-03.)

Conclusion Regarding Cable Trays

244. Based on the absence of any design significant weld discrepancies on SCC cable tray work, the load bearing redundancies present in the cable tray system, and the conservative design of the cable trays and conservative analytical criteria used by Sargent & Lundy, we conclude that the quality of the

cable trays supplied by Systems Control, including solid-bottom trays and fittings and ladder trays and fittings, is adequate. (Kostal, prepared testimony at 34-37, ff. Tr. 10,159; Kostal, Tr. 10,235; Johnson, prepared testimony at 37-41, ff. Tr. 10,294; Johnson, Tr. 10,302-03; Muffett, prepared testimony at 12-16, ff. Tr. 10,478; Muffett, Tr. 10,479-80, 10,521.)

e. Cable Tray Hangers

245. Cable tray hanger assemblies supplied by SCC are installed to support the cable trays. A typical assembly has horizontal and vertical members that are joined by connections which are comprised of welds applied in the shop by SCC and welds applied in the field by Hatfield Electric Company, the contractor responsible for hanger installation. (Kostal, prepared testimony at 10-11, ff. Tr. 10,159.)

246. Mr. Kostal detailed the several engineering evaluations that have been performed on varying aspects of the cable tray hanger system over last several years, none of which ever found any weld discrepancies of design significance. (Kostal, prepared testimony at 12-20, ff. Tr. 10,159.) The most significant of these evaluations was conducted in 1984 pursuant to Applicant's nonconformance reports regarding weld quality discrepancies found by Hatfield Electric Company on the SCC shop welds. (Kostal, prepared testimony at 12, ff. Tr. 10,159.) To address the general concern for SCC weld quality, Sargent & Lundy identified for weld inspection a random sample of 80

hangers out the population of 5717 SCC cable tray hangers at the Byron Station. The sample captured all commonly used connection types, and 44 connections that were deemed to be highly stressed. (Kostal, prepared testimony at 12-13, ff. Tr. 10,159.) The 80 selected hangers included 358 SCC shop-welded connections. Of these, 252 were found to have no discrepancies, and 106 were found to have some form of discrepancy such as underlength, undersize, overlap, undercut, and craters. Two of the discrepant connections were missing portions of welds. No cracks were found on the welds. (Kostal, prepared testimony at 12-13, ff. Tr. 10,159.)

247. Sargent & Lundy's engineering evaluation of the discrepant SCC hanger welds conservatively deleted the discrepant portion of the weld from the total weld length, and new connection capacities were thereby calculated. (Kostal, prepared testimony at 13, ff. Tr. 10,159.) Comparison of these newly calculated connection capacities against the design capacities showed that none of the discrepant welds had design significance. (Kostal, prepared testimony at 13, ff. Tr. 10,159.)

248. A further analysis was performed with respect to the most discrepant welds identified during the inspection program. Detailed computer models were developed for the three hanger assemblies which contained the three welds found during the evaluation of the 358 connections to have the greatest reductions in load capacity. All identified weld discrepancies

for each of those hanger assemblies were incorporated in the computer model. The analysis of this model redistributed the loads among the hanger connections to reflect the presence of weld discrepancies. This analysis showed that despite the reduction in weld capacity, there remained a design margin of at least a factor of three, that is, each of the three hanger assemblies analyzed could accommodate three times the design load without exceeding code-allowable stress for any of the connections or structural members. (Kostal, prepared testimony at 14-15, ff. Tr. 10,159; Kostal, Tr. 10,241.)

249. Although the two instances of missing portions of welds on the SCC cable tray hanger connections were evaluated and found to be without design significance, they caused the greatest amount of capacity reduction in the evaluated connections. The greatest capacity reduction was found to be 53 percent. (Kostal, Tr. 10,261-62.) To assure that missing welds do not compromise the adequacy of other connections, an additional inspection program was undertaken. This program called for every connection which cannot accommodate a capacity reduction of 53 percent when subjected to design loads to be inspected for missing portions of welds. (Kostal, prepared testimony at 23, ff. Tr. 10,159; Kostal, Tr. 10,243-248, 10,255-256.) The program also called for any welds found to be missing a portion of weld to be evaluated and restored if required by design. (Kostal, prepared testimony at 23, ff. Tr. 10,159.)

250. There are approximately 3000 SCC hanger connections which cannot accomodate a 53 percent capacity reduction under design loads. (Muffett, Tr. 10,506.) At the time of Mr. Kostal's testimony, the additional inspection program was approximately 30 percent completed. (Kostal, Tr. 10,256.) By the time the NRC Staff witnesses testified, slightly more than two weeks later, that program had been completed and had identified at least one instance where a hanger connection capacity was reduced by more than 53 percent. (Muffett, Tr. 10,507.)

251. Because of the finding of an instance where a missing weld caused a hanger connection capacity reduction in excess of 53 percent, the inspection program was expanded to include inspection of all accessible SCC hanger connections for missing welds. (Muffett, prepared testimony at 17-18, ff. Tr. 10,478.) In addition, all SCC DV-8 and DV-8(a) type connections are being reinspected, regardless of their accessibility, i.e. fireproofing or block walls will be removed to access these connections. (Muffett, Tr. 10,484, 10,488-489.) The DV-8 and DV-8(a) connections are being 100 percent inspected since they have been found to have had the most discrepancies, including the missing welds. (Muffett, Tr. 10,484.)

252. Under the expanded hanger connection inspection program, if a portion of a missing weld is found, an evaluation will be performed to determine whether the capacity of the con-

nection is reduced by greater than 53 percent. (Muffett, Tr. 10,512.) If any hanger connection is found to have a capacity reduction in excess of 53 percent, the program will be further expanded to include all inaccessible connections. (Muffett, Tr. 10,483, 10,512-13.) However, further expansion of the inspection program may not be necessary if Applicant can demonstrate the NRC Region III Staff circumstances associated with the connection which would obviate the necessity of inspecting all inaccessible connections on the hangers. (Muffett, Tr. 10,483-84.)

253. The expanded hanger connection inspection program is an extensive undertaking. There are approximately 10,000 DV-8 and DV-8(a) connections, accessible and inaccessible, and approximately 20,000 connections of all other types, 80 to 90 percent of which are accessible and therefore subject to the expanded reinspection program. (Muffett, Tr. 10,488.) At the time of the hearings, Applicant had established a procedure for conducting the expanded program of inspection for missing welds on SCC cable tray hanger connections. This procedure was reviewed by the NRC Region III Staff and found to be acceptable for the purpose of determining the acceptability of the installed cable pan hangers. (Muffett, prepared testimony at 17-18, ff. Tr. 10,478; Muffett, Tr. 10,480-81, 10,500; NRC Staff Exhibit R-1 "Instruction for Walkdown of Cable Tray Hanger Connection Welds, Byron Station.")

254. Although the results of the expanded inspection program were not yet available at the time of the hearings, we find no need to hold the record open for its results. (Tr. 11, 169-71.) We conclude that responsibility for final resolution of the adequacy of the SCC cable tray hangers may be appropriately delegated to the NRC Region III Staff. As a basis for this conclusion, we note that the expanded inspection program for SCC cable tray hangers calls for a 100 percent inspection of all accessible hanger connections for missing welds. This is a task requiring little subjective or skilled analysis. (Tr. 10,253.) All that remains to be done is to confirm that this work is completed and that any necessary repairs are made. The NRC Region III Staff's acceptance of the expanded inspection program confirms our judgment that the program will adequately resolve any question as to the quality of the SCC cable tray hangers.

f. Local Instrument Panels

255. Local instrument panels are located throughout the Byron plant and are used to support instruments which monitor and control functions and equipment located in proximity to the panels. SCC supplied 76 local instrument panels to the Byron Station. The panels are four feet or eight feet wide and are constructed of horizontal, vertical and angular steel members joined by welded connections. (Kostal, prepared testimony at 37-38 and Figures 11, 12, ff. Tr. 10,159.)

256. As stated previously in the background discussion of this section, a 100 percent reinspection of the SCC local instrument panels was performed by PTL after the discovery in 1980 of discrepant welds in the panels. Weld discrepancies on the local instrument panels discovered during the PTL reinspection were repaired to preserve the validity of prior seismic qualification tests conducted by Wyle Laboratories. These tests concluded that all local instrument panels fabricated by SCC were seismically qualified as long as their fabrication conformed with the fabrication drawings and specifications that were used in the fabrication of the panel tested by Wyle Laboratories. (Kostal, prepared testimony at 38-40, ff. Tr. 10,159.)

257. However, in June, 1984, during the course of its sample inspection of seven of the SCC local instrument panels, Torrey Pines found 17 weld discrepancies. The Torrey Pines inspection encompassed 205 welds, which is approximately 10 percent of the total number of welds on the sample of seven panels. Three of the panels had no discrepancies. (Kostal, prepared testimony at 40-41, ff. Tr. 10,159; Johnson, prepared testimony at 23-24, ff. Tr. 10,294.)

258. The Torrey Pines inspection findings raised the possibility that the as-built condition of the non-tested local instrument panels might be sufficiently different from the condition of the Wyle-tested panel such that the seismic qualifi-

cation test results could not be used as a basis for reaching conclusions regarding the seismic qualification of all remaining local instrument panels. (Johnson, prepared testimony at 28-29, ff. Tr. 10,294.) Thus, Applicant implemented a weld inspection program to confirm that the local instrument panels installed at Byron were sufficiently equivalent to the Wyle-tested panel to warrant application of the seismic test results to the entire population of local instrument panels. (Johnson, prepared testimony at 28; Kostal, prepared testimony at 41, ff. Tr. 10,159.)

259. Under this new weld inspection program, Sargent & Lundy Level III weld inspectors inspected 17 of the local instrument panels including the Wyle-tested panel. (Kostal, prepared testimony at 41-42, ff. Tr. 10,159.) A total of 389 connections, encompassing 1455 welds, were inspected. (Kostal, prepared testimony at 42, ff. Tr. 10,159.) The inspection found 271 discrepancies, none of which were cracks or missing welds. (Kostal, prepared testimony at 42, ff. Tr. 10,159.) Based on comparisons of the total effective weld, Sargent & Lundy found the untested panels are equivalent to the Wyle-tested panel for purposes of application of the seismic qualification. (Kostal, prepared testimony at 43, ff. Tr. 10,159.) Sargent & Lundy thus concluded that the entire population of SCC local instrument panels at the Byron Station is in sufficiently equivalent condition to the Wyle-tested panels to jus-

tify application of the seismic qualification test results to the non-tested panels. (Kostal, prepared testimony at 43-44, ff. Tr. 10,159.)

260. Sargent & Lundy's conclusion is further supported by a computer analysis it performed utilizing a finite element model of one of the local instrument panels. A dynamic analysis of the model found that the model shared similar dynamic characteristics with the Wyle-tested panel. (Kostal, prepared testimony at 44, ff. Tr. 10,159.) The analysis also showed that the most highly stressed connection was stressed to only 10 percent of the code-allowable stress. Further, application of the greatest reduction in weld capacity that was identified in the inspections of the local instrument panels to the most highly stressed connection showed that connection to be stressed to only 12 percent of its code-allowable stress, thus indicating a design margin factor of at least eight in all local instrument panel connections. (Kostal, prepared testimony at 44-45, ff. Tr. 10,159.) Thus, Sargent & Lundy concluded that the quality of the SCC local instrument panels is adequate. (Kostal, prepared testimony at 45, ff. Tr. 10,159.)

261. Torrey Pines also concluded that the SCC local instrument panels are adequate for design use. (Johnson, prepared testimony at 24, ff. Tr. 10,294.) Torrey Pines' conclusion is based on its review of the seismic qualification testing performed by Wyle Laboratories, and the equivalency of

the seven local instrument panels inspected by Torrey Pines to the Wyle-tested panel. (Johnson, prepared testimony at 24-27, ff. Tr. 10,294.) Torrey Pines' conclusion is also based on the presence of redundant load paths in the panels' components and the significant design margin in the construction of the panels. (Johnson, prepared testimony at 27-28, ff. Tr. 10,294.) Torrey Pines also reviewed the recent inspection and evaluation performed by Sargent & Lundy of the local instrument panel welds and found that analysis to be complete and accurate. (Johnson, Tr. 10,302.)

262. The NRC Staff also reviewed the Sargent & Lundy evaluation of the local instrument panels and the Wyle Laboratory seismic qualification tests. (Muffett, prepared testimony at 11, ff. Tr. 10,478.) The NRC Staff found that the equivalency analysis and the finite element model computer analysis demonstrate the structural adequacy of the SCC local instrument panels. (Muffett, prepared testimony at 11, ff. Tr. 10,478.)

g. Conclusion Regarding Adequacy Of Systems Control Work Corporation's Equipment

263. We do not condone the fact that Applicant did not fully meet its commitment to the NRC Region III Staff in 1980 to conduct source inspections of the SCC-supplied equipment. However, Applicant has not attempted to justify its failure to fully meet its source inspection committment, devoting its attention instead to an extensive inspection and analytical effort designed to evaluate the adequacy of SCC equipment in

its as-installed condition. The results of this effort are satisfactory, indicating both that the design of these components was sufficiently conservative so that they could accomodate many minor discrepancies in fabrication without compromising their ability to withstand design basis events and that the recent inspection efforts have been sufficiently extensive so as to have uncovered any significant discrepancies that had previously gone undetected.

264. Based on this uncontroverted evidence, we find that, except for cable tray hangers, the SCC equipment at the Byron Station has been demonstrated to be adequate to accept design loads without exceeding the code-allowable stresses. With regard to the cable tray hangers, we find as discussed above that the final resolution of the adequacy of that equipment may be delegated to the NRC Region III Staff. Thus, we conclude that the adequacy of SCC equipment no longer presents a safety issue requiring our further attention.

XII. CABLE OVERTENSIONING

265. In our June 8 Order we requested a full evidentiary presentation on the cause and safety significance of alleged instances of overstressing of electrical cables during pulling and the relationship of these instances to the Byron Reinspection Program. This matter was not considered during the reinspection program because cable pulling is not a recreatable activity. (Love, prepared testimony at 25, ff. Tr. 9510.)

266. Applicant presented two witnesses to address this issue. James O. Binder, Applicant's Project Electrical Supervisor at Byron, discussed the history of the cable overtensioning issue at Byron and explained Applicant's response to items of noncompliance and open items regarding cable overtensioning which were identified by the Staff during various inspections. Bobby G. Treece, Sargent & Lundy's Senior Electrical Project Engineer at Byron, described the analysis performed by Sargent & Lundy of all of the safety-related electrical cables installed in conduit at Byron before December, 1982. The purpose of this analysis was to determine whether any of those cables had been rendered unacceptable due to overtensioning. (Treece, prepared testimony at 3, ff. Tr. 9408.) The testimony of R. S. Love of the NRC Staff also addressed the question of possible cable overtensioning. (Love, prepared testimony at 25, ff. Tr. 9510.)

267. Hatfield Electrical Company was responsible for cable installation at Byron. Cable tension criteria, addressing both maximum allowable tensile strength and maximum allowable sidewall pressures, have been established to give reasonable assurance that the cable's published rating will not be impaired during installation. Tension in excess of either criterion could render a cable unable to perform its intended function. (Binder, prepared testimony at 3-4, ff. Tr. 9406.)

268. Possible cable overtensioning was first identified during an NRC Staff inspection conducted in September, 1981, when it was observed that Hatfield's procedure governing class 1E cable installation did not address verification that allowable tension has not been exceeded when small cables were pulled. (Binder, prepared testimony at 5 and Attachment A - Inspection Report 81-16/81-12 at A-7 to A-8, ff. Tr. 9406.) Hatfield revised its procedure to address the precautions to be taken when small cables are pulled and the NRC Staff subsequently closed this unresolved item. (Binder, prepared testimony at 6 and Attachment B - Inspection Report 83-16 at B-6, ff. Tr. 9406.)

269. The Construction Assessment Team ("CAT") inspection conducted in the Spring of 1982 found that Hatfield's cable installation procedures did not address the requirements for calculating electrical cable sidewall pressure and did not provide instructions regarding cable rework. (Binder, prepared testimony at 6 and Attachment C - Inspection Report 82-05/82-04 at C-70 to C-71, ff. Tr. 9406.) In response, Hatfield revised its procedures to address allowable pulling tension considering sidewall pressure limitations and instructions regarding electrical cable rework. The revised procedures were implemented in December, 1982. The NRC Staff found the revised procedures satisfactory and closed this portion of the item of noncompli-

ance. (Binder, prepared testimony at 7 and Attachment B Inspection Report 83-16 at B-6, ff. Tr. 9406.)

270. For cables installed prior to the implementation of the revised procedures, Applicant committed to review the reports for previously installed cables against the current criteria and to take appropriate corrective action, if needed, to ensure that regardless of when installed, all cables would perform their intended function. (Binder, prepared testimony at 8 and Attachment D at D-3, ff. Tr. 9406.)

271. Mr. Treece explained the details of the analysis and methodology of this review, which was performed by Sargent and Lundy. The analysis covered all safety-related cables installed in conduit prior to December, 1982, including those cables for which cable pull reports do not exist. Most of these cables were found acceptable based on information found in the cable pull reports, or, where such reports are nonexistent, on calculations which showed that the expected pulling tensions did not exceed the cable's allowable pulling tension. (Treece, prepared testimony at 5-9, ff. Tr. 9408.) For those cables for which the actual or expected pulling tension was found or calculated to have exceeded the allowable pulling tension, specific analyses were performed by the manufacturers of the cables to determine whether the cables were acceptable. (Treece, prepared testimony at 6-7, 9-10, ff. Tr. 9408.) Based on this review by Sargent & Lundy and the cable

manufacturers, all safety-related cables pulled in conduit before December, 1982, were determined to be acceptable, i.e. their ability to perform their intended functions had not been impaired by overtensioning. (Treece, prepared testimony at 10, ff. Tr. 9408.)

272. The NRC Staff reviewed Sargent & Lundy's analysis and concluded that there was reasonable assurance that the safety-related cables that were the subject of the analysis would perform their intended functions. (Treece, prepared testimony at 11 and Attachment D - Inspection Report 84-27/84-19 at D-14 to D-15, ff. Tr. 9408; Love, prepared testimony at 26-27, ff. Tr. 9510.)

273. Allegations concerning Hatfield's construction activities prompted an NRC Staff special inspection between August, 1983, and January, 1984. As a result of that inspection it was determined that the one allegation regarding an instance in which a cable had been overstressed to the breaking point had been mooted by the documented replacement of that cable. (Binder, prepared testimony at 9 and Attachment F - Inspection Report 84-02 at F-14, ff. Tr. 9406.)

274. The NRC Staff inspection in response to the allegations also involved a review of Applicant's Nonconformance Report (NCR) Log; at least 25 NCRs concerning potential cable overtensioning were found. The allegations thus resulted in an open item, pending verification of corrective action on cables

installed prior to December 1982, and cables identified in NCRs and Discrepancy Reports (DR) as potentially overtensioned. (Binder, prepared testimony at 9-10 and Attachment F at F-17, ff. Tr. 9406.) The former part of this open item was closed out by the Sargent & Lundy analysis and the subsequent NRC review described above. The latter portion of this open item prompted an NRC Staff review of Applicant NCRs. Since some of the NCRs had yet to be closed by Applicant, the NRC considered the item unresolved. (Binder, prepared testimony at 10-11 and Attachment G - Inspection Report 84-09 at G-6 to G-9, ff. Tr. 9406.) The unresolved item was closed by the Staff upon their review of Applicant's subsequent disposition of the open NCRs. The NRC Staff found the disposition of the NCRs pertaining to potential cable overtensioning to be acceptable. (Binder, prepared testimony at 11 and Attachment E at E-15, ff. Tr. 9406.)

275. Applicant dispositioned its NCRs pertaining to potential cable overtensioning by determining the acceptability of the cable as installed through analyses performed by Sargent & Lundy or by the cable manufacturer. When analysis demonstrated that a cable was unacceptable, it was replaced. (Binder, prepared testimony at 11-12, ff. Tr. 9406.)

276. The NRC Staff inspection also reviewed 1,000 discrepancy reports prepared by Hatfield. One of those reports, which concerned potential cable overtensioning of neighboring cables during a cable removal, was determined to have been

inadequately dispositioned and resulted in an item of noncompliance. (Binder, prepared testimony at 12 and Attachment G - Inspection Report 84-09/84-07 at G-12 to G-13, ff. Tr. 9406.) The DR was faulted for providing an inadequate written description of the problem, which prevented the evaluating engineer from addressing the actual problem. Subsequent verification by a different QC inspector determined that the engineering resolution adequately addressed the problem as described, thus closing the discrepancy report. (Binder, prepared testimony at 13-14, Tr. 9406.)

277. This item of noncompliance was resolved by replacement of all cables in question and review of all other DRs concerning cables pulled out of conduit to confirm that the inaccurate description associated with the improperly dispositioned discrepancy report was an isolated incident. (Binder, prepared testimony at 14-15 and Attachment I - April 25, 1984, letter from Applicant to NRC, ff. Tr. 9406.) To prevent recurrence of this kind of problem, Applicant established criteria for determining the allowable pulling tension when cable is pulled out of conduit. (Binder, prepared testimony at 15 and Attachment J - February 2, 1984 letter from Applicant to Hatfield.) The NRC Staff accepted this resolution of the item of noncompliance. (Binder, prepared testimony at 15 and Attachment E - Inspection Report 84-27/84-19, at E-15, ff. Tr. 9406.)

278. Based on the revised procedures implemented by Hatfield in December, 1982, and the Sargent & Lundy analysis of the safety-related cables installed in conduit at Byron prior to that time, the Licensing Board concludes that all such cables at the Byron Station are acceptable and that their ability to perform their intended functions has not been impaired by overtensioning. Although the inspection of this activity by a quality control inspector was deemed not recreatable for purposes of the BRP, the revision to procedures and analyses described above indicate the acceptability of the cables, ~~and demonstrate that the BRP is not the sole basis on which work quality can be determined.~~

XIII. TABLING ALLEGATION

279. During the hearings held in the Spring of 1983, former Hunter QA auditor Michael Smith testified, inter alia, that he was sometimes instructed not to include in his final inspection reports discrepant conditions he had discovered. He was told, he said, that the problem would be caught later on. As an example, Mr. Smith described an incident in which he was allegedly instructed not to document missing component supports and support documents. (I.D., ¶ 137.) In our Initial Decision we found that Edison had failed to meet the thrust of this "tabling" allegation. (I.D., ¶ 139.) We concluded that the essence of the tabling allegation had been substantiated, our

particular concern being a perceived lack of assurance that missing component supports had been identified and that adequate documentation existed for all component supports. (I.D., ¶ 144.) We also concluded that an effective reinspection program was essential to a verification of the adequacy of Hunter's QA program. (I.D., ¶ 170.)

280. We identified this tabling issue as a proper subject for the remanded hearing, insofar as the BRP would address our concerns regarding tabling. Applicant addressed this concern through the testimony of Malcolm Somsag. Mr. Somsag is the site quality assurance supervisor for Hunter at Byron. He has previously testified for Applicant, primarily in response to Mr. Smith's allegations. (Somsag, prepared testimony at 1, ff. Tr. 9452.) Messrs. Connaughton and Ward addressed the tabling issue on behalf of the Staff. (NRC Staff, prepared testimony at 19-21, ff. Tr. 9510.)

281. The BRP included a review of a sample of safety-related component supports installed by Hunter Corporation and of a sample of documentation associated with the installation of such supports. (Somsag, prepared testimony at 4, ff. Tr. 9452.) The BRP sample did not identify one instance in which documentation of safety-related component supports required by the design was missing or one instance in which documentation existed but the associated support was not installed. (Somsag, prepared testimony at 4, ff. Tr. 9452.) Thus, the results of the BRP tend to confirm the adequacy

of the inspection program established by Hunter to provide assurance that component supports at Byron have been properly installed and documented. (Somsag, prepared testimony at 4, ff. Tr. 9452; NRC Staff, prepared testimony at 21, ff. Tr. 9510.)

282. Mr. Somsag described the inspection program to which the BRP was applied in detail. The program consists of four broad inspection types to which all safety-related work, including the installation of safety-related component supports, is subjected. Type 1 inspections are conducted during initial installation of activities to verify the existence and adequacy of required documentation. Type 2 inspections are also conducted during installation activities and are designed to determine whether the hardware meets design requirements and whether the documentation continues to reflect the status of construction and inspection. (Somsag, prepared testimony at 2, 3, ff. Tr. 9452.)*/

283. Once the work and Type 1 and 2 inspections associated with the work on a construction drawings are completed, Type 3 inspections are conducted to verify the overall adequacy work. Type 3 inspections include a detailed review of documentation

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*/ Mr. Somsag testified that this program was established in March, 1980. Hunter conducted an inspection of 100% of the supports installed prior to March, 1980 to assure that these supposts had been properly installed and documented. (Somsag, prepared testimony at 2, ff. Tr. 9452.)

generated during construction to verify that all required inspections have been conducted and documented, and that the hardware conforms to the requirements of the construction drawings and associated as-built documentation. (Somsag, prepared testimony at 3, ff. Tr. 9452.)

284. Type 4 inspections take place immediately before Hunter notifies Applicant that its work on a given system has been completed. The Type 4 inspection program was developed in part to deal with the concern we expressed in our initial decision, that hangers which had been installed and inspected might subsequently be removed during construction without follow-up inspection. The Type 4 inspection program requires physical reinspection of 100 percent of the safety-related hardware installed by Hunter to verify that the installations have remained in place, intact and undamaged. (Somsag, prepared testimony at 3-5, ff. Tr. 9452.)

285. Mr. Somsag further testified that even if, following completion of Type 3 or Type 4 inspections, hardware is removed or altered other than as required by a design change, the Hunter QA program requires that a Hardware Removal/Alteration Report be filed detailing the change. The report is routed to the QA Department and triggers reinspection to verify that the hardware has been reinstalled and is acceptable. (Somsag, prepared testimony at 5, ff. Tr. 9452.)

286. We find that the design of the program described by Mr. Somsag, if executed properly, would assure that component supports were properly installed and documented, and that supports were not subsequently altered or removed without the knowledge of the Hunter QA organization. ~~We find that the results of the DRP confirm that this program was improperly implemented.~~ However, we find Mr. Somsag's self-serving testimony too slight a basis upon which to resolve our concerns stated in the initial decision.* (per Forsse letter 9.17.84)

XIV. APPLICANT QA OVERSIGHT OF HATFIELD, HUNTER AND PTL SINCE AUGUST 1983

287. In accordance with our June 8 Order, Applicant, through Mr. Shewski, provided testimony regarding QA department oversight of Hatfield, Hunter and PTL between August 1983, when we closed the record, and the start of the reopened proceedings.

288. Mr. Shewski told us that special audit and surveillance attention was paid to Hatfield during this period. He testified that 14 audits and at least ~~22~~ 222 surveillances of Hatfield were performed. (Shewski, prepared testimony at 32, ff. Tr. 8423.) (per Edison correction)

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*/ In passing, we also note that Mr. Somsag also directly addressed Mr. Smith's tabling allegation. According to Mr. Somsag, during the course of a Hunter audit (059-3), Mr. Smith initially selected for review certain non-safety related component supports. Since non-safety related supports are not subject to quality assurance review, Mr. Somsag instructed Mr. Smith not to review those supports as part of the audit. Mr. Somsag believes these were the supports which were referenced in Mr. Smith's testimony. Thus, Mr. Somsag ascribes no safety significance to Mr. Smith's specific allegation. (Somsag, prepared testimony at 5-7, ff. Tr. 9452.) ~~We agree with Mr. Somsag.~~

289. The audits covered Hatfield's work activities, including welder qualification testing, material traceability, procedures, inspections, auditing, personnel qualifications, corrective actions, training, installation activities, calibration activities, records, fire protection, storage and housekeeping, field change requests, design control and document control. (Shewski, prepared testimony at 32, ff. Tr. 8423.)

290. The Hatfield surveillances looked at such items as corrective actions, personnel qualifications, calibration activities, document control, welding, inspection reports, installation activities and design change control. (Shewski, prepared testimony at 33, ff. Tr. 8423.)

291. The Hatfield audit results identified 17 deficiencies (7 findings and 10 observations). The findings involved audit follow up and objective errors, inadequate identification on weld traveler cards, lack of inspection of combination hangers, improper disposition of discrepancy reports and failure of some QC inspectors to perform required read/study activities. (Shewski, prepared testimony at 32, 33, ff. Tr. 8423.)

292. Hatfield's correction actions consisted of additional inspections, auditing, training, review of personnel documentation packages and review of discrepancy reports to ensure proper disposition. Mr. Shewski testified that for all audit findings acceptable corrective action by Hatfield has been achieved

or is underway. (Shewski, prepared testimony at 33, ff. Tr. 8423.)

293. Mr. Shewski concludes that, overall, quality assurance implementation by Hatfield during this period has been acceptable. (Shewski, prepared testimony at 33, ff. Tr. 8423.)

294. In Hunter's case, Applicant's quality assurance organization has conducted 14 audits and at least 142 separate surveillances between August, 1983 and the start of the reopened hearing. The audits covered the key aspects of Hunter's work activities and quality program requirements, including width restraint installations, handling, storage and shipping, nonconformances, welder qualification testing, inspector qualifications, design and installation methodology, control of field change notices, concrete expansion anchors and bolted connections, equipment installation, corrective action, auditing, piping and equipment component support, installation and engineering activities, document control and quality assurance implementation in general. (Shewski, prepared testimony at 30, ff. Tr. 8423.)

295. The 142 surveillances performed of Hunter looked at such items as personnel qualifications, calibration activities, welding and weld rod control, housekeeping and storage, inspecting and walkdown activities and installation activities. (Shewski, prepared testimony at 31, ff. Tr. 8423.)

296. In view of the extensive scope of these audits and surveillances, the results demonstrate exceptional performance by Hunter. Of the 16 deficiencies identified (6 finding and 10 observations), none were found to be significant and each required only minor corrective action. All deficiencies were closed out by subsequent surveillances. (Shewski, prepared testimony at 30, 31, ff. Tr. 8423.)

297. For PTL, 8 audits and at least 51 surveillances have been performed since August, 1983. The audits covered PTL's inspection activities in such areas as tool, gauge and instrument control, calibration activities, corrective actions, trending, inspections of electrical installations, document control, test/inspection reports, visual weld inspections, handling, storage and shipping, procurement and equipment control, auditing, and radiographic and ultrasonic examination. (Shewski, prepared testimony at 31, ff. Tr. 8423.)

298. The 51 surveillances of PTL covered such items as calibration activities, personnel qualifications, ultrasonic, radiographic, magnetic particle and dye penetrant examinations, visual weld inspections, document control, material control and civil activities. (Shewski, prepared testimony at 31, 32, ff. Tr. 8423.)

299. The PTL audits identified 10 deficiences (4 findings and 6 observations). These involved an inspector improperly accepting seven two-inch welds, a receiving inspector not hav-

ing proper certification, whiteout having been used by one person on sample logs, and incomplete documentation on ultrasonic test records. Corrective action for these deficiencies basically involved retraining. Mr. Shewski testified that these PTL findings and observations did not have significance and that adequate corrective measures were easily achieved. (Shewski, prepared testimony at 32, ff. Tr. 8423.)

300. Applicant's QA program prescribes that a large number of varied types of audits and surveillances be conducted at its nuclear construction sites. As we noted in our Initial Decision, Applicant's practice is to delegate the initial responsibility for quality control and quality assurance to the contractors actually performing the work. (I.D., ¶ D-80.) According to Mr. Behnke, this is based on CECo's belief that the organization doing the work will produce a higher quality product if it inspects and audits itself. This is also consistent with CECo's policy to insist on obtaining documented quality performance from each of the contractors and vendors with whom it does business. (Behnke, prepared testimony at 5, 6, ff. Tr. 9336.) We find that Applicant's QA oversight since August, 1983 of Hatfield, Hunter and PTL was extensive and indicates that Applicant has in part overcome ~~any~~ the excessive delegation of the quality assurance function to those contractors which was previously observed. However, see ¶ 166 e above.

XV. APPLICANT'S QA MEASURES TO PREVENT INACCURATE OR UNRELIABLE CONTRACTOR DOCUMENTATION PRACTICES

301. Given the concerns expressed in our initial decision regarding the reliability of Hatfield's documentation and our assessment that Applicant's initial evidentiary presentation on this issue "bordered on default," we heard evidence in the reopened proceeding regarding Applicant's current efforts to assure itself that quality documentation is accurate and reliable. As background for this issue Mr. Shewski testified on the changes in Hatfield documentation which have taken place over the years and on the current state of Hatfield's documentation practices. (Shewski, Tr. 8755-60.)

302. According to Mr. Shewski, Hatfield's documentation procedures have gone through several changes since Hatfield began work at Byron in 1976. Originally, weld inspections were performed using drawings as the inspection document. In this regard, about 5% of the welds were spot checked against the drawings and the results were indicated on the drawings. Thereafter, Hatfield changed from inspections based on drawings to the use of weld traveler cards. These traveler cards constitute the primary record of weld quality and record the inspection results by Quality Control Inspectors (See App. Ex. R-1) In 1981, Hatfield changed from spot checks to 100% inspection of all welds. (Shewski, Tr. 8756-57.) It should be noted that all cable pan hangers installed prior to this re-

quirement for 100% inspection were inspected on a retrospective basis, (Shewski. Tr. 8758; Del George, Tr. 8760; Behnke, prepared testimony at 10, ff. Tr. 9336.) Mr. Shewski testified that, based on his experience, neither Hatfield's documentation practices nor its procedures over time differ markedly from those of electrical contractors at other nuclear sites. (Shewski, Tr. 8736.) This evolution in inspection practices and documentation is at least partially responsible for the apparent difficulty which Hatfield has experienced in maintaining proper documentation from time to time. Since Hunter performs much of its construction work under the ASME Code they have always had a weld traveler system and documented inspections and have not experienced documentation problems comparable to Hatfield's. (Shewski, Tr. 8761.)

303. Mr. Shewski told us that since mid-1982, special attention has been given by Applicant's site quality assurance organization to actions by site contractors which might lead to inaccurate or unreliable documentation. Training for detecting possible alterations to documents was conducted for site QA personnel. Lead auditor retraining also covers this subject. Auditors have been trained to check for improper records as part of document review activities, even when specific questions are not on the audit checklist. We earlier discussed CECo's audit of Hatfield's implementation of the BRP which specifically included a review of the accuracy and reliability

except for ¶ 184 above.

of Hatfield's records (¶'s 87 - 90, supra). There is no evidence that the records of certification of QC and QA inspectors or of the BRP are inaccurate or unreliable. (Shewski, prepared testimony at 25, 26, ff. Tr. 8423; Hansel, Tr. 9013.)

304. A two month long Applicant audit of over 10,500 records was conducted in late 1982 to verify the authenticity of contractor QC documentation. Another related audit was performed for the BRP in early 1984 by Applicant's general office quality assurance department. Hunter, Hatfield and PTL records were covered by the audit. One purpose of the audits was to make certain that no fradulent documentation practice has occurred. The contractors' method of control and administration of QC qualification tests were reviewed, including reviews to verify that retests were done with a different test than the original and that tests and test answers were controlled. Calibration records were reviewed to ensure that information and date were unique, complete and not improperly altered and that signatures on documents were original and by authorized personnel. Reviews were also conducted to verify that site QA personnel were checking contractor welder qualifications and QC inspector qualification packages for acceptability and authenticity. No fradulent activities were identified. (Shewski, prepared testimony at 26, ff. Tr. 8423.)

305. Mr. Shewski concluded that recently increased audit and surveillance programs have shown that all of the contrac-

tors, including Hatfield, are currently doing a good job of maintaining accurate documentation. (Shewski, Tr. 8669.) In his opinion, any problems have been isolated and have involved human errors or misunderstandings without serious impact. (Shewski, Tr. 8685, 8759.)

306. ~~On the basis of~~ Despite Mr. Shewski's testimony, we find that in our initial decision, at 19 NRC 214-15, paragraph D-438, we did not ~~misunderstood~~ misunderstand Hatfield's documentation procedures when we stated that Hatfield appeared incapable of maintaining reliable records. ~~This~~ Only some of the confusion was caused ~~in part~~ by Hatfield's changing documentation methodology. (Shewski, Tr. 8756.) ~~We also conclude that Applicant has satisfactorily demonstrated adequate measures to prevent inaccurate or unreliable documentation by Hatfield as well as by the other contractors.~~

XVI. ACTIVITIES OF PITTSBURGH TESTING LABORATORY

307. PTL has been on site at Byron since September, 1977. PTL has not been responsible for any underlying construction work. (Del George, prepared testimony at 4, ff. Tr. 8406.) Rather, PTL reports to the CECo Site QA Department and performs independent inspections and destructive and nondestructive testing involving many of the key activities of the site contractors. The scope of work performed by PTL includes nondestructive testing of welds, concrete testing, aggregate testing, concrete expansion anchor inspection and testing, soils

testing, calibration, and bolting inspection. The nondestructive testing includes radiographic testing of welding and most of the magnetic particle, liquid penetrant and ultrasonic testing. (Shewski, prepared testimony at 27, 28, ff. Tr. 8423.)

308. PTL also performs overinspections to check construction work performed and inspected by the site contractors and to survey contractor activities in the structural, mechanical and electrical disciplines. These overinspections have been performed by PTL since 1980 and are in addition to the QC inspections required of the site contractors. They generally cover up to 10 percent of a work activity and have been concentrated in the areas of welding, electrical installations and HVAC installations.

309. In September, 1982, Applicant's quality assurance department initiated an additional form of inspection called a unit concept inspection ("UCI") which PTL is required to perform each week at Byron. PTL uses a team of inspectors who are qualified in various disciplines to inspect items installed within particular spatial boundaries or in conjunction with specific equipment for compliance with vendor and engineering documents. This particular inspection encompasses all contractors who performed work activities within a given area. These UCIs are in addition to the normal inspections and overinspections performed on site. (Shewski, prepared testimony at 28,

29, ff. Tr. 8423; Del George, prepared testimony at 53, ff. Tr. 8406.) As the Board found in ¶ 166C above, however, PTL's

310. ~~The Board finds that the~~ overinspections and UCIs provide little additional confidence that the field work and the inspection activities of the contractors have been performed acceptably. (Shewski, prepared testimony at 28, ff. Tr. 8423.)

XVII. DISPOSITION OF ALLEGATIONS

311. In our Initial Decision, we expressed concern over several matters regarding Hatfield arising from worker allegations that were still pending with the Region III and the Office of Investigations, and noted that the NRC Region III Staff intended to close out several allegations on the basis of the results of the reinspection program. (I.D., ¶'s D-406, D-407, D-439.) In our June 8, 1984 prehearing order, we clarified that our concern was limited to whether, in accordance with the NRC Staff's expectations, the BRP has been effective in resolving some of the worker allegations. We also asked whether the NRC Staff or Applicant had identified any allegations, as having independent and important relevance to the reinspection program. (Memorandum and Order at 8-9, June 8, 1984.)

312. The NRC Staff presented a panel of two witnesses, Messrs. Hayes and Connaughton, to address these matters. (Hayes, Connaughton, prepared testimony, ff. Tr. 9964.) The

BRP was relied upon to resolve two worker allegations regarding Hatfield welding, and supplemented the resolution of three others. The remainder of the 23 allegations assigned to Region III and as yet uninvestigated at the close of the August, 1983 hearings have since been resolved independent of the BRP. (Hayes, prepared testimony at 3, ff. Tr. 9964.)

313. Of the two allegations resolved by the BRP, one concerned widespread undercut in excess of AWS code limits. This allegation was found to be unsubstantiated through third-party inspections and independent NRC inspections. (Hayes, prepared testimony at 3 and Attachment A, ff. Tr. 9964.) The other allegation, received in August, 1982 stated that two QC inspectors were unqualified. The allegation was considered substantiated, but was subsequently resolved by the BRP's extensive examination of the work of QC inspectors at the Byron Station. (Hayes, prepared testimony at 3-4, ff. Tr. 9964).

314. The three allegations whose resolution was supplemented by data from the BRP all concerned Hatfield welding. (Hayes, prepared testimony at 4 and Attachment C, ff. Tr. 9964.) One allegation, that approximately 90 percent of certain Hatfield hangers which were covered with fireproofing and which were inspected because of missing weld trevelers were rejectable, was disproven by results of inspections which were conducted to resolve a related nonconformance report. The BRP reinspected welds that were covered with fireproofing and found

none that required repair, thus confirming the above results. (Hayes, prepared testimony at 4, ff. Tr. 9964.) A second allegation claimed that the rejection rate for Hatfield hanger welds merited removal of fireproofing to reinspect additional welds. This allegation was resolved in the course of the BRP, which removed all the fireproofing in areas identified by the alleger and the finding thereby of only one unacceptable connection. (Hayes, prepared testimony at 4-5, ff. Tr. 9964.)

315. A third allegation charged that fireproofing covered tack welds and that there was no documentation of such unacceptable welds. This allegation was resolved by the inspection and completion of the welds identified by the alleger, and the BRP inspection of 5,500 fireproofed welds which found only two tack welds. Further, it was found that discrepancy reports were not issued because the tack welds had not yet been accepted by QC at the time of the allegation. (Hayes, prepared testimony at 5, ff. Tr. 9964.)

316. In response to our second request, the NRC Staff found, with one exception, no other allegations of independent and important relevance to the BRP. In the one exception, the NRC Staff found an allegation regarding the improper certification of one QC inspector to be substantiated. Appropriate corrective actions were taken with respect to this individual and found acceptable to the NRC Staff. (Hayes, prepared testimony at 5-6, ff. Tr. 9964.)

317. Based on the NRC Staff's testimony, we find that the BRP has been ~~effective, as expected by the NRC Staff,~~ only of some assistance for resolving certain allegations regarding Hatfield. ~~Thus, our questions in this regard have been satisfied.~~

XVIII. MODIFICATION OR WITHDRAWAL OF FINDINGS AND CONCLUSIONS IN INITIAL DECISION

318. Based on this supplemental decision, ~~several~~ few of the findings and conclusions in our Initial Decision of January 13 must now be either modified or withdrawn. ~~The Summary and Comments Section of our Initial Decision~~ does not constitute any portion of our factual findings and we make no change in that part of our Initial Decision. Similarly, we make no change in the Conclusion and Order Section of the Initial Decision, stating, however, that it is superseded in its entirety by the Conclusions of Law and Order Sections of this Supplemental Initial Decision.

319. Findings D-137 through D-145 of our Initial Decision are modified insofar as they suggest that Mr. Smith's allegation of "tabling" has safety significance. (See ¶'s 279 - 286.) Accordingly, our conclusion in finding D-169, that the alleged "tabling" is a serious matter which could have important consequences, is withdrawn.

320. Finding D-378 is modified to reflect the final results of the ~~BRP for inspector qualifications.~~ (See ¶'s 99 - 101.) The findings and conclusions herein supplement those of our initial decision, which was correct at that time, except as noted below.

321. The concerns expressed in findings D-403 and D-404 regarding possible fradulent contractor practices have now been resolved in our satisfaction and CECo has established that Hatfield documentation is not fraudulent and is adequately reliable and accurate. (See ¶'s 301 - 306.)

322. Finding D-410 is modified insofar as it suggests that Region III has taken exception to the 90 percent acceptance criterion for subjective inspections and the definition of subjective weld attributes. Undisputed testimony in the reopened hearing has shown that the Staff fully concurs with this acceptance criterion and the definition of subjective weld attributes. (See ¶ 54.)

323. Finding D-414 is modified insofar as it suggests that Edison's presentation on the BRP has been inadequate.

324. Finding D-429, which concludes that Intervenors prevail on the essence of the quality assurance contention, is withdrawn. We now conclude that Edison has fully met its burden of proof on the quality assurance issue.

325. The second sentence of finding D-433, which concludes that Edison does not have an adequate quality assurance program, is withdrawn.

326. In finding D-434 we concluded that we did not have confidence in the quality of Hatfield's work at Byron. On the basis of the testimony adduced at the reopened hearing, we now

~~have confidence in the quality of Hatfield's work. Finding~~ D-434 is therefore withdrawn.

327. Findings D-435, D-436 and D-437, which raise questions as the adequacy of the BRP, are withdrawn.

328. Finding D-438 is withdrawn. The testimony of Mr. Shewski and others has convinced us that Hatfield is not incapable of maintaining reliable records of nonconforming and deviating conditions. In addition, our concerns as to the validity and accuracy of the BRP results for Hatfield have been satisfied.

329. Findings D-439 and D-440 are modified to reflect the fact that the BRP has resolved all allegations within the scope of the reinspections conducted pursuant to that program.

330. Finding D-441, which concludes that Hatfield's quality assurance program is inadequate, is withdrawn. The BRP results, together with the other testimony is the reopened hearing, show that Hatfield quality control inspectors were qualified, that Hatfield work quality is adequate and that ~~Hatfield's quality documentation is adequate~~.

319 ~~331~~. Finding D-442, which states our conclusion regarding the adequacy of SCC equipment, is modified to incorporate our discussion of SCC in ¶ 166c above. ~~withdrawn except for its first three sentences which may remain as stated. The status of Applicant's commitment to conduct source inspections of SCC equipment and the status of its program to reinspect the SCC~~

work has been addressed in this supplemental decision. (See ¶'s 204 - 265.)

332. Finding D-444 is modified insofar as it suggests that the quality of Hunter's work is inadequate. Testimony in the reopened hearing has shown that Hunter inspectors were qualified and that Hunter work quality is ~~in~~adequate. ← (per Furse letter 9.17.84)

333. The first sentence of Finding D-448, which concludes that Edison's QA performance with respect to Hatfield and Hunter has been inadequate, is withdrawn.

XIX. CONCLUSIONS OF LAW

320. ~~334.~~ Applicant has not met its burden of proof with respect to Contention 1A, and the contention is hereby ~~rejected~~ sustained. ~~Having decided in our previous decision that Applicant had met its burden of proof with respect to the other seven issues in controversy, the Licensing Board concludes with respect to each of these contentions that there is reasonable assurance that the Byron Nuclear Power Station can be operated without endangering the health and safety of the public.~~

XX. ORDER

WHEREFORE, IT IS ORDERED, in accordance with 10 C.F.R. §§ 2.760(a) and 2.762, that the Initial Decision as modified by this Supplemental Initial Decision shall constitute the final action of the Commission thirty (30) days after the date of

issuance hereof. Within ten (10) days after service of our Supplemental Initial Decision any party aggrieved by that decision shall notify the Appeal Board of its intention to modify its pleadings and briefs before the Appeal Board. The form of such further pleadings and briefs and the time within which such further pleadings and briefs shall be filed, shall be in accordance with an order issued by the Appeal Board.