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
	)		50-455 OL
	)		
(Byron Nuclear Power Station, Units 1 & 2)	)		

SUMMARY OF DIRECT TESTIMONY OF DR. WILLIAM H. BLEUEL ON CONTENTION 1 (THE REINSPECTION PROGRAM)

I. Dr. William H. Bleuel, Ph.D., has twenty-five years of business experience in design assurance (which includes both reliability engineering and maintainability engineering) and quality assurance. His experience has been in a range of industries including aerospace, defense, computers, control systems and business equipment. He holds academic degrees in reliability engineering, statistics and electrical engineering, and has taught production management, including quality assurance and quality control, at the university level.

II. The purpose of his testimony is to suggest that the Byron Reinspection Program does not provide reasonable assurance that the plant will be operated safely, for three principal reasons:

1. Edison's failure to perform a failure modes and effects analysis.

2. Edison's failure to define clearly at the outset the criteria for evaluation of safety significance of discrepancies found during the program, or, failing that, to retain an independent firm to conduct an after-the-fact evaluation.

3. Edison's assumption that inspectors would perform least well during their initial three months is inconsistent with his business experience.

III. A failure modes and effects analysis is a tool of reliability engineering. By identifying potential hardware failures with the greatest likelihood of causing serious safety problems, such an analysis enables one to focus resources (inspectors, engineering analysis, managerial attention) on the most safety significant components and subsystems. It also both permits and demands the application of stricter standards (such as reliability requirements) to the most safety significant failure modes. Finally, it focuses on the system, rather than on individual components in isolation, and requires calculation of statistical reliabilities for the system rather than by individual attribute.

IV. In Dr. Bleuel's opinion, without performing a failure modes and effects analysis, one cannot have reasonable assurance that adequate reliability of Byron and its associated safety requirements can be achieved.

V. In Dr. Bleuel's opinion, the often highly judgmental criteria and methods used by Sargent & Lundy to evaluate discrepancies should not be considered as a reliable basis for adjudging safety significance, because they were not clearly defined at the outset. In his experience, if not so defined, applicable criteria can generally be defined during the course of evaluation to guarantee success, especially in a highly judgmental context. This basic tenet of quality assurance requires no inference of bad faith.

VI. When the criteria are not clearly defined at the outset, an acceptable alternative is to have the evaluation conducted by an independent entity with no economic or institutional stake in the outcome. Sargent & Lundy is not such an entity with respect to the Byron Reinspection Program.

VII. Edison's assumption that inspectors would perform least well during their initial three months is inconsistent with his business experience, especially for attributes which the inspector did not inspect during the first three months.

VIII. Dr. Bleuel also has concerns relating to the use of PTL for overinspections and to the exclusion of certain inadequately documented welds from the Reinspection Program.

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In The Matter of COMMONWEALTH EDISON COMPANY (Byron Nuclear Power Station, Units 1 & 2)	)))))))	Docket Nos. 50-454 OL 50-455 OL

DIRECT TESTIMONY OF DR. WILLIAM H. BLEUEL
ON CONTENTION 1 (THE REINSPECTION PROGRAM)

Q.1. Please state your name, business address and your current position.

A.1. I am Dr. William H. Bleuel, Ph.D. I am a partner in Zarkov & Gordon, 5400 Newport Drive No. 2, Rolling Meadows, Illinois. Our firm provides a range of services to the computer industry, including assistance in developing hardware service plans and strategies as well as direct provision of hardware service.

Q.2. Please describe your professional background and expertise.

A.2. My doctoral thesis was in the field of reliability engineering for repairable complex systems. I also hold a Master's degree in statistics and a Bachelor's degree in electrical engineering. I have twenty-five years of business experience in design assurance and quality assurance in the fields of aerospace, defense, computers, control systems and business equipment. From 1959-1961, as a design instrument engineer for Aerojet General, I designed instrumentation systems for low thrust engines for deep space applications. From 1961-1964, I worked in quality control for the Endevco Corporation, which manufactured vibration measurement systems for the Surveyor satellite that made the first soft landing on the moon. From 1964 through 1970, as an engineer for General Dynamics working under contract with the U.S. Department of Defense, I worked on design assurance, including reliability engineering, for military communications systems. Since 1970 my experience has been in the fields of computers, control systems and business equipment. I am co-author of the book Service Management, the first definitive work on the subject, and author of the American Management Association monograph, "Service Planning." I have won various awards for applications of management science in the fields of reliability engineering and maintainability engineering. My resume is attached to this testimony.

Q.3. Do you have any experience with nuclear power plants?

A.3. No.

Q.4. Does your expertise have any bearing on questions of quality assurance and quality control at a nuclear power plant?

A.4. Yes. My extensive practical experience in design assurance (which includes both reliability engineering and maintainability engineering) and quality assurance has been in a variety of business contexts. It has included experience in matters of critical safety significance, such as work for the Defense Department on military communications. My work has also called for practical business application of such statistical tools as Military Standard 105D. As Assistant Quality Control Manager for Endevco, among other activities, I wrote standards for welding. My business experience, as well as my academic training, has given me an understanding of the tools and principles of design assurance and quality assurance, which can be applied to any particular business or industry, including the nuclear power industry.

Q.5. What is the purpose of your testimony?

A.5. The purpose of my testimony is to suggest that the Byron Reinspection Program, as structured and implemented, does not provide adequate assurance that the plant will be operated safely.

Q.6. Why do you hold that opinion?

A.6. There are three principal reasons, discussed below in my testimony. First, Edison failed to employ a failure modes and effects analysis, which is a tool of reliability engineering, in formulating and implementing the program.

Second, in its engineering evaluation of discrepancies, Edison failed to define exactly at the outset what would be the criteria for determining failure, or, in the alternative, to retain an independent firm with no direct economic or institutional stake in the outcome to perform an after-the-fact reliability assessment. Sargent and Lundy, an engineering firm directly and extensively involved in Byron, was asked, after the program was already underway, to analyze the safety significance of the discrepancies detected in the program. That analysis was highly judgmental, and was not conducted according to predetermined, clearly stated criteria for success or failure. Third, the program's assumption that inspectors would perform least well during their initial three months is inconsistent with my experience.

Q.7. What is the basis for your opinion?

A.7. My opinion is based on the application of my training and practical business experience in the tools and principles of design assurance and quality assurance to the particular case of the Byron Reinspection Program. To familiarize myself with that program, I have read the Reinspection Program Report of February, 1984; the June, 1984 Supplemental Report; the direct testimony of Edison witnesses Laney, Hansel and Singh; and some related materials.

Q.8. What is failure modes and effects analysis?

A.8. Failure modes and effects analysis is a tool of reliability engineering. Essentially it entails three steps: first, identifying each of the possible ways (modes) in which a system could fail; second, analysing the effects of each such failure mode; and third, categorizing the failure modes according to their effects. For example, they may be critical (e.g., pose a threat of death due to excessive radiation); major (e.g., pose a threat of temporary plant shutdown with attendant economic costs); or minor (e.g., cosmetic).

For purposes of conceptual illustration, one common device is to depict a "fault tree" for the system in question. By graphically representing each of the identified failure modes, the fault tree assists one to analyze the ultimate effect of any one failure mode (fault) on the entire system.

The importance of failure modes and effects analysis is that it enables the analyst to focus, not on individual items viewed in isolation, but on the item in the context of the system as a whole, based on thorough understanding of its systemic interactions and their relative importance.

The practical value of failure modes and effects analysis is, first, that it enables one to focus resources (inspectors, engineering analysis, managerial attention) on the critical failure modes (taking into account both their criticality and their likelihood). Second, it both permits and demands the application of stricter standards (such as statistical reliability standards) to the critical modes then are applied to less important modes.

Q.9. Was failure modes and effects analysis utilized in the Byron Reinspection Program?

A.9. No, the documents which I have reviewed contain no evidence of this analysis having been done.

Q.10. In what respect did the Reinspection Program fail to use failure modes and effects analysis?

A.10. In many respects. Most fundamentally, the Reinspection Program, as designed and implemented, neither concentrated resources and effort, nor utilized stricter criteria, for the components of the most critical failure modes at Byron. Indeed, there appears to have been no effort in the original program even to identify, analyze or categorize critical failure modes, let alone to act on such analysis.

Q.11. What is the significance of this failure?

A.11. This failure may be understandable in light of the program's primary purpose as stated by Edison, namely, to determine whether inspectors, who may not have been properly qualified, nevertheless performed capably.

However, with respect to the Program's second (and apparently not initial) purpose -- namely, to demonstrate that the quality of work at Byron is adequate to provide reasonable assurance that the plant can be operated safely -- the absence of any failure modes and effects analysis is a serious flaw. In my opinion, without performing a failure modes and effects analysis, one cannot have reasonable assurance that adequate reliability of the plant and its associated safety requirements can be achieved.

Q.12. How might a failure modes and effects analysis have been incorporated into the Byron reinspection program?

A.12. To accomplish this purpose credibly, a wholly different approach would have been required. Rather than spread reinspection resources randomly among inspectors, without regard to the relative safety significance or systemic impact of the work they inspected, the program would have begun by identifying the most safety significant failure modes, and the components involved in each.

This task is achievable. For example, Byron's Startup Coordinator, Mr. Richard Tuetken, at his deposition and upon request of intervenors' counsel, categorized all the Hatfield procedures and PTL and Hunter attributes according to their safety significance, in categories 1, 2, 3, and "Least," ranging, respectively, from the first rank of safety significance, to the second and third ranks, to least important. (A copy of Mr. Tuetken's categorizations, which has previously been engineering evaluation (e.g., reinspection of other welds subject to load redistribution effect due to the failure of the weld originally reinspected); and stricter engineering evaluation criteria (e.g., more conservative ratios of actual to allowable stress).

Moreover, Mr. Tuetken's categories might have been refined, with even greater scrutiny given to the most critical sub-categories. For example, his category of visual weld inspections might have been divided into highly stressed welds on critical safety components, less highly stressed welds on critical safety components, highly stressed welds on less critical components and lightly stressed welds on less critical components.

Q.13. Would such a failure modes and effects analysis also have affected the statistical reliability assessment of the program?

A.13. Yes. For the most critical procedures, in addition to ensuring larger sample sizes than for less important procedures, one would use stricter statistical standards. If Military Standard 105D were to be used, for example, then one would use Inspection Level III rather than Inspection Level II, a higher than usual confidence level, and a higher than usual reliability standard. In fact, the statistical requirements demanded by NASA during my quality control work for Endevco went beyond the minimum requirements of Military Standard 105D.

The reliability required for the overall vibration measurement system for the Surveyor satellite was 99.9, and for the transducer, cable and pieces of the amplifier the reliability requirements were at least 99.999.

Of equal importance is the fact that in a failure modes and effects analysis, reliabilities would not be calculated for individual procedures or attributes in isolation from others (as Edison's Reinspection Program Report does in Chapter VII). Rather, the question would be the reliability of the particular system. To obtain the reliability for the system, one would multiply the reliabilities of the individual components. Since these reliabilities are less than 1.0, the system reliability would be lower than the reliabilities for the individual components. However, since failure modes in actuality occur by systems, the system reliability would, more accurately than any individual component's reliability, predict the likelihood of a safety-sigificant failure. In my opinion, Edison erred seriously by failing to calculate reliabilities for systems.

Q.14. Does the Supplemental Report of June 1984 remedy the failure of the February, 1984 Reinspection Program Report to employ failure modes and effects analysis?

A.14. No. The Supplemental Report moves in the right direction. For example, it includes analysis of additional welds selected on the basis of being highly stressed. However, rather curing the deficiencies, these partial steps merely illustrate what is wrong with the entire Reinspection Program.

For instance, in the case of the highly stressed welds, it is not clear that an effort was made to select welds that were highly stressed on the most safety significant components, let alone the most highly stressed welds throughout an entire system identified as critical through a failure modes and effects analysis.

Thus, while the Supplemental Report properly recognizes that the original Report's engineering evaluation of the most visually discrepant welds missed the point, the Supplemental Report, too, misses the point to the extent it selected welds for evaluation based on their degree of stress rather than on their safety significance.

Moreover, the degree of inspection and engineering scrutiny of all reinspected procedures and attributes should have been based, not merely on which inspector happened to inspect them, or on their visual appearance, or on their degree of stress, but on their relative safety significance, i.e., the extent to which any discrepancy in the particular procedure or attribute would contribute to failure of a critical system, as determined by a failure modes and effects analysis.

Q.15. Do you have an opinion on the criteria and methods utilized to assess the safety significance of discrepancies found in the Reinspection Program?

Q.15. Yes. My opinion is that the often highly judgmental criteria and methods used by Sargent & Lundy to assess the design significance of discrepancies should not be considered as a reliable basis for adjudging safety significance, because they were not clearly stated at the outset.

A basic tenet of quality assurance is that the criteria for determining failure should be clearly defined before any evaluations of success or failure are actually conducted. Otherwise the criteria, especially in a highly judgmental context, can generally be defined during the course of the evaluation to guarantee success, regardless of the actual reliability of the system being evaluated. No charge of bad faith need be made to support this practical lesson from my years of experience in the field.

Q.16. How did the failure to specify evaluation criteria at the outset affect the reliability of the engineering evaluations for the reinspection program?

A.16. I have not analyzed the specific engineering criteria and methods utilized by Sargent & Lundy to evaluate the Byron Reinspection Program, nor would I be competent to do so. Rather, I am making a universal point, based on extensive business experience in design assurance and quality assurance, that criteria for evaluations of success or failure -- no matter who conducts the evaluations -- should be clearly defined at the outset, if the evaluations are to be deemed reliable.

The point has particular force where, as here, the choice of criteria and methods for the evaluation is highly judgmental. A reading of the Reinspection Program Report shows plainly that such was the case here.

Appendices C and D to the Report concern the engineering evaluations of discrepancies. Of three types of evaluations (Categories X, Y and Z defined in Appendices C and D of the Report, excerpts from which are appended as Attachment C to my testimony), Category 4 is expressly described as evaluation based on engineering judgment. In the case of subjective discrepancies, of 4,132 total discrepancy evaluations, 3,074 fell in this category; of 2117 Hatfield subjective discrepancy evaluations, 2064 were in this category of evaluation by judgment. (Table C-2, p. C-4, in Attachment C to my testimony.)

Judgment was likewise involved in the evaluations in categories X and Z, least significantly in subjective category

X where the principal judgment was simply that certain types of weld discrepancies did not reduce weld strength, and most significantly in category Z, which involved evaluation by engineering calculations. Such calculations, of course, require the exercise of considerable judgment as to both the criteria and the methods for the evaluation.

Recent testimony in this case by Sargent & Lundy engineers McLaughlin and Kostal, which has been brought to my attention by intervenors' counsel, illustrates the use of judgment in such calculations. In the case of the Reinspection Program, I am advised that the testimony suggests that individual welds on a component were evaluated by calculations which did not necessarily entail reinspection of other welds subject to load redistribution effects (unless, by coincidence, those other welds happened to have been captured in the Reinspection Program sample). (McLaughlin testimony, Transcript at 9154-56; Kostal testimony, Transcript at 10,238-10,240.) In contrast, for purposes of preparing his testimony on the engineering evaluations of Systems Control Corporation weld discrepancies, Mr. Kostal selected certain cases in which load redistribution effects were calculated, and any welds thereby affected were visually reinspected. (Transcript at 10,238-10,240.)

Now, in the testimony just cited, both engineers expressed their judgment that these additional calculations and reinspections were not necessary, but that is precisely my point. They so determined by an exercise of <u>judgment</u> -- one of many such judgments which permeate engineering calculations. If this judgment were to govern the evaluations, it (along with many others) should have been clearly stated at the outset. The very fact that Mr. Kostal felt it desirable to perform these additional calculations and reinspections for his testimony suggests that it is not irresponsible to raise legitimate questions about the validity of the particular judgment.

In short, the criteria and methods for evaluation should have been clearly specified before any reinspection results were received, especially because the engineering evaluations were highly judgmental.

Q.17. Is there any acceptable alternative to clearly defined criteria for success or failure at the outset?

A.17. Yes. In cases where the criteria for success or failure are not clearly defined at the outset, an acceptable alternative is to have the evaluation conducted by an independent entity with no economic or institutional stake in the outcome. This avoids the situation of the "rabbit guarding the cabbage patch."

Intervenors' counsel has asked me to review NRC Chairman Nunzio Palladino's February 1, 1982 letter to Congressman John Dingell, concerning criteria for an independent design review of the Diablo Canyon nuclear power plant. I have reviewed the letter (Attachment D to my testimony). In my opinion, the criteria set forth therein appear adequately to describe an acceptable degree of independence for review in a case, like this one, in which the criteria for success or failure are not clearly defined at the outset and are highly judgmental. I refer particularly to the following language in Chairman Palladino's response to the portion of Congressman Dingell's question 1 which asked for a definition of the term, "independent":

> Independence means that the individuals or companies selected must be able to provide an objective, dispassionate technical judgment, provided solely on the basis of technical merit. Independence also means that the design verification program must be conducted by companies or individuals not previously involved with the activities at Diablo Canyon that they will now be reviewing.

Sargent & Lundy, of course, has been extensively involved in the design, prior partial evaluations of, and advice concerning the activities at Byron which it was asked to evaluate in the Reinspection Program. It has a direct economic and institutional stake in the outcome, both of the Reinspection Program and of this licensing proceeding. If engineering evaluation were to show serious safety problems at Byron, and Byron were not to be licensed, the firm, which according to press reports has recently laid off engineers due to loss of business resulting in part from cancellations of other nuclear power plants, might lose business at Byron. Its business at Edison's Braidwood plant, also designed by Sargent & Lundy and quite similar to Byron, would likewise be in question, and its reputation might be jeopardized, threatening further loss of business.

None of this is to impugn in any way the integrity of Sargent & Lundy. I am merely pointing out that Sargent & Lundy is not in any real sense, or in the sense of Chairman Palladino's definition, "independent" for purposes of engineering evaluations of the work at Byron.

In sum, based on my extensive business experience in design assurance and quality assurance, when the criteria for success or failure are not clearly defined at the outset, the evaluation must be done by a firm which is independent, if the evaluation is to be deemed reliable. Here the evaluation was done by a firm which is plainly not independent, and the evaluation therefore should not be deemed reliable.

Q.18. Does the NRC Staff review of Sargent & Lundy's engineering evaluations supply the necessary degree of independent review?

A.18. No. The evaluation itself, not merely a limited, partial review of the evaluation, must be independent, if it is to be relied upon.

Q.19. Do you have an opinion on whether the use of each selected inspectors' first three months as a sample introduced a conservative bias into the Reinspection Program?

A.19. Yes. Based on my years of business experience in servicing of hardware, I believe that use of the first three months had the opposite effect. My experience on this point is mainly in supervision of technicians performing repairs on business equipment. However, from my experience in Quality Control for Endevco, I believe that for this purpose the two types of activities -- hardware repairs and hardware inspections -- and the behavior patterns of the human beings who perform them, are comparable.

My experience has been that the technicians are most enthusiastic, most informed on technical points, and try the hardest when they first start. Once they get settled into the job, their enthusiasm tends to drop and they tend to get sloppy unless they are continually challenged.

An important factor is how often their training is reinforced. If they are trained for several different kinds of activities, but during their first months on the job their activities are confined mainly to one of them, they tend to forget what they have learned on the others.

As applied to this case, an inspector might do quite well in his or her first three months on one or two attributes, but if not retrained, may later do poorly on other attributes which he or she did not inspect much until after the first three months. Thus the use of the first three months is likely to mask subsequent deterioration in inspector performance, especially as to inspections of attributes for which few inspections were done during the inspector's first three months.

Here again, as in my answer to question 11 concerning the absence of failure modes and effects analysis, the problem arises in part from Edison's effort to stretch the Reinspection Program to cover a purpose for which it was not originally intended, and for which it clearly was not designed. In other words, had the only purpose of the Program remained to resolve questions about the adequacy of inspectors' initial certifications and qualifications, then use of the first three months for sampling would have made good sense. But once the purpose shifts away from initial qualifications to the question of how the inspector in fact performed throughout his tenure, then use of the first three months is no longer a conservative sample. On the contrary, based on my experience, such a sample period is likely to overstate the inspector's actual performance over time.

Q.20. Do you have other concerns relating to Edison's Byron Reinspection Program?

A.20. Yes. The selection of PTL for overinspectors was inappropriate because PTL inspectors were not certified to higher standards than the reinspectors; in fact, PTL inspectors overall scored significantly lower than inspectors for other companies. In addition, the Reinspection Program Report at p. IV-5 indicates that certain welds for which complete documentation was not available were not reviewed, yet it would seem likely that inadequately documented welds are among those most in need in reinspection.

RESUME OF WILLIAM H. BLEUEL, Ph. D.

Education:

- Ph.D., Texas A & M University, 1970. Doctoral dissertation in the field of reliability engineering for repairable complex systems.
- M.S. in Statistics, University of Rochester, 1967.
- B.S. in Electrical Engineering, Texas A & M University, 1959.

Experience:

- Aerojet General Corporation, Design Instrument Engineer, 1959-61. Designed instrumentation systems for low thrust engines for deep space applications.
- Endevco Corporation, 1961-64. Served for all but a brief portion of this period as Assistant Quality Control Manager for Endevco, which manufactured vibration measurement systems for the Surveyor satellite that made the first soft landing on the moon.
- General Dynamics, 1964-70. Under contract with the U.S. Department of Defense, responsibilities concerned design assurance, including reliability engineering for military communications systems.
- SSR Corporation (Stochastic Systems Research), President, 1970-72. SSR provided consulting in systems analysis.
- Xerox Corporation, 1972-75. Served as manager in charge of all field services reporting systems, equipment field reliability analysis and development of mathematical models for service.
- Taylor Instrument Company, National Service Manager, 1975-79. Responsible for field service, factory repair and related activities of 250 persons, for Taylor's business which involved provision of control systems to a variety of industries.
- AM International Service Division, Director of Planning and Control, 1979-80. AM was a conglomerate; my Division's annual sales exceeded $100 million.

Experience: (cont.)

- Barber Colman, Director of Marketing for the Environmental Controls Division, 1980-83. Division marketed HVAC systems to industry.

- Zarkov & Gordon, Principal, 1983 to present. Our firm provides services to the computer industry, including both hardware servicing and assistance in developing hardware service plans and strategies.

Publications:

- Co-author of the book, Service Management: Principles and Practices.

- Numerous articles and professional presentations in the fields of reliability engineering, operations research and service management.

Awards (partial list):

- Operations Research Society of America, 1968 award for a paper on the reliability of radio hardware for military communications systems.

- Institute of Management Science, First Prize in 1975 national competition on the Practice of Management Science.

- Armitage Medal from the Society of Logistics Engineers, 1978, for my book on service management, which is used for logistical support for defense systems.

- Association of Field Service Managers, S.B. Ross Award, 1980, for contributions to the literature of service.

Teaching Experience:

- From 1970 through 1975, I taught production management, including quality assurance and quality control, in the graduate business schools at the University of Rochester and Rochester Institute of Technology.

Current Professional Activities:

- Board of Directors, Association of Field Service Managers.
- Chairman, Committee on Publications, Association of Field Service Managers.
- Certified Service Executive, National Association of Service Managers.

MLCO 1-1

Procedure	Inspection Type	TEUTKEN SAFETY CATAGORY
#2	Embedded Conduit	2
#3	Underground Duct Runs	2
#5	Material & Equipment Receiving	3
#9A	Cable Pan Hangers	1
#9B	Cable Pans	3
#9C	Cable Pan Covers	3
#9E	Cable Pan Identification	3
#10	Cable Installation	1
#11	Cable Terminations	1

Attachment B

- 1

Procedure	Inspection Type	TEUTKEN SAFETY CATAGORY
#12	Equipment Installation	2
#12A	Equipment Modifications	1
#12B	Non-Seg Bus Duct	2
#13AF	Visual Weld Inspection	1
#14	Material Handling	Least
#20	Exposed Conduit	1
#25	A325 Bolt Installation	2
#26	Stud Welding	3
#27	Limit Switch Gasket Replacement	3

1

nleo 1-5

Procedure	Inspection Type	TEUTKEN SAFETY CATAGORY
#20	Removal of Heat Shrink Tubing On Conax Penetrations	3
#30	Housekeeping	Least
N/A	Conduit As Built	3

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
CEA's - Blount	Supports, Columns	2
CEA's - Hunter	Piping, Hangers	
CEA's - Hatfield	Conduit / Cable Pan Hangers	
CEA's - P-A-P	Instrument Piping Hangers	
CEA's - RSH	Ductwork Hangers	
CEA's - JCI	Instrument Piping Hangers	
Rebar Detection - Blount, Hunter, Hatfield, P-A-P, RSH, JCI	For Installation of CEA's	Least
Bolting - Turn-of-Nut - Blount	Connections	2
Calibrations - Blount, Hunter, Hatfield, P-A-P, RSH, JCI, NISCo, Midway	Torque wrenches, Thermometers, Feeler Gauges, Scales, Gauges	Least

PTL 3-2

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
Cadwelds - Blount	Rebar Coupling	3
Soils - Blount	Back Fill	2
Concrete Field - Blount	Placement	2
Concrete Lab - Blount	Aggregate	2
Visual Weld Inspection - Am. Bridge Mid-City Blount	Weld Inspection	1

HUNTER

2-1

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(1) Visual Weld	Piping - Visual Weld Inspection	/
(1) Visual Weld	Whip Restraint - Visual Weld Inspection	/
(1) Visual Weld	Component Support Visual Weld Inspection	/

Hunter 2-2

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(2) Documentation	Piping - Mech. Jt. Documentation	Least
(2) Documentation	Ferrite Inspection Documentation	Least
(2) Documentation	Hydrostatic Test Documentation	Least
(2) Documentation	Weld Interpass Temp. Documentation	Least
(2) Documentation	Joules Test Documentation	Least
(2) Documentation	Code Name Plate Change Documentation	Least
(2) Documentation	Documentation of Weld Defect Removel Cavity	Least

Hunter Z-3

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(2) Documentation	Piping - Weld Documentation	Least
(2) Documentation	Whip Restraint - Weld Documentation	Least
(2) Documentation	Component Support - Weld Documentation	Least
(2) Documentation	Piping - Component Inspection Documentation	Least
(2) Documentation	Whip Restraint - Component Inspection Documentation	Least
(2) Documentation	Piping - Fitup Documentation	Least
(2) Documentation	Whip Restraint - Fitup Documentation	Least
(2) Documentation	Piping - Bend Documentation	Least
(2) Documentation	Component Support Inspection - Documentation	Least
(2) Documentation	Dimensional Location of Field Welds	Least

Hutr 2-4

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(2) Documentation	Buried Pipe Covering Inspection - Documentation	Least
(2) Documentation	Concrete Expansion Anchor - Documentation	Least
(2) Documentation	Piping - Pre-Heat Insp. Documentation	Least
(2) Documentation	Whip Restraint - Pre-Heat Inspection Documentation	Least
(2) Documentation	Pipe Weld - Shield Gas Documentation	Least
(2) Documentation	Component Support - Snubber Sticking Documentation	Least
(2) Documentation	Piping & Component Support, Temporary Attachments Documentation	Least
(2) Documentation	Bolting - Turn-of-Nut Documentation	Least

Hunter 2-5

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(2) Documentation	Piping - Small Bore Final Inspection (Type 3) Documentation	Least
(2) Documentation	Piping - Small Bore Final Inspection (Type 4) Documentation	
(2) Documentation	Whip Restraint - Final Inspection (Type 3) Documentation	
(2) Documentation	Whip Restraint - Final Inspection (Type 4) Documentation	
(2) Documentation	Piping - Large Bore Final Inspection (Type 3) Documentation	
(2) Documentation	Component Support - Final Inspection (Type 3) Documentation	
(2) Documentation	Component Support - Final Inspection (Type 4) Documentation	
(2) Documentation	Equipment Installation- Final Inspection (Type 3) Documentation	

Hunter 2-6

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(3) Hardware	Piping - Mech. Jt. Torque	2
(3) Hardware	Visual Inspection of Valves	2
(3) Hardware	Ferrite Inspection	3
(3) Hardware	Piping Hydrostatic Test	3
(3) Hardware	Piping Weld Interpass Temperature Inspection	3
(3) Hardware	Joules Test Inspection	3
(3) Hardware	Code Name Plate Change	Least
(3) Hardware	Inspection of Weld Defect Removal Cavity	2
(3) Hardware	Piping - Component Inspection	1

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(3) Hardware	Whip Restraint - Component Inspection	2
(3) Hardware	Piping - Fitup & Tack Weld	3
(3) Hardware	Whip Restraint - Fitup & Tack Weld	3
(3) Hardware	Piping - Bends	2
(3) Hardware	Component Support Inspection	1
(3) Hardware	Dimensional Location of Field Welds	Least
(3) Hardware	Component Support Torque	2
(3) Hardware	Potted Pipe Covering Inspection	Least
(3) Hardware	Concrete Expansion Anchor Inspection	3
(3) Hardware	Piping - Pre-Heat Inspection	3

Hunter 2.8

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(3) Hardware	Whip Restraint - Pre-Heat Inspection	3
(3) Hardware	Pipe Weld - Shield Gas Verification	3
(3) Hardware	Component Support - Installation	3
(3) Hardware	Piping & Component Support, Temporary Attachments	3
(3) Hardware	Bolting - Turn-of-Nut	2
(3) Hardware	Piping - Small Bore Final Inspection (Type 3)	2
(3) Hardware	Piping - Small Bore Final Inspection (Type 4)	1
(3) Hardware	Whip Restraint - Final Inspection (Type 3)	2
(3) Hardware	Whip Restraint - Final Inspection (Type 4)	1

Hutr 2.9

Attribute Classification	Inspection Type	TEUTKEN SAFETY CATAGORY
(3) Hardware	Piping - Large Bore Final Inspection (Type 3)	1
(3) Hardware	Component Support - Final Inspection (Type 3)	2
(3) Hardware	Component Support - Final Inspection (Type 4)	1
(3) Hardware	Equipment Installation	2

C. CATEGORIZATION OF SUBJECTIVE DISCREPANCIES

An engineering evaluation has been performed for each observed subjective (weld) discrepancy. The evaluation methods used can be divided into three categories. These three categories are related to the acceptance criteria for visual weld inspection. The acceptance criteria consists of inspecting welds for arc strike, spatter, convexity, crater, incomplete fusion, overlap, porosity, undercut, underrun, and cracks. The presence of these weld inspection items are considered as weld discrepancies. These weld discrepancies vary in degree as to their effect on weld capacity.

Category X - Evaluation by comparison with current design parameters and tolerances.

Category X contains weld discrepancies that do not reduce the weld capacity. Arc strikes and spatter are cosmetic indications that relate only to appearance. Convexity relates to weld metal on the face of a weld in excess of the weld metal necessary for the required weld size. Convexity has no effect on weld capacity (see Exhibit C-2 Section C.1).

Category Y - Evaluation based on engineering judgment by comparison of the discrepancy with design margins.

Category Y contains some of the following weld discrepancies: crater, incomplete fusion, overlap, porosity, undercut, or underrun. Portions of the weld with these discrepancies are considered ineffective, and weld capacity is based on a reduced weld length. Engineering judgment is used to evaluate the weld discrepancies based on the available design margin in the weld and the reduced weld length, which accounts for the assumed ineffective portions. Typically, this results in less than a 10% reduction in weld strength properties to account for the weld discrepancies.

<u>Category Z</u> - Evaluation by engineering calculations.

Category Z evaluations are based on reducing the weld length to account for the presence of weld discrepancies as given for Category Y. Two welds with cracks were evaluated in Category Z. The method for evaluating the discrepancies is based on engineering calculations because the magnitude and types of discrepancies cannot be judged as adequate without a detailed calculation.

D. RESULTS OF SUBJECTIVE DISCREPANCY EVALUATION

The results of the subjective discrepancy evaluation for each contractor are summarized in Table C-2.

A more detailed breakdown of discrepancy evaluation is shown for each contractor in Exhibit C-1, which contains Tables CE-1 (Johnson Controls), CE-2 (Hunter), CE-3 (Hatfield), CE-4 (Powers-Azco-Pope), CE-5 (Pittsburgh Testing), and CE-6 (Peabody).

A more detailed description of the engineering evaluations that were performed is presented in Exhibits C-2 (AWS Welding) and C-3 (ASME and ANSI B31.1 Welding).

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Table C-2
Summary of Subjective Discrepancy Evaluation Results

Contractor	No. of Discrepancy Evaluations	Category X No. Within Parameters	Category Y No. Acceptable by Judgment	Category Z No. Acceptable by Calculation	No. with Design Significance
Blount Brothers*	N/A	N/A	N/A	N/A	0
Johnson Controls	65	15	12	38	0
Hunter	109	25	23	61	0
NISCo	0	0	0	0	0
Hatfield Electric	2,117	11	2,064	42	0
Powers-Azco-Pope	914	201	77	636	0
Pittsburgh Testing	905	1	887	17	0
Peabody Testing	22	0	11	11	0
TOTAL	4,132	253	3,074	805	0

*Inspection of Blount Brothers was performed by Pittsburgh Testing. Inspection results are reported under Pittsburgh Testing.

Table C-2 shows that 6% of the discrepancies identified in the Reinspection Program as Category X are not "valid" discrepancies and represent work that is within current design parameters. The Category X discrepancies result primarily from design parameters that have been expanded since the time of the original inspection and therefore are within current design limits.

The Category Y evaluation in Table C-2 indicates that 74% of the observed weld discrepancies, wherein weld capacity was reduced by approximately 10% after accounting for the weld discrepancy, are acceptable. In all cases, the design margin remained within design limits.

The Category Z evaluation in Table C-2 indicates that 19% of the observed weld discrepancies are acceptable. The reduction in weld capacity varied after accounting for the weld discrepancy. However, in all cases, the design margin remained within the specified design limits.

C. CATEGORIZATION OF OBJECTIVE DISCREPANCIES

An engineering evaluation has been performed for each observed objective discrepancy. The evaluation methods used are divided into three categories. The categories and typical types of evaluation methods used in each category are shown below:

Category X - Evaluation by comparison with current design parameters and tolerances.

Perform a comparison of actual component locations to the corresponding design location with applicable installation tolerances to show that the actual locations are within tolerance.

Perform a comparison of the actual installation to the designed installation for discrepancies with minor documentation errors to show that error was limited to the documentation and did not affect the actual installation.

Perform a comparison of actual component dimensions to the corresponding design dimensions with applicable tolerances applied to show that the actual dimensions are within tolerance.

Category Y - Evaluation based on engineering judgment by comparison of the discrepancy with design margins.

Perform a comparison of discrepancy to current design analysis or calculations to determine that the discrepancy was not significant.

Review the component design function to determine that the function of the component was not affected by the discrepancy.

Category Z - Evaluation by engineering calculations.

Revise the existing design documents to incorporate the design change reflected in the discrepancy.

Prepare a specific calculation to address the impact of the discrepancy on the design.

D. RESULTS OF OBJECTIVE DISCREPANCY EVALUATION

The results of the objective discrepancy evaluation for each contractor is summarized in Table D-2.

Table D-2
Summary of Objective Discrepancy Evaluation Results

Contractor	No. of Discrepancy Evaluations	Category X No. Within Parameters	Category Y No. Acceptable by Judgment	Category Z No. Acceptable by Calculation	No. with Design Significance
Blount Brothers	28	10	8	10	0
Johnson Controls	47	15	19	13	0
Hunter	684	614	52	18	0
NISCo	12	0	12	0	0
Hatfield Electric	1,675	1,243	74	358	0
Powers-Azco-Pope	295	232	5	58	0
Pittsburgh Testing	66	1	9	56	0
Peabody Testing*	N/A	N/A	N/A	N/A	N/A
TOTAL	2,807**	2,115	179	513	0

*Reinspection of Peabody Testing involved only subjective inspections.

**In some cases, more than one discrepancy was associated with a component. This results in the number of discrepancy evaluations (2,807) shown in Table D-2 being different than the number of discrepancies (3,247) shown in Table D-1.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

CHAIRMAN

Attachment D

February 1, 1982

The Honorable John D. Dingell, Chairman
Committee on Energy and Commerce
United States House of Representatives
Washington, D.C. 20515

Dear Mr. Chairman:

We share the concerns expressed in your November 13, 1981 letter regarding the implication of the recent seismic design errors detected at the Diablo Canyon nuclear power plant. The implication of these errors has been and will be thoughtfully considered by the Commission.

The timing of the detection of these errors, so soon after authorization for low-power operation, was indeed unfortunate and it is quite understandable that the Congress' and the public's perception of our licensing process has been adversely affected. Had this information been known to us on or prior to September 22, 1981, I am sure that the facility license would not have been issued until the questions raised by these disclosures had been resolved.

Because of these design errors, on November 19, 1981 we suspended Pacific Gas and Electric Company's (PG&E) license pending satisfactory completion of the following:

1. The conduct of an independent design review program of all safety-related activities performed prior to June 1, 1978 under all seismic-related service contracts used in the design of safety-related structures, systems and components.

2. A technical report that fully assesses the basic cause of all design errors identified by this program, the significance of the errors found and their impact on facility design.

3. PG&E's conclusions of the effectiveness of the design verification program in assuring the adequacy of facility design.

4. A schedule for completing any modifications to the facility that are required as a result of the design verification program.

In addition, the Commission ordered PG&E to provide for NRC review and approval:

1. A description and discussion of the corporate qualifications of the company or companies that PG&E would propose to carry out the

independent design verification program, including information that demonstrates the independence of these companies.

2. A detailed program plan for conducting the design verification program.

In recognition of the need to assure the credibility of the design verification program, NRC will decide on the acceptability of the companies proposed by PG&E to conduct this program after providing the Governor of California and Joint Intervenors in the pending operating licensing proceeding 15 days for comment. Also, the NRC will decide on the acceptability of the plan proposed by PG&E to conduct the program, after providing the Governor of California and the Joint Intervenors in the pending operating license proceeding 15 days for comment.

Prior to authorization to proceed with fuel loading, the NRC must be satisfied with the results of the seismic design verification program and with any plant modification resulting from that program that may be necessary prior to fuel loading. The NRC may impose additional requirements prior to fuel loading necessary to protect health and safety based upon its review of the program or any of the information provided by PG&E. This may include some or all of the requirements specified in the letter to PG&E dated November 19, 1981.

Responses to each of the four questions in your letter are enclosed.

A decision to permit PG&E to proceed with fuel loading will not be made until all the actions contained in the Commission's November 19, 1981 Order are fully satisfied.

Sincerely,

Nunzio J. Palladino

Nunzio J. Palladino

cc: Rep. Carlos Moorhead

Enclosures:
1. Commission Order, dated 11/19/81
2. Ltr from Office of Nuclear Reactor Regulation, NRC to PG&E dated 11/19/81
3. Responses to Questions

Fax
To: Steve Lewis
From: Steve B.
3-Page

RESPONSES TO QUESTIONS IN NOVEMBER 13, 1981 LETTER TO CHAIRMAN PALLADINO FROM CONGRESSMEN DINGELL AND OTTINGER

Question 1: Please provide, prior to the issuance of the 50.54(f) letter, the definition of the terms (i) "independent," (ii) "competent," (iii) "integrity," and (iv) "complete.

Response: Although one of the options under consideration by the Commission was a 50.54(f) letter, the Commission decided to suspend PG&E's license to load fuel and conduct tests up to 5 percent power by Memorandum and Order dated November 19, 1981, pending satisfactory completion of certain actions, including the conduct of a design verification program. Also, a staff letter of the same date required PG&E to carry on other design verification programs prior to issuance of any license authorizing operation above 5 percent power.

The most important factor in NRC's evaluation of the individuals or companies proposed by Pacific Gas and Electric to complete the required design verification program is their competence. This competence must be based on knowledge and experience in the matters under review. These individuals or companies should also be independent. Independence means that the individuals or companies selected must be able to provide an objective, dispassionate technical judgment, provided solely on the basis of technical merit. Independence also means that the design verification program must be conducted by companies or individuals not previously involved with the activities at Diablo Canyon that they will now be reviewing. Their integrity must be such that they are regarded as reputable companies or individuals. The word "complete" applies to the NRC requirement for review of all quality assurance procedures and controls used by each pre-June 1978 seismic and non-seismic service related contractor and by PG&E with regard to that contract. A comparison of these procedures and controls with the related criteria of Appendix B to 10 CFR 50 is also required. Any deficiencies or weaknesses in the quality assurance procedures and controls of the contractor and PG&E will be investigated in more detail. In addition, calculations will be checked in an audit program. Numerical calculations for which the original basis cannot be determined will be recalculated to verify the initial design input.

Question 2: Please provide the criteria to be used in assuring that the proposed audit will be "independent."

Response: The competence of the individuals or companies is the most important factor in the selection of an auditor. Also, the companies or individuals may not have had any direct previous involvement with the activities at Diablo Canyon that they will be reviewing.

In addition, the following factors will be considered in evaluating the question of independence:

1) Whether the individuals or companies involved had been previously hired by PG&E to do similar seismic design work.

2) Whether any individual involved had been previously employed by PG&E (and the nature of the employment).

3) Whether the individual owns or controls significant amounts of PG&E stock.

4) Whether members of the present household of individuals involved are employed by PG&E.

5) Whether any relatives are employed by PG&E in a management capacity.

In addition to the above considerations, the following procedural guidelines will be used to assure independence:

1) An auditable record will be provided of all comments on draft or final reports, any changes made as a result of such comments, and the reasons for such changes; or the consultant will issue only a final report (without prior licensee comment).

2) NRC will assume and exercise the responsibility for serving the report on all parties.

Question 3: In view of the licensee's past performance, and that of its subcontractors, what procedures will be utilized to ensure that there are not conflicts of interests in the performance of any required audits?

Response: We are requiring that PG&E provide the NRC with a description and a discussion of the corporate qualifications of the companies proposed to carry out the various design verification programs, including information that demonstrates the independence of these companies. This information will be provided to the Governor of California and the Joint Intervenors for comments. Based upon review of the information provided by PG&E and the comments of the Governor and Joint Intervenor, the NRC will decide on the acceptability of the companies with respect to their "independence" and "competence." In addition, approval will not be given by NRC if we determine that a potential conflict of interest exists in the performance of any required audits that cannot be adequately addressed by procedural safeguards.

Question 4: What plans does the NRC have to ensure that a similar situation will not arise at other plants now under construction? What, if any, additional quality control procedures does the NRC propose to institute in its inspection program?

Response: The Commission is developing an action plan that will result in improved NRC review of quality assurance programs at operating nuclear power plants and nuclear power plants under construction. The details of the action plan will be available in the near future.