UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of PACIFIC GAS AND ELECTRIC COMPANY (Diablo Canyon Nuclear Power Plant, Units 1 and 2)	Docket Nos. 50-275 50-323 (Design Quality Assurance)

AFFIDAVIT OF R. C. ANDERSON, M. J. JACOBSON, M. E. LEPPKE, L. E. SHIPLEY

STATE OF CALIFORNIA)
) ss.
CITY AND COUNTY OF SAN FRANCISCO)

The above, being duly sworn, depose and say:

I, Richard C. Anderson, am Engineering Manager for the Diablo Canyon Project.

I, Michael J. Jacobson, am Project Quality Assurance Engineer for the Diablo Canyon Project.

I, Myron E. Leppke, am Onsite Project Engineer for the Diablo Canyon Project.

I, Larry E. Shipley, am Technical Consultant for Piping for the Diablo Canyon Project.

8404090491 840306
PDR ADOCK 05000275
G PDR

By letter dated February 7, 1984 (PGandE Letter No.: DCL-84-046) we forwarded to the NRC a response to questions raised as a result of the recent NRC investigation into allegations regarding small bore piping design (attached hereto as Exhibit 1). We supervised and participated in the preparation of this response, and it is true and correct to the best of our knowledge, information, and belief.

Dated: March 5, 1984

R. C. ANDERSON

M. J. JACOBSON

M. E. LEPPKE

L. E. SHIPLEY

Subscribed and sworn to before me this 5th day of March, 1984.

Nancy J. Lemaster, (SEAL)
Notary Public in and for the City and County of San Francisco, State of California.
My commission expires April 14, 1986.

NANCY J. LEMASTER
NOTARY PUBLIC-CALIFORNIA
CITY AND COUNTY OF SAN FRANCISCO
My Commission Expires April 14, 1986

List of Exhibits

PACIFIC GAS AND ELECTRIC COMPANY

COPY

Exhibit No.1

February 7, 1984

PGandE Letter No.: DCL-84-046

Mr. Darrell G. Eisenhut, Director
Division of Licensing
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Re: Docket No. 50-275, OL-DPR-76
Diablo Canyon Unit 1
Small Bore Piping

Dear Mr. Eisenhut:

During the recent NRC investigations into allegations listed in SSER 21, the Staff raised several questions with respect to the design of small bore piping. These questions were discussed by the Staff at the Diablo Canyon Power Plant exit interview on January 19, 1984 and at the January 31, 1984 meeting in San Francisco between the NRC and PGandE.

The Staff questions and PGandE's responses are documented in the enclosure.

Kindly acknowledge receipt of this material on the enclosed copy of this letter and return it in the enclosed addressed envelope.

Sincerely,

J. O. Schuyler

by J. D. Shiffer

GCWu/BSL/JDS/JOS:naw
Enclosures

cc: T. W. Bishop
G. W. Knighton
J. B. Martin
H. E. Schierling

bcc: Diablo Distribution

0174d/0007K

ENCLOSURE

I. INTRODUCTION

1. General

This submittal is provided in response to questions raised as a result of the recent NRC investigation of allegations regarding small bore piping design by the Onsite Project Engineering Group (OPEG). This submittal sets forth the questions raised, responses to those questions, conclusions, and if applicable, the corrective action being taken by the Project.

To prepare this submittal, the Project reviewed the information developed by the NRC investigators and noted the explanations and conclusions provided by the investigators during exit meetings and the public meeting of January 31. After investigating the facts giving rise to these concerns, basic causes of discrepancies and generic implications were carefully considered. Conclusions have been derived as to adequacy of the design, effectiveness of the quality assurance program, and needs for corrective action and for strengthening the program.

The questions appear to encompass the following issues:

- Adequacy of small bore pipe design
- Effectiveness of the quality assurance program for OPEG
- Generic implications from discrepancies found
- Corrective actions which might be necessary or desirable

It is important to recognize that none of the evidence demonstrates that there were inadequate designs or that the overall quality assurance program was ineffective. At most, concerns were raised which create a need for additional information to provide requisite levels of assurance. The investigation also identifies where improvements are desirable in Project programs and practices.

2. Nature of Concerns

The concerns raised cover a wide range of small bore piping design activities that are more thoroughly explained and evaluated in the individual sections or subsections to follow. However, it is possible to provide some statements and perspectives regarding the review effort:

a. Discrepancies have been found in the small bore piping design work.

b. Such discrepancies are of a minor nature and, when revised calculations or analyses were performed, all of the piping and supports fully met the licensing criteria and commitments. Thus, it can be concluded that there is no technical or safety concern with the as-designed and constructed safety-related small bore piping.

c. The presence of these discrepancies raised concerns regarding the control of the engineering work within the OPEG small bore piping group and its overall level of quality. Such concerns have been addressed by the explanation and discussion given for each specific concern and by the corrective action being taken.

d. The major corrective action to date involves the review of 110 small bore pipe support analyses: 57 of the more complex (computer analyzed) safety-related small bore pipe support designs; 25 of the simpler (hand calculated) small bore pipe supports; and the 28 calculations identified by the NRC during its investigation. Additionally, certain strengthened training and procedural requirements and commitments have been made.

3. The OPEG Organization

The OPEG is organizationally a part of Project Engineering, but is located at the site and thus physically separated from the San Francisco engineering group. It was established to meet construction's need for expeditious responses from design engineering, to provide more direct feedback to design engineering on construction and startup matters, and to perform certain engineering activities (e.g., small bore piping design) that are best performed in proximity to the physical plant. The OPEG group functioned with substantial autonomy, because of the need for close-coupling with site construction and operations, and because its scope was rather closely defined. This was intended to make it more responsive to a need for on-the-spot resolution of problems.

The scope of OPEG's responsibilities is limited by Engineering management to matters within its capabilities, considering such factors as staff support, facilities, abilities of assigned personnel, and number of people. This scope is clearly set forth in writing. Typically, the work performed by OPEG includes design of Class I small bore pipe and supports, limited resolution of physical interferences, resolution of non-conformances, and assistance in startup problems. It serves the needs of both Units 1 and 2. By far, the greatest proportion of its work is related to design of small bore pipe and supports. No other major design work or analysis was performed by OPEG.

The OPEG organization is headed by an onsite Project Engineer, reporting to the Project Engineers for Units 1 and 2 and receiving assignments from them. The number of people has varied widely, ranging from several dozen, up to almost 300. Because of the unique requirements of this group and the nature of their work, more than 50% of its technical personnel were comprised of

non-permanent engineers provided by contract firms. The engineers are, however, carefuly screened for technical competence by PGandE or Bechtel, and by the contract firm prior to hiring.

4. Conclusions

It is clear that the results of the reviews completed to date establish that there is reasonable assurance that the as-constructed small bore piping meets all design requirements and, thus, poses no safety concerns. Strengthened controls will minimize recurrence of similar issues.

Specific conclusions are as follows:

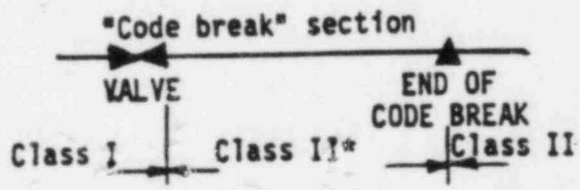
- Based on reviewing a sample of 110 piping support designs, it is concluded that final designs were not affected by the number of approximations and minor mistakes in the calculations of pipe supports and reasonable assurance of the adequacy of small bore piping design does exist. It should be noted that as of the time of this submittal, 6 of the 110 support analyses are not complete.
- Because of the unique features of the OPEG Small Bore Piping Group (e.g., work scope and how it functioned), there is no reason to believe that similar concerns exist elsewhere.
- Compliance with NQAM requirements, including numerous audits, plus the lack of significant errors, show the engineering quality assurance program was effective, but would benefit from strengthening in areas of training, technical audits, and procedure control.
- Perjorative charges in small pipe design work cannot be supported.

II. TECHNICAL ISSUES

NRC Question: The NRC has raised a question about Code Break designations (Allegations 55, 86, and 88, SSER 21). This matter was further addressed by Dr. Hartzman at the public meeting on January 31, 1984.

Response

The term "code break" is used to describe the section of a piping system where the safety-related piping (Class I) changes to nonsafety-related (Class II) piping (see the figure below). This "code break" section is always located on the Class II piping and starts at the valve which is the point at which the fluid system class changes from Class I to Class II. Within the "code break" section is a system of supports or an anchor that dynamically isolates the Class I piping from the remainder of the Class II piping. The "code break" section of the pipe ends when dynamic isolation has been accomplished. The criteria used to achieve the desired isolation, as discussed in the Phase I Final Report, require that the system of supports that provides dynamic isolation be made up of either: (1) an anchor or (2) at least two lateral supports in each direction and one axial support. The anchor, or supports, are denoted as Class II* supports and are designed to the same criteria that are used for Class I supports.



Class I = Safety-related
Class II* = Nonsafety-related but supported to achieve isolation of the Class I piping ("Code Break" section)
Class II = Nonsafety-related nonseismic design

In the above schematic, the length of Class II* piping is not important as long as the code break requirements are met by providing supports or an anchor. If the length of the Class II* section of piping can be shortened by relocating the Class II boundary closer to the Class I boundary, the system would then require fewer Class II* supports; this relocation is only accomplished by adding supports or an anchor to the code break section closer to the Class I boundary. As an example, assume that following the valve, the code break section included five bilateral supports (these provide support in both lateral directions at one location) and then an axial support. All these supports would require Class 1 qualification. Two alternatives for improvement of the design that are acceptable and meet all licensing criteria are: (1) to add an anchor at the location of the first bilateral support, or (2) to add an axial support at the location of the second bilateral support. Both alternatives reduce the length of the code break and the number of supports requiring Class I qualification.

The allegation that the code break boundaries were relocated in violation of some engineering precept, project instruction, or licensing criteria is fallacious. While it is true that the length of Class II* piping was minimized wherever possible by modification or addition of supports, there is no reason <u>not</u> to reduce the amount of the Class II* piping to the minimum.

NRC Question: The NRC has raised a question about including as-built gaps to reduce thermal loads (Allegations 55 and 79, SSER 21). This matter was further discussed by Mr. Yin at the January 31, 1984, public meeting.

Response

When performing small bore piping stress analysis for thermal expansion or thermal anchor motion, actual restraint clearances or as-built gaps are sometimes included in the qualification calculations as described in Piping Procedure P-11 (Section 4.6.2). The gaps that are included are physical clearances that exist between the pipe and a structural element. Thermal loads can be eliminated by gaps in pipe supports and, therefore, the inclusion of gaps in the qualification analyses is completely appropriate. In each case where gaps are included to reduce thermal loads, adequate assurance is available that the gap can be relied on to be present throughout the plant lifetime.

Before any gaps were included in a piping stress analysis, Piping Procedure P-11 required as-built reverification. Accordingly, a plant walkdown was conducted to establish the actual gap configuration. The gap configuration was modeled and included in the documentation of the stress analysis calculation. This practice of including gaps to reduce thermal loads is used in the industry as a method of accounting for actual plant conditions.

As a result of this NRC question, a review of all small bore piping stress analyses was conducted. The results of the review demonstrated that as-built gaps were included in 25 piping analyses affecting a total of 64 pipe supports. The 64 supports represent about 3% of the supports analyzed. As reported in the Project's supplemental letter to the Staff dated December 28, 1983, 16 of the 25 piping stress analyses involved piping with service conditions below 200°F. In these 16 analyses, thermal movements are minor and not of technical concern. The 9 remaining pipe stress analyses affect only 16 supports (see Table 1) which are less than 1% of all the small bore pipe supports analyzed.

A description of the 9 pipe stress analyses in which as-built gaps were modeled into the computer analysis and the piping system temperature exceeds 200°F for normal thermal load cases was presented in the December 28, 1983, letter. These 9 analyses fall into two categories. Category 1 gaps were modeled to accommodate thermal anchor movement (TAM) of large bore piping. Since these gaps are caused by the thermal movement of large pipes and equipment expected to have repeatable thermal growth, the gaps are expected to be present throughout the plant's lifetime. All but one support falls in this category. Category 2 consists of gaps modeled to release thermal loads and stresses induced by two opposing supports restraining the pipe in the same direction. Because of the piping configuration that exists, it is clear that the as-built gaps will remain throughout the plant's lifetime.

The consideration of actual restraint clearances, as described in the supplemental December 28 letter, is a reasonable and adequate technique for the piping geometries involved. This method is consistent with the licensing criteria for Diablo Canyon and has gained widespread use in the nuclear industry where the more conservative approach of ignoring as-built gaps results in excessive thermal loads. Finally, the use of actual restraint clearance involved a very small part of the small bore pipe and supports that were analyzed.

Table 1*

Small Bore Piping Corresponding Calculation No. Piping Analysis was Modeled		Small Bore Support Gap Modeling No. for which Gap Data Point	Category (See Note)
S118	63-7	15	1
	181-84	550	1
	181-96	556	1
3-302A	53-1	50	1
	53-1	65	1
	53-1	67	1
3-302B	53-1	70	1
4-302	42-6	19B	1
8-310	2152-09	20	1
8-312	47-19	100	1
	47-24	175	1
8-314A	66-22	24	1
	2185-1	44	1
	66-25	58	1
	66-24	78	1
	66-51	32	1
8-328	2157-14	34	2
9-309	181-20	105	1
	181-42	200	1

NOTE: Category 1 = Gaps were modeled to accommodate thermal anchor movement (TAM) of large bore pipe whose movements are determined to be repeatable.

Category 2 = Gaps were modeled to release thermal loads and stresses induced by two opposing supports restraining the pipe in the same direction.

*Isometrics for this table were previously submitted with letter of December 28, 1983.

NRC Question: The NRC has raised questions about the use of different stiffnesses for the same rigid supports in static and dynamic pipe analysis (Allegations 55 and 88, SSER 21). This issue was also addressed by Dr. Hartzman during the January 31, 1984, public meeting.

Response

Piping support flexibility was modeled in 4 of 129 analyses (total number of ME-101 analyses) to more accurately determine the actual system behavior that occurs during thermal expansion of the piping and to reduce calculated thermal loads. The nature of thermal expansion produces only static (displacement limited) loads and not dynamic loads such as the seismic loads. Inclusion of support flexibility in the thermal piping system analysis is an acceptable method of more accurately predicting the load that will be produced at any given pipe support. This approach is consistent with accepted engineering practice.

The Hosgri Report, Section 8.2, states that seismic supports may be considered rigid if the natural frequency is greater than 20 Hz. Since the natural frequencies of these supports are greater than 20 Hz, the seismic analysis considered them to be rigid.

The support itself is qualified for the combined thermal plus seismic loads. Further, these loads are derived from two totally different loading phenomena: one static (thermal), and one dynamic (seismic).

Even though these calculations have met all licensing criteria, we have reperformed the 4 original analyses mentioned above with the support flexibilities also included in the seismic analysis to demonstrate the appropriateness of the original assumption. The results of these additional analyses demonstrate that the stresses and support loads are within the licensing criteria even when the support stiffness is included in both static and dynamic piping analyses.

In summary, the apparent inconsistent treatment of support stiffness for static and dynamic analyses is technically justified. The adoption of this approach was largely dictated by the desire to consistently implement seismic licensing criteria which analyze supports as rigid if their natural frequency is greater than 20 Hz. In any event, this practice does not violate licensing criteria even if support stiffness is included in both static and dynamic analyses.

NRC Question: The NRC has raised a question about computation errors and modeling deficiencies in small bore pipe support design packages. These issues were discussed by Dr. Hartzman and Mr. Yin at the public meeting held on January 31, 1984.

Response

The following response discusses and puts into perspective the calculational errors, the modeling anomalies, the engineering judgments, and the documentation inconsistencies found in small bore pipe support calculations. The analytical approach is reviewed to give perspective as to significance of real and perceived deficiencies. The necessity for precision in small bore calculations is discussed and a summary of the additional review effort that has been undertaken to address the NRC's concern is presented.

Although there are discrepancies in the calculation packages, one must recognize the large number of decisions that an analyst must make, and a checker must review, in a given calculation package compared to the number of discrepancies discovered by the NRC reviewers and by our own reviewers. Small bore pipe supports are designed with adequate precision to achieve the design function. The primary reason for the acceptability of this level of precision in small bore piping design is due to conservatisms and structural redundancy in the small bore piping and supports completed with the low magnitude of loads which they experience. Nevertheless, the need for originating and checking engineers to more rigorously document acceptance of minor calculational errors is acknowledged.

Some of the pipe supports reviewed by the NRC inspectors are among the most complex small bore supports in the plant. The discrepancies found in our study of the NRC review actually represent a small percentage of the total number of decisions/actions that must be performed to arrive at a complete analysis. These analyses have been reviewed by the Project in detail and it has been determined that no modifications are required as a result of the discrepancies. This review is described below. The fact that no modifications were required confirms a conclusion that the design process and conservatisms are tolerant to minor anomalies and that the engineers responsible for the design of supports have ensured that significant errors do not exist.

a. Pipe Support Design Process

In the case of frame structure supports, the design generally consists of two phases. The first phase consists of the analysis of the frame structure and the second phase consists of the analysis of the associated base plates. Associated steps include evaluation of welds and qualification of standard components (struts, snubbers, U-bolts, etc.).

During the analysis of the frame structure, the analyst must translate a support drawing into a three-dimensional representation describing the placement, orientation, and properties of the steel members and the directions and combinations of the applied piping loads. Upon completion the analyst must perform a final check of the overall results to assure compliance with design criteria.

A moderately complex small bore pipe support at Diablo Canyon consists of, for example, approximately 10 discrete steel structural members and connections. In addition, the support has many supplementary items such as U-bolts or other small members which act to restrain the pipe. The model eventually developed by the engineer will contain approximately 30 joints and 25 elements. To develop the model, the engineer has had to specify 30 directional (x-y-z) coordinate points and define the connectivity of the elements to these joints. This means ensuring that approximately 90 numbers are correctly calculated, all digits and signs are correct, and indicating the proper numerical combinations to define member connectivity are indicated. Also, the engineer has to indicate the orientation of the strong and weak axes of the member. When the analysis is completed, the engineer applies the loads to the support model.

Typically, small bore supports are bilateral (supporting the pipe in two directions) and many are gang supports (supporting two or more pipes). For example, consider a frame that acts as a support for two pipes. Given the number of loads that must be specified (deadload, tributary mass loads, normal and accident thermal loads, and three different seismic loads), one arrives at a total of 32 individual loads that must be correctly transferred from the piping analysis, including directional sign. Also, he must specify parameters, such as unbraced length, for code checking purposes. The engineer then submits the input for computer analysis. Upon receipt of the computer analysis, the engineer reviews the ouput for appropriateness of deflections and stresses. Up to this point, the engineer has had to correctly develop and specify at a minimum approximately 300 numbers, assuring that all digits and signs are correct. In addition, he has had to review numerous pages of computer output.

After the engineer has completed his frame analysis, he must now begin the task of analyzing the base plates. For the evaluation of base plates, the analyst must similarly deal with hundreds of numbers or combinations of numbers. The engineer must choose from the many load combinations the sets of forces and moments to be input into the plate/anchor bolt analysis. The local coordinates of the baseplate model must be correlated with the local/global coordinates of the frame model. The plate size, thickness and shape, in addition to anchor bolt location, stiffness, capacity, spacing, and derated capacity edge distances, must also be reviewed and input. Taken as a package, it is not difficult to conclude that the engineer in the above discussions has had to deal with and review up to 1000 numbers.

The judgment and capability of the engineer throughout the design process helps assure a safe design. His engineering training, experience, and insight are important in visualizing the model and loading conditions, as well as deciding that the results are acceptable. The engineer is responsible for assuring that the support design is free of significant error by applying his experience from performing analyses of many pipe supports.

Additionally, the reviewing engineer provides an important function in assuring that major errors do not exist by applying his general experience in evaluating the final piping system. The small size of these components allows good visualization and a heurestic understanding of the adequacy of a design, even without formal calculations and analyses. The engineer's understanding and experience lead to the identification of any major error by observing any obvious inconsistencies such as undersized members from that provided for other pipe supports.

The broad responsibility of the reviewing engineer is to assure that the calculation is sufficiently accurate for its intended purpose, i.e., to document how the support meets the design requirements. Therefore, minor discrepancies in areas of the calculation that would not lead to a criteria exceedence would not be expected to be documented. The fact that when the discrepancies were addressed the supports were acceptable without modification substantiates the adequacy of the design process. Nevertheless, discrepancies uncovered should have been documented.

b. Documentation of Small Bore Support Design

There are approximately 4000 small bore pipe supports which were designed and qualified in the field. Of necessity the process used to design and qualify these supports was a production-oriented process. The flow of work required a receipt of a set of loads and displacements, design of the support, preparation of design calculations, checking of the design calculations, and review and approval of the as-built drawings. Both the originator and reviewing engineer focused on the parameters of primary importance to the adequacy of the support. Although satisfactory for criterion and safety considerations, the level of rigor associated with these supports was different from that achieved in other parts of the plant. In general, this variation in rigor is clear to those familiar with design practices in power plant and industrial plant facilities throughout the country. More importantly, the rigor of design documentation varies according to (1) the importance of the system, (2) the degree to which the system design may be challenged (large loads vs. small loads), and (3) the conservatism which exists in the design.

The level of rigor of the small bore design documentation was technically consistent with the number of supports and the conservatism and structural redundancy inherent in the designs; however, compliance with quality program documentation was less than fully achieved in some instances.

c. Design Characteristics

The previous section described the design process and the conservatism inherent in small bore design. The fact that the margin is very large for this class of piping is often discussed but its importance must not be underestimated. Small bore piping is fabricated from materials with ductilities into the 30% to 40% range (resulting ductilities from the design analyses are typically less than 1%). The supporting systems provide for a highly redundant set of supports in which deflection of an individual support results in the transfer of load to adjacent supports. Additional conservatisms exist and are frequently tabulated in the methods used to calculate small bore loads on supports, especially when span tables are used for calculating stresses in the supports. The result is that the small bore piping system and supporting structures are highly conservative in design and highly insensitive to variations in the details of individual support designs.

d. Review of Supports

A significant number of small bore pipe support calculation packages have been reviewed in detail. Some were reviewed prior to the January 31, 1984 meeting and many have been reviewed since then. The IDVP reviewed a total of 19 calculation packages as documented in ITRs 60 and 61. The Project has reviewed 110 small bore pipe support analyses: 57 of the more complex (computer analyzed) safety-related small bore pipe designs; 25 of the simpler (hand calculated) small bore pipe supports; and the 28 calculations identified by the NRC during its investigation.

This Project review has been conducted to reverify the adequacy of the small bore piping design and to define the necessity for further improvement in documentation of the design adequacy. Each calculation package has been subjected to a detailed engineering review by the Project to identify all possible deficiencies or errors. This review has, of course, been far more rigorous and detailed than that performed in the original checking process.

Each of the selected calculation packages was reevaluated by a reviewer and reconfirmed by a checker. A checklist was used to aid in the review process. Results of the review were documented on the checklist and supplemental comments sheets, if required.

The reviewers verified that the structural model was adequate and complete, that the loads used in the calculations were properly applied, and that the structural model reflected the latest as-built drawing. Calculations were reviewed for required documentation, such as weld calculations, anchor bolts, base plate, spring variability, frequency, and structural analysis, to demonstrate compliance with appropriate project criteria, procedures and instructions.

The results were summarized into three categories.

The first category, "Hanger Acceptable As Is or With Minor Supplemental Calculations or Comments," is used to indicate those support calculation packages that were found to contain complete and acceptable information or to indicate those support calculation packages that were found to be acceptable, but which, for example:

(1) Lacked certain statements needed to document the conclusions reached.

(2) Did not contain documented evidence of the evaluation of certain items which the reviewer felt was prudent to include in the calculation package.

(3) Contained information from which the reviewer could not make an assessment and thus deemed it necessary to perform supplemental calculations in order to support his evaluation and conclusions.

It is not surprising that, due to the detail in the review, minor supplemental calculations or comments were required. Other engineers, rigorously looking after the fact, will generally always comment on some aspect of someone else's design calculation.

The second category, "Hanger Acceptable With Detailed Calculations," is used to indicate those support calculation packages that were found to be acceptable, but where, for example:

(1) The reviewer believed that it was advisable to perform additional analyses or modify and rerun the existing computer analyses.

The term "Hanger Acceptable" indicates acceptability to the design criteria which were originally used to qualify the supports. The methods and criteria were not modified for this evaluation. Highly sophisticated analysis, such as plasticity calculation, was not used to qualify any of these supports.

The last category, "Hanger Unacceptable," is used to indicate those support calculation packages that were found to contain errors which, upon reanalysis, showed that the hanger required modification.

There were 129 support calculations included in the review. The results are as follows:

Category	% of Supports
Acceptable with Minor Supplemental Calculations or Comments	78%
Acceptable with Detailed Calculations	17%*
Unacceptable	0%

*Detailed calculations for 6 supports (5%) have yet to be completed.

These results are significant. Of the 129 small bore supports, some among the most complex in the plant, the fact that no modifications were required indicates the minor impact of the anomalies noted.

It is also interesting to characterize the discrepancies themselves. The discrepancies noted in the review were tabulated into one of three categories. These categories were (1) modeling, input, or calculational error, (2) modeling or engineering judgment (verified by subsequent calculation), and (3) documentation discrepancy.

The first category includes such items as mis-modeling a beam property, having the wrong sign on an applied load, or performing a mathematical calculation incorrectly. The second category includes items which the reviewer noted as a modeling or engineering judgment, but felt that a supplemental calculation was necessary to verify the conclusion, and subsequently performed the calculation and verified the judgment. The third category includes reference to non-Project documents and a clear engineering judgment made but not explicity stated as such.

The conclusions drawn from this categorization are as follows:

Category	Percent of Discrepancies
Modeling, Input, or Calculation Error	74%
Modeling or Engineering Judgment	7%
Documentation Discrepancy	19%

The design process for small bore piping presents a large number of opportunities for the support designer to err in both the analysis and documentation of that analysis. On the other hand, the design process provides sufficient conservatism to assure that such deficiencies do not result in supports that do not meet licensing criteria. An extensive review program of the documentation for the design of pipe supports was conducted. The results of this program demonstrate that, while the level of documentation of these calculations should have been better, the small bore piping supports are adequate and met design requirements when the documentation discrepancies were corrected.

NRC Question: The NRC raised questions about the placement of new restraints adjacent to old restraints as a means of qualifying the old restraints (Allegation 88, SSER 21).

Response

New pipe supports were added to small bore piping for many reasons; e.g., to meet code break, valve acceleration, or thermal criteria. In some cases these new supports were located near existing supports. This approach would obviously have the effect of reducing loads on the existing supports. The small bore piping program was explicitly conducted to ensure that all supports met the licensing criteria. In some cases, conditions were modeled where a structural restraint that was not a pipe support was present. For example, there are several instances in which a penetration was modeled as a seismic restraint. When a support was modeled in the final analysis, either a support or restraint physically existed in the plant or a new support point was modeled in the stress analysis calculation. If a new support is added, a documentation number is assigned to the new pipe support and remains with it throughout the design, construction, as-building, and final engineering approval cycle. This documentation trail ensures that the support is constructed in accordance with the design.

NRC Question: The NRC raised questions about snubbers located adjacent to rigid restraints being inoperative during dynamic loading (Allegation 88, SSER 21). This question was discussed further by Mr. Yin at the public meeting held on January 31, 1984.

Response

During a site visit, the NRC identified 16 snubbers that were located in close proximity to rigid restraints (proximity restraints). There was concern that in the event of a seismic disturbance, the rigid restraint would prohibit the snubber from actuating. The "lost motion" or "dead band", resulting from mechnical clearances in the snubber, must be overcome before the snubber will begin to restrain the piping. These clearances are typically very small and a review of the test results for the Diablo snubbers indicates an average dead band of 0.021 inches (roughly the thickness of 5 sheets of paper).

We agree that there are snubbers located in close proximity to rigid restraints at Diablo Canyon just as there are at other nuclear plants. It has been industry practice to ignore the dead band when performing seismic analysis. This was believed to be justified since the non-linearities induced by the small dead band described above are not sufficient to affect the results of the seismic analysis. Further, seismic stress is induced in a piping system only when large movements of the piping occur relative to the building structure. If the piping is allowed to move 0.021 inches, the induced stresses will be of an insignificant nature. It is recognized that loads on pipe supports may change.

Therefore, in order to address the potential changes in piping stresses and support loads and to provide assurance to the NRC that there is no safety concern, the DCP has undertaken a 100% review of all proximity restraints. This program is described in detail in Attachment 1. Attachment 2 describes the results of this program.

The results of this study demonstrate that in no case is a section of piping overstressed or a support overloaded when the piping movement is not sufficient to lock a snubber or engage a rigid restraint.

ATTACHMENT 1

(Proximity Restraints)

An issue concerning the significance of snubbers located in close proximity to other seismic restraints has been raised. In its initial form, the issue was that snubbers located close to rigid restraints may not lock up during a seismic event. The safety significance of this, if any, was unknown and it was felt that it should be reviewed. The review involved removing the identified snubber from the piping seismic analysis if actuation was not predicted, and reanalysis of the three seismic load cases: DE, DDE, and Hosgri.

Each of the 16 snubbers identified by the Staff were reviewed. A reanalysis of the DE, DDE and Hosgri seismic load cases was performed to determine the amount of movement. If actuation was not predicted for the identified snubber, the snubber was removed from the piping seismic analysis. If the seismically induced piping movement was found to be greater than the amount required for the snubber to actuate, the snubber was considered acceptable since it would function. If the movement was less than the actuation level, the snubber was assumed not to function, and additional evaluations of pipe stress, valve acceleration levels, and loading on pipe supports were performed. The results of those evaluations are presented in Attachment 2.

In this review, the actuation level, or "lock-up" movement, was taken as the average value from the test results of snubbers in use at Diablo Canyon. The actual test results for the mechanical snubbers were used to extract the "lost motion" or "dead band" movement that occurs prior to snubber actuation. This lost motion includes the effects from the minute clearances in the snubber itself as well as the ball bushing and hinge pin. These movements are typical of any snubber and are not unique to Diablo Canyon. Every plant that uses snubbers has a lost motion movement of this magnitude.

Attachment 2 shows that, independent of whether the snubber will actuate, the piping system meets all licensing criteria. This confirms the validity of the design engineer's technical judgment that specific analytical treatment of snubbers was not warranted.

Therefore, our subsequent review demonstrates that the systems are fully acceptable, with snubber actuation specifically included. To better appreciate why snubber actuation was not initially included in the calculations, several facts should be recognized. In actual installation, there are clearances (gaps) in the rigid restraint that are designed to allow thermal expansion or construction tolerances. These clearances allow the piping to move sufficient distance to actuate an adjacent snubber, even though the analysis may not predict actuation. More importantly, if a snubber cannot actuate because of a nearby rigid support, the movements of the system are so small (less than 0.021 inches) that the actual piping stress cannot be significant; i.e., the failure of the snubber to actuate will not affect the piping integrity.

In order to provide even further assurance that there is no safety concern with snubbers next to rigids and anchors, and rigids next to anchors, a thorough review was made of the locations of all seismic restraints in the plant. A screening criteria was developed to assess the proximity of:

1. snubbers next to rigids (SR)
2. snubbers next to anchors (SA)
3. rigids next to anchors (RA)

These screeening critieria considered the piping stress that would be developed as a result of the snubber "dead band". This dead band would allow movement of the pipe prior to the snubber/rigid load acceptance. An initial screening was made using a 3-diameters (3D) spacing criterion.

In order to assess the sensitivity of the 3D criterion an additional review was undertaken of all of the snubbers within 5-diameters (5D) of a rigid or anchor. Note that the 5D criterion had been previously accepted as a method for screening snubbers next to anchors on SNUPPS. The NRC both raised this question and accepted the 5D response. A summary of the results is as follows:

Proximity Restraint Type	3D	5D
SR	25	37
SA	2	6
RA	25	37

As can be seen from the above table, the number of snubber interactions is small and demonstrates that good engineering practice was employed at DCPP. These proximity restraints were reviewed using the same methodology described previously for the initial 16 snubbers.

The results of this comprehensive study of all proximity restraints demonstrate that in no case is a section of piping overstressesd when the piping movement is not sufficient to lock a snubber or engage a rigid restraint. With over one-half of the support evaluations completed, all design criteria have been met.

The snubber and rigid interface issue raised by the Staff is a concern of recent vintage and, while it is worthy of attention from an ALARA point of view, it is not a safety concern. This issue was not part of the DCP criteria, procedures, or instructions, nor has it been an industry practice to consider the gaps in rigid restraints or the "dead band" in snubbers. As a consequence, the IDVP did not review this issue. As we have stated in several NRC meetings, PGandE will undertake a snubber optimization program.

ATTACHMENT 2

HANGER NO.	ANALYSIS NO./REV.	DE DISP. w/o SNUB.	DDE DISP. w/o SNUB.	HOS DISP. w/o SNUB.	SNUBBER ACTUATION*	COMMENTS
16-47SL	2-105/2	0.090"	0.180"	0.376"	Yes	
16-49SL	2-105/2	0.063"	0.126"	0.298"	Yes	
16-28SL	4-102/4	---	---	---	---	This snubber was identified as a potential interference problem, not as a snubber actuation problem.
16-29SL	4-102/4	0.007"	0.014"	0.042"	Hosgri	Pipe Stresses OK Support Loads OK Valve Accelerations NA
16-63SL	4-102/4	0.021"	0.042"	0.169"	Yes	
16-77SL	4-102/4	0.081"	0.162"	0.253"	Yes	
4-2SL	4-135/2	0.001"	0.002"	0.013"	No	Pipe Stresses OK Support Loads OK Valve Accelerations NA
4-32SL	8-109/2	0.056"	0.112"	0.131"	Yes	
4-33SL	8-109/2	0.066"	0.132"	0.159"	Yes	
15-63SL	8-110/4	0.015"	0.030"	0.108"	DDE, Hosgri	Pipe Stresses OK Support Loads OK Valve Accelerations OK

ATTACHMENT 2

HANGER NO.	ANALYSIS NO./REV.	DE DISP. w/o SNUB.	DDE DISP. w/o SNUB.	HOS DISP. w/o SNUB.	SNUBBER ACTUATION*	COMMENTS	
15-64SL	8-110/4	0.002"	0.004"	0.007"	No	Pipe Stresses Support Loads Valve Accelerations	OK OK OK
16-79SL	8-116/2	0.004"	0.008"	0.011"	No	Pipe Stresses Support Loads Valve Accelerations	OK OK OK
16-67SL	8-117/4	0.001"	0.002"	0.099"	Hosgri	Pipe Stresses Support Loads Valve Accelerations	OK OK OK
16-68SL	8-118/2	0.001"	0.002"	0.010"	No	Pipe Stresses Support Loads Valve Accelerations	OK OK OK
22-400SL	3-313	0.132"	0.264"	0.210"	Yes		
22-401SL	3-313	0.050"	0.100"	0.054"	Yes		
	Summary	8 of 15 Lock Up	9 of 15 Lock Up	11 of 15 Lock Up			

*Test results from vendors indicate an average lock up displacement of 0.021".

NRC Question: The NRC has raised questions about possible improper resolution of pipe interferences (Allegation 89, SSER 21).

Response

During the course of modifying piping supports, interferences and obstructions were encountered. These were identified to Engineering and dispositions requested. As an example of this process, it was noted in one case that a Unistrut beam for the support of electrical conduit was constructed near a pipe and subsequently identified to Engineering for disposition (Allegation 89 from SSER 21). In fact, a walkdown program designed to identify all such unintentional restraints is commonly performed at the end of a project. Such a walkdown was performed at Diablo Canyon and any unintentional restraints were resolved by Engineering.

In a case such as the one involving the above-mentioned Unistrut, Engineering went through the following process of qualification. First, an attempt was made to requalify the system with the added restraint of the Unistrut present. In this case it was not possible to protect the Unistrut so the addition of a support at the location of the Unistrut was investigated. This investigation showed that the Unistrut was not required and it was removed from the plant. All of this was part of the iterative practice of qualifying an installed piping system and is not unique to this plant. All applicable procedures were followed in this process. Since all design criteria were met, there is no safety significance to this item. In fact, it would appear that this situation demonstrates good communication between Construction and Engineering, sound engineering practice, and a proper solution that resulted in a system that meets the design criteria.

NRC Question: The NRC has raised a question about the calculation of the load-carrying capacity of the small bore piping supports (Allegation 79 and 88, SSER 21).

Response

Different methods exist to qualify a piping system to design criteria. These methods often require iteration between engineering designers. An example of this can be seen in small bore piping qualification, where the pipe stress analysis produces reactions or loads on the pipe supports. After obtaining the loads on the supports, the pipe stress analyst transmits results to the pipe support engineer for his use in qualification or design of the supports for these loads. The pipe support engineer reviews existing as-built pipe support drawings. If the support is determined to be inadequate to sustain this initial load, the support designer and the stress analyst may well review the system to determine if the engineering assumptions in the piping stress analysis have excessive conservatism. An additional series of more realistic calculations may be performed before it can be shown that the support meets criteria. This process of recalculation may occur many times before the support is qualified. Such an approach is a logical and orderly method of qualifying small bore piping systems.

Another method used to qualify a piping system involves use of the maximum capacity of the pipe supports for qualification. This method can be more efficient than the method discussed above by reducing the number of iterations and recomputations between the stress analyst and the pipe support engineer. In this situation, the pipe support engineer calculates the maximum capacity of a support for each load case. This information is provided to a pipe stress analyst, who compares the computer results of the piping stress analysis to these maximum allowable loads. If the calculated support loads are in excess of the allowable, the piping analyst can perform a reanalysis iteration without requiring the pipe support engineer to recalculate stress in the support. This so-called technique of a "reverse calculation" is used to reduce the number of calculations and interfaces between the engineers. However, it does not alter the final result since both the piping and the supports must be shown to be qualified to the applicable licensing criteria. When the piping analysis is complete, all loads are transmitted to the support engineer for final acceptance or support modification and documentation. The reverse calculation technique is often used in the industry and is analogous to calculating an acceptable load rating of standard supports.

This question also conveyed the implication that intermediate or iterative calculations were being improperly destroyed. Such an implication is erroneous. Procedure 3.3 contained in the PGandE Engineering Manual requires the preservation of the final stress analysis calculation packages. Pursuant to procedure 3.3, all final calculation packages are retained and permanently filed. There is no regulatory or other Project requirement to retain the intermediate or iterative analyses.

NRC Question: The NRC has raised a question about assumption of joint releases for rigid connection (Allegation 88, SSER 21).

Response

"Joint releases" refers to a method of providing an accurate representation of end connections in structural members. An initial calculation of a pipe support frame might conservatively assume that welded ends at structural members are completely rigid. However, it is obvious that no joint is completely 100% rigid. The structural member may have very little moment resistance in some rotation axes, and assuming rigidity is not representative of actual behavior. An engineer may model the joint to closely represent its actual physical characteristics. In many instances, the joint is modeled so that no moment resistance is offered by the steel to which the member is attached (i.e., assume that moment loads are not transmitted). This method provides a more realistic model of the structural behavior of the frame.

The weld at the joint is still considered in the computer model, and there is no intent or need to remove it since the forces transmitted by the weld and associated stresses are evaluated and verified to be acceptable. This practice is standard in structural engineering evaluation of frame structures.

NRC Question: The NRC raised questions about U-bolt allowables (Allegation 85, SSER 21).

Response

During the January 31 meeting the NRC indicated that it was currently reviewing the information that had been submitted on December 28, 1983, concerning U-bolt interactions. One area of review that remained was the test sample size. The following information provides the justification for establishing U-bolt allowables by compliance with ASME testing requirements

ASME Section III, Subsection NF-3260, provides the procedure by which U-bolt allowable ratings were developed. Per NF-3260, the procedure for load ratings consists of imposing a total load on one or more duplicate full-size samples of a component support. The total load is to be equal to or less than the load under which the component support fails to perform its required function. If a single test sample is performed, NF-3260 requires the load ratings to be derated by 10%.

The tests performed for the Diablo Canyon supports were more numerous than the single test permitted by the code but were less than the "statistically significant sample" allowed by the code as an alternate. The conservatisms added in the generation of allowables is at least equivalent to a derating of allowables by 10%. The following is a summary of conservatisms:

(1) A minimum of four U-bolts were tested for three loading conditions for each pipe size. The loading conditions consisted of the application of side loading, tension loading and a combination of side and tension loads (45°). The allowables for tension and side loading were based on the lowest test load of all pipe sizes tested using a given diameter U-bolt. The test loads used in the equations of NF-3260 represent the lowest tension and side test loads found for 1/4-in. and 3/8-in. diameter rod U-bolts, respectively.

(2) The added conservatism occurs in the interaction formula with the application of both tension and side loading because the minimum tension test results and the minimum side loading test results are combined.

(3) U-bolt tension failure did not occur for any U-bolts for piping sizes greater than 1-1/4 inches in diameter. The allowables were based on the testing machine's capacity rather than the U-bolt's capacity. Therefore, substantial margin exists for the larger U-bolts.

In summary, the load ratings for U-bolts meet the requirements of the ASME Code for qualification by type testing. The use of allowable U-bolt ratings determined by qualification testing will reliably ensure a conservative design and is consistent with all design criteria.

NRC Question: The NRC has raised a question about angle-shaped structural members (Allegation No. 95 from SSER 21).

Response

In this response, the following symbols are used.

List of Symbols

B = Length of angle leg

t = Thickness of angle leg

L = Length of span

Fy= Minimum Yield Strength

b_f= Width of Compression Flange

In small bore pipe support design, angle-sectioned beams are frequently used for structural members because of the small loads typically encountered in small bore piping.

Angle sections were used at Diablo Canyon prior to the verification program. Where modifications to existing supports were made during the verification program, structural tubing was often substituted for the original angle section.

The criteria for the use of angles as laterally unsupported beams subjected to bending forces were based upon evaluations initiated in 1977. Project-specific criteria were required because the AISC Manual of Steel Construction (Ref. 1) does not provide guidance for angles with laterally unsupported spans greater than 76.0 b_f/Fy. The term 76.0 b_f/Fy is the allowable span for an unbraced length of a member not meeting the requirements of Section 1.5.1.4.6a of Reference 1. However, these criteria were developed for I beams and not specifically for angles. Reference 1 does not provide criteria for laterally unbraced members greater than 76.0 b_f/Fy. The lack of specific guidance in this area has been recognized in the literature (see Reference 2). However, AISC recognizes that special investigations are necessary for angles with laterally unsupported spans greater than 76.0 b_f / Fy. This is indicated on page 2-21 of Reference 1 where a statement is provided which explains the use of angle load tables. The statement is as follows:

"The tables are not applicable for angles laterally unsupported or subjected to torsion; for such members a special investigation is necessary."

Because the AISC did not completely address the design of laterally unsupported angles, PGandE performed a literature search in 1977 to determine if other information was available which would be adequate to set criteria. In late 1977 it was found that extensive testing of laterally unsupported angles loaded in bending had been performed in Australia. Literature which describes the testing, findings, and recommendations has been previously provided to the NRC staff (References 3, 4, and 5).

In the Australian tests, various sizes of angles were characterized by different B/t ratios. Angle sections with B/t ratios between 6 and 16 (Reference 5) have been tested. The majority of angles at Diablo Canyon fall within this range. The only angles at Diablo Canyon not falling into this range have B/t values less than 6. However, at this end of the range (beams with B/t less than 6 are less slender) the data can be used conservatively since the net effect is to allow an increase in acceptable unbraced lengths. Based on the tests and comparison to structural theory, simple formulas were developed in Reference 5 for use in the design of laterally unsupported angles in bending using several different methods of load application.

For all the various angle sections and load cases investigated, Reference 4 recommends that an allowable bending stress of 0.66 Fy may be used if L/t is less than 300. The Diablo Canyon Project Design Criteria M-9 limits the maximum bending stress to 0.6 Fy and a maximum L/t ratio of 270. These limits used at Diablo Canyon fall within the recommendation of Reference 4 and are therefore acceptable.

References

1. American Institute of Steel Construction (AISC) Manual of Steel Construction, Seventh Edition, AISC, New York.

2. B. F. Thomas, J. M. Leigh, M. G. Lay, Civil Engineering Transactions, 1973, The Institution of Engineers, Australia.

3. B. F. Thomas and J. M. Leigh, The Behaviour of Laterally Unsupported Angles BHP Melb. Res. Lab. Rep. MRL 22/4, December 1970.

4. J. M. Leigh and M. G. Lay, Laterally Unsupported Angles with Equal and Unequal Legs. BHP Melb. Res. Lab. Rep./ MRL 22/2, July 1970.

5. Safe Load Tables for Laterally Unsupported Angles, Australian Institute of Steel Construction, September, 1971.

NRC Question: The NRC has raised questions about the calculation of fundamental frequencies for small bore piping.

Response

The Rayleigh method for the determination of natural frequency was not used in the analysis of piping supports for small bore piping. A static equivalent approach was employed, whereby a unit force (1.0g times the tributary mass of the piping) was applied in the restraining direction of the pipe support. The corresponding deflection of the pipe support was then compared to an allowable limit. A deflection of less than 0.025 inches indicates a support that has a natural frequency of over 20 Hz. Simple beam theory was used to convert the desired frequency to a deflection criteria. The Hosgri report (Section 8.2, page 8-8) indicates that the support was to be assumed rigid in the seismic analyses if its natural frequency is above 20 Hz.

During the January 31, 1984 meeting with the NRC, a question was asked to clarify the loading direction in calculation MP-988 for the applied unit load. A review of calculation MP-988 indicates that the 1.0g load was, in fact, applied in the restraining direction of this particular pipe support as the horizontal plane is the restraining direction for this pipe support.

NRC Question: The NRC has raised a question about the size of the sample utilized for reverification of small bore piping.

Response

The program to verify the small bore piping at DCP began in 1981 by the selection of a sample of typical piping and supports. This sample was rigorously analyzed for compliance with all applicable licensing commitments and criteria. The results of the initial sample analysis indicated that there were several areas where incorrect or incomplete assumptions had been used in the original analysis. Additionally, areas were identified where the original criteria had not been totally followed. These errors were generic to all small bore piping analysis and were, therefore, addressed by reanalysis for all portions of piping where these generic errors could result in noncompliance with design criteria. Examples of these generic issues were allowable active valve acceleration, consideration of anchor movements, thermal analysis of piping, and code breaks.

The identification of these generic issues caused the original sample program to be revised and expanded. These generic issues would be evaluated for all piping and a sample approach would be used in the qualification of the remainder of the small bore piping. In accordance with that philosophy, a sample size was selected by the ITP and subsequently approved by the IDVP and the NRC. This concept used a worst case scenario for selecting the sample piping that would be reanalyzed. For example, systems were selected in areas of the plant where the response spectra were the highest. The initial sample selected in the fall of 1982 remained the "sample" throughout the small bore verification program. In its original form, the 5000 feet of sample piping was intended to qualify 25,000 feet of a total of 43,000 feet of piping in the plant. The remaining 18,000 feet required reanalysis because of the generic issues.

The reanalysis required for the generic issues proceeded by identifying all piping and supports in the plant that could be affected by these generic issues. All small bore pipe was reanalyzed and modified if necessary for these issues, including the sample piping. As this effort proceeded, it became obvious that additional generic issues had been identified and should be included. For example, one original generic issue was qualification of hot piping. Further analysis indicated that the intermediate-range temperature piping required reanalysis and should also be included as a generic issue.

Therefore, as the program evolved, the amount of piping that was analyzed as part of the generic program grew and the amount qualified by the sample program shrank. When all of the issues had been evaluated and the final program completed, 28,000 feet of small bore piping were qualified by rigorous reanalysis and 15,000 feet were qualified by the 5,000-foot sample. It must also be remembered that all the generic issues were also addressed even in the 15,000 feet qualified by the sample program.

The sample program was only used to qualify low temperature piping systems (less than 200°F for carbon steel and 160°F for stainless steel) without remote operated valves, code boundary changes, or significant anchor movements.

During the IDVP review of the ITP, the small bore program was exhaustively examined. The IDVP reviewed in detail completed samples of span rule application of File 44. Because the IDVP selected a portion of the sample program to review, they explicitly reviewed the File 44 methodology. This was because substantial amounts of File 44 analyses were included in the sample program. Of the 5,000 foot of sample piping, 3,400 feet had been qualified by File 44, which was the original analysis method used prior to 1981. The only hardware modifications installed on piping originally analyzed by File 44 were to address generic concerns.

NRC Question: The NRC raised a question that ITR No. 60 identified one case where the proper criteria had not been used for the review of natural frequency.

Response

EOI 1139 identified one small bore support that had incorrectly compared the calculated value of pipe support deflection (used for natural frequency determination) to an allowable of 0.0625 inches. The proper allowable was 0.025 inches. This calculation was recalculated using a more complete model and a computer solution. The results indicated that the frequency was above the 20 Hz criteria.

It should be noted that even if the value of the natural frequency was below 20 Hz, an insignificant change in system response would result. The reason for maintaining the natural frequency of a pipe support above 20 Hz is to permit consideration of a rigid restraint in the piping stress analysis. An equally acceptable analysis technique is to calculate the frequencies or stiffnesses of the supports and to analyze the piping with these stiffnesses included. Since there are many pipe supports on one system (analysis), the reduction of the natural frequency on one support to below 20 Hz would result in an insignificant effect on the piping system response and support loads.

To ensure that this was an isolated, random error rather than one that was generic or indicative of a programmatic breakdown in training or design control, other calculations of natural frequency performed by the same originating engineer have been checked to assure that he had not systemically used the improper allowable. In all these cases the correct allowable was used. Additionally, the review being performed in conjunction with the concern for calculational errors has not uncovered any other instances where this incorrect comparison has been made. We therefore conclude that this was an isolated mistake that was not representative of a generic concern or a programmatic breakdown.

III. NONTECHNICAL ISSUES

NRC Question: The NRC has raised questions about "destroyed documentation" (Allegation 87, SSER 21) and "altered current documentation" (Allegations 55, 87, and 79, SSER 21). These concerns were discussed further by Dr. Hartzman at the public meeting held January 31, 1984.

Response

The verification process for small bore piping analysis is an iterative one. The initial analytical attempt is usually a conservative, simplified bounding calculation which, if successful, expedites the verification process. If, however, this bounding calculation does not demonstrate adequacy of design, a more sophisticated analysis is then initiated. This process is repeated until either the adequacy of design is shown or a determination is made that modifications are necessary. ANSI standard N45.2.9 (1979) does not require retention of intermediate calculations. The only calculations required to be retained are the final calculations which reflect the analysis actually relied upon to show adequacy of design. For the situation considered, no superseded calculations are required to be retained by regulation, regulatory guide, standard, or procedure. Despite this fact, DCP procedures, based on judgment of the analyst and checker, call for retention of superseded calculational records "to the extent necessary to support and verify final designs."

The specific calculations involved in Allegation 87 are MP-988 and MP-944. These Unit 1 calculations were originated and checked by individuals in OPEG who had working responsibility for small bore piping analysis. After origination and checking, but prior to approval of the calculations in question, the OPEG group was divided into Unit 1 and Unit 2 sub-groups. The analysts who had derived these calculations were reassigned to the Unit 2 group. The two calculation packages were reassigned to individuals of the Unit 1 group who elected to re-perform the unapproved calculations for MP-988 and MP-944. The new calculations were checked and approved in accordance with applicable procedures; thus, the earlier unapproved calculations were not retained in the calculational packages.

Several factors have led to confusion and misunderstanding of the calculations in question. First, the initial calculation of MP-988 showed the support not to be qualified. The second attempt, by a different analyst, showed the support to be qualified but unfortunately that calculation contained an error. Had the error not been made, the support would not have qualified in the second analysis. Obviously one could speculate that the second analysis was somehow dishonestly done (as opposed to an "honest mistake") to "make the problem go away." Such was not the case. A third analysis was completed which shows that indeed the support is qualified as designed and constructed.

MP-944 was a calculation that had not been approved at the time of the personnel transfers and the checker of the original calculation became the analyst of the next iteration. Obviously that individual was aware of the

status of the original analysis and qualified the support in the normal iterative process.

Adding to the misunderstanding is the issue of a master log and an unofficial informal log which, on the surface, appear to contain conflicting information. Each calculation package contains a calculation index and, in addition, there is a master log which lists the design calculation number, revision number, hanger number, calculation status, analyst's name and date, checker name and date, and approval date.

Confusion has arisen because of the existence of the unofficial informal log that was kept as an aid to the Assistant Onsite Project Engineer in tracking engineering activities. The informal log showed the two calculations and the original assigned analysts. Other than indicating the completion or approval date, the informal log was never updated to reflect the reassignment of the calculations to the new analysts and checkers. The informal log was not, however, the record calculation index or master log, but rather a management tool which was not required to indicate the information contained in the master log.

Both the calculation index and the master log properly documented the approved calculations for MP-988 and MP-944. In accordance with applicable procedures, calculations are not indexed in the calculation index or logged on the master log until they are approved. Because the original calculations had never been approved they were neither indexed in the calculation index nor logged on the master log. Thus, in neither case were official calculations, nor calculations "necessary to support and verify final design," destroyed.

Based on comments made by the NRC Staff at the January 31, 1984 public meeting, Allegation 55 seems to be based on two calculations, MP-072 and MP-345. Calculation MP-072, Rev. 0, analyzed hanger 2171-16 and showed that a U-bolt would be overstressed. The originator suggested the use of a cut plate bracket instead of a U-bolt. The recommended design modification was checked and approved according to written procedures. Prior to issuance for construction, the stress analysis was redone and new loads were issued. An analyst was given the hanger to review. Our investigation has not positively determined who wrote the phrase "too costly to fabricate" on the original design but it is believed it was the analyst who also did Rev. 1 of the calculations which also indicated overstress of the U-bolt. Thereafter, Rev. 2 of the calculations was performed analyzing the support showing an angle iron in lieu of the U-bolt. This analysis was also performed by the original analyst. The calculation was checked, approved, and issued for construction. During construction the support was further modified and an as-built was issued by Construction. That as-built condition was approved pursuant to applicable procedures. Our review indicates that all design and construction activities concerning MP-072 met all procedural requirements and criteria.

The second calculation, MP-345, analyzed hanger 2182-74. The originator of this calculation proposed a design modification to the support because the axial thermal movement exceeded that allowed by drawing 049243, Rev. 11. The support was otherwise capable of accepting the piping load. The group leader approved the calculation as "preliminary" without modification, but noted at the end of the calculation that a modification was not required due to an insignificant uploading in the support (less than 4% of allowable). This note was signed and dated. At the time of his decision, the group leader was aware of a pending revision to drawing 049243, which would support his decision. Thus, the calculation indicated the design adequacy of the hanger in accordance with the to-be-approved revision of drawing 049243. This calculation was subsequently reviewed to verify its compliance with the revised drawing and was then approved. Again, we are unable to discern any "altered current documentation" in our review of this calculation. In each of the above instances there was some initial iteration of design approaches after which the final design was derived, reviewed, and approved in accordance with applicable procedures.

In conclusion, our analysis of Allegations 55 and 87 does not indicate any destruction of documentation that was required to be retained nor does it show any instances of alteration of documentation in the pejorative sense.

NRC Question: The NRC has raised questions about the extent and timeliness of training of onsite pipe support engineers (Allegation 82, SSER 21). Concern was also raised that the responsibility and authority of small bore piping group personnel did not appear to have been delineated in writing.

Response

The Project provides formal training in the Engineering Manual Procedures ("EMP") which implements Project QA requirements. Those requirements meet QA Criterion II of 10 CFR 50, Appendix B, and are set forth in Nuclear Quality Assurance Manual, ("NQAM") and Bechtel Quality Topical Report, Rev. 3A ("BQ-TOP-1") which has been approved by the NRC for the Project. Each engineer assigned nuclear safety related work receives indoctrination and training in EMP in accordance with Procedure 2.1 of that manual. This course for the engineers identifies and describes the procedures applicable to their work. It includes a review of procedures on design criteria memoranda, design calculations, design changes, drawing control, discrepancy reports and nonconformance reports.

PEI-15 specifies that the indoctrination and training are to be given within 30 days of assignment to the Project. Training records indicate that approximately 70% of all OPEG design engineers on the current OPEG roster received Engineering Manual training within 30 days of assignment as required. Approximately 95% received such training within four months of assignment. The majority of those instances where an engineer did not receive training within 30 days of assignment occurred early in the Project. Project Audit 28.4, conducted in February 1983 and closed in May 1983, resulted in the correction of most of these discrepancies. Since May 1983, only five OPEG design engineers have exceeded the 30-day training requirement by more than a few weeks. As 100% compliance is required, administrative changes are being made to assure that all engineers receive required indoctrination and training within the prescribed times.

The training program covered by EMP 2.1 is consistent with QA Criteron II and is directed at the process of design control, design change, design calculation, discrepancy and nonconformance procedures. EMP 2.1 is not addressed to the professional qualification of engineers and designers, and therefore does not encompass the technical education necessary to enable an engineer to properly perform design work. To ensure technical competence, pipe support engineers are hired in large part on the basis of interviews, educational qualifications, and previous experience. For permanent or temporary employees, the professional credentials of all are required to be verified by either the Personnel Departments of Bechtel or PGandE. For contract employees, such verification is a contractual requirement for the contract firm. This process is detailed in Table I. A thorough review of the engineer's work experience is confirmed through technical interviews conducted by senior Engineering personnel. Additionally, the engineer's first assignments are carefully selected to provide an adequate opportunity for the designer to gain familiarity with project calculation format and methods, and

his work is closely monitored to assess the designer's capabilities. Future assignments are determined on the basis of assessing the engineer's performance on these early assignments.

A review of the technical background of the engineers in the small bore pipe support group at the site shows that experienced, technically qualified engineers had been hired, with little or no need for additional instruction in small bore piping calculations other than that normally provided to familiarize them with the proper design criteria and Project calculational methodology. Of all the pipe support engineers employed at OPEG, more than 41% (36) had greater than five years of nuclear related experience. Most of the engineers had worked on two or more other nuclear power projects, with many having worked on five or more plants. All have at least a BS in Engineering or equivalent, and their minimum professional experience is one year, the maximum professional experience is 14.5 years, and the average professional experience is greater than five years.

In SSER 21 (Allegation 82), the Staff identified five individual engineers who had not received procedural training within 30 days of commencement of their assignment as required by PEI-15. The project has reviewed the work of those individuals along with all of the pipe support engineers. The apparent discrepancies in calculations that are currently being reviewed are being correlated with indoctrination and training completion dates for persons originating and checking the questioned calculations. For each such discrepancy checked to date (the 23 Stokes calculations), all individuals completed the QA orientation program prior to approval of the final calculation under review.

While some individuals did not receive indoctrination and procedure training within the 30 day specified period, the records indicate that the discrepancies in calculations that have been observed are not related to either indoctrination and training or professional experience, but rather are random events. Consequently, the delayed completion for the training of a few design support engineers does not appear to relate to the discrepancies detected.

In order to better implement Project training requirements, the Project proposes the following new actions for OPEG:

1. Training records of all engineering personnel working on the Project have been reviewed. Effective immediately, any person who currently does not have the required training in QA and engineering procedures will not be allowed to continue engineering design work until such training is completed.

2. Weekly training sessions in QA/Engineering procedures will begin immediately to train new arrivals. Also, a refresher course will be held three times a year for all engineering personnel who complete or who have completed QA/Engineering procedures.

3. No person newly assigned to OPEG will be permitted to perform, check, or approve any calculation until the QA/Engineering procedure training has been completed.

4. Failure to complete a refresher course within 30 days of requirement will disqualify an engineer from performing, checking, or approving any calculation.

5. All training personnel will utilize a formal syllabus which shall be reviewed and approved by engineering and QA management. Initially, the training sessions shall be monitored by engineering and QA management to assure that required matters are properly addressed. Training sessions will give special attention to changes in procedures that have been implemented in the last year.

6. All such training requirements will be formalized and documented, and compliance will be verified by QA audits.

Concern also has been raised that the responsibility and authority of small bore piping group personnel did not appear to have been delineated in writing. The small bore piping design group personnel authority and duties are delineated in writing through the DCP QA Program, procedures applicable to the engineering work, and organization charts.

OPEG is an extension of the home office project engineering organization which is located in a different geographical area. This relationship is defined in the DCP Nuclear Quality Assurance Manual (NQAM) Section 1 No. 7. As part of the project engineering team, OPEG carries out the Engineering Department's responsibilities outlined in NQAM Section 1 No. 7, as directed by the Project Engineer to whom OPEG reports (Reference NQAM Section I No. 1, Figure 7).

The specific duties, responsibilities, and authority of OPEG at the Diablo Canyon jobsite are delineated in procedure PEI No. 9, Rev. 0. The accomplishment of these duties and responsibilities is delegated through the organizational chain from the Onsite Project Engineer/Assistant Onsite Project Engineer to lead discipline engineers, then to the discipline group engineers. Assignment of these duties and responsibilities is made by the OPE/AOPE and lead discipline engineers. The organizational chain within OPEG is defined both in PEI No. 9 and in a written organization chart maintained by the Onsite Project Engineer.

The authority and duties of personnel shown on the established organization chart are delineated in writing as follows:

a. Onsite Project Engineer/Onsite Assistant Project Engineer responsibilities and authorities are defined in PEI NO. 9, Paragraphs 3.3 and 3.4. Signature authority of the OPE/OAPE is defined in PEI No. 9, paragraph 4.3, and responsibility for

approval of design changes initiated by OPEG is defined in PEI No. 9, paragraph 4.2.4. Additional duties are defined in other procedures applicable to design of piping and piping supports, consisting of Engineering Manual procedures; Piping Group Controlled Procedures, Instructions and Criteria; and Project Engineer's Instruction (Reference PEI No. 9, Paragraph 4.2.1).

b. Lead Discipline Engineers are jobsite representatives from the Home Office Engineering Group Supervisors (EGS). The Lead Discipline Engineers receive technical direction from the Home Office EGS and administrative direction from the Onsite Project Engineer. These authorities and responsibilities are documented in PEI No. 9 Paragraph 3.5. Authority for sign-off of OPEG originated design changes is documented in PEI No. 9, Paragraph 4.2.4.

   In representing the EGS for activities within OPEG's scope, additional duties of the EGS/Lead Discipline Engineer are defined in other procedures applicable to design of piping and piping supports as listed in item (a) above. For example, Engineering Manual Procedure 3.3 Rev. 5 and Piping Procedure P-6 Rev. 2 require the engineering discipline group leader or supervisor to approve design calculations for pipe supports. For OPEG pipe support calculations, the Lead Discipline Engineer has this duty as described above.

c. Area Leaders and Squad Leaders are responsible to assist the Lead Discipline Engineer in the performance of his duties and to work under his direction. This organizational responsibility is delineated in the OPEG organization chart.

d. OPEG engineers work under the direction of the Lead Discipline Engineer as defined in the OPEG organization chart. All work performed by the OPEG discipline group engineers is coordinated and supervised by the Lead Discipline Engineer. The discipline engineers do not have any other authority and duties except to follow the direction of the Lead Discipline Engineer in accomplishing the assigned task. Their specific authorities and duties with respect to assigned tasks are delineated in the procedures that apply to their work. The procedures applicable to design of piping and pipe supports are defined in PEI No. 9, Paragraph 4.2.1. For example, an engineer assigned to check a calculation has authority to require corrections to calculations, as delineated in Engineer Manual Procedure 3.3, Paragraph 4.2.6, and he has the duty to perform checking in accordance with Engineering Manual Procedure 3.3, Paragraph 4.2.2.

The more general authorities and duties expected to be performed by personnel assigned to OPEG in specific positions within the discipline group are defined and delineated in accordance with established Bechtel practices. Generally,

they cover three categories of personnel: (1) permanent employees, (2) contract (job shop) personnel, and (3) temporary personnel. The process for each is summarized in Table I.

In light of the foregoing, it is evident that the onsite small bore piping design group authority and duties are established, and are described in writing to the extent necessary to fulfill the requirements of Criterion I to 10 CFR, Part 50, Appendix B.

Attachments:
Table I
Attachment A - Example Job Description

TABLE I

A. Permanent Personnel

1. Opening is identified and and related to Job Description (e.g., Attachment A), by Project.

2. Chief Engineer either provides a proven individual from elsewhere in the organization, or finds a new employee through Personnel Department.

3. In hiring a new employee, the Chief Engineer makes selection based upon personal interviews, reviews of experience and educational background, other credentials, and as much inquiries of former employers or supervisors as he can make.

4. After hire, the Personnel Department confirms key parts of employment and educational background to the extent practical.

5. Three (3) months after hire, the employee is given a formal performance evaluation, followed by another in nine (9) months, and thereafter one every twelve (12) months or upon change of supervisor.

B. Contract (job shop) Personnel

1. Same as A-1, above.

2. Chief Engineer requests Personnel Department to have contract agencies provide resources of candidates.

3. Chief Engineer reviews resumes, conducts interviews, and selects most suitable candidates (typically one out of eight candidates).

4. Personnel Department executes agreement with contract agency to provide selected personnel, which includes responsibility of contract agency for accuracy of background information and credentials.

5. Personnel are initially indoctrinated and closely supervised. They are also periodically ranked, and those with lowest rankings are replaced.

C. Temporary Personnel

1. Same as A-1.

2. Chief Engineer identifies personnel for temporary status from among contract personnel, having made selection as above.

ATTACHMENT - A

(Example)

JOB DESCRIPTION

TITLE SENIOR ENGINEER	CODE NUMBER 100A, 150A — OVERTIME CODE EST
REPORTS TO ENGINEERING SUPERVISOR	APPROVED SALARY GRADE 25, 26
ORGANIZATION ENGINEERING OFFICE ENGINEERING	EFFECTIVE DATE July 5, 1980
	REPLACES DESCRIPTION DATED

SUMMARY:

Plans and conducts independent work requiring judgment in the evaluation, selection, application and adaptation of engineering techniques, procedures and criteria. Devises new approaches to problems.

For salary grade determination, see attached addendum.

JOB DIMENSIONS:

A. **Supervision Received**

- Performs most assignments independently with instructions as to the general results expected. Receives technical guidance from Engineering Specialists or Supervisors on unusual or complex problems and supervisory approval on proposed project plans.

B. **Supervision Exercised**

- Provides technical direction and assigns work to engineers, designers, drafters, technicians and others who assist in performing specific assignments, however is not responsible for staff planning or salary actions.

C. **Contacts**

- Independently contacts vendor's representatives and project field personnel to gather or give information. Contacts client counterparts as directed.

PRINCIPAL RESPONSIBILITIES:

1. Plans, schedules, conducts, and coordinates detailed phases of engineering work usually in one discipline in a project or staff group. Performs work which involves conventional engineering practice but may include complex features such as resolving conflicting design requirements, unsuitability of conventional materials and/or difficult coordination requirements.
2. Plans, coordinates or prepares equipment or work specifications, bid evaluations and award recommendations for equipment.
3. Coordinates engineering efforts in assigned areas between specialty and other engineering groups or disciplines, with the client, suppliers, and contractors and between other divisional groups.
4. When delegated, assumes a lead role over other engineers or project sub-groups for completing specific tasks.
5. Assists in on the job training of assigned personnel and provides input for their performance evaluations.
6. Prepares letters to vendors and clients.
7. Reviews bid analyses and makes recommendations.
8. Prepares or assists in preparation of conceptual studies, designs, reports or proposals.
9. Performs or assists in the performance of problem analysis and original design.
10. Reviews project controls, cost estimates, quantity take off's and manpower requirements for proposals, forecasts and change orders.
11. Reviews and checks work of subordinate engineers.

JOB KNOWLEDGE

A thorough knowledge of engineering techniques, the design of engineered systems, and engineering and design calculations. A broad knowledge of the application of engineering to plant constructability as applied to construction methods and materials. Up-to-date knowledge of computer applications to engineering and design. Working knowledge of engineering planning and control methods including computerized methods.

A broad knowledge of precedents in the specialty area and a good knowledge of principles and practices of related technical areas.

A knowledge of related construction practices and the economics involved.

TITLE
SENIOR ENGINEER

APPROVED SALARY GRADE
25, 26

A current knowledge of industry or regulatory standards and design criteria pertinent to the particular engineering discipline.

Skill in oral and written communication.

The above is normally acquired through:

- A recognized degree in an engineering or scientific discipline from an accredited college or university

OR

- A professional license in an appropriate engineering discipline from a recognized licensing board.

OR

- Sufficient number of specialized courses in relevant general engineering or appropriate engineering disciplines to meet job requirements.

AND

- Practical work experience in design engineering or relevant equivalant experience in allied types of engineering sufficient to demonstrate competence as a trained engineer.

TITLE

SENIOR ENGINEER

APPROVED SALARY GRADE

25, 26

ADDENDUM

Salary Grade Determination for SENIOR ENGINEER

Grade 26

Plans and coordinates independent work requiring judgment and experience in the application and substantial adaptation of engineering techniques. Devises new approaches to technical problems.

Provides technical direction for specific tasks and assigns work to subordinate senior engineers, engineers, designers, drafters or project sub-groups.

Requires experience and demonstrated skill in handling professional work at the grade 25 level and a broad knowledge of precedents in the industry.

Grade 25

Plans and conducts independent work requiring judgment in the application of engineering techniques. Normally uses conventional approaches to technical problems encountered.

Provides technical direction and assigns work to engineers, designers, and drafters who assist on specific assignments.

NRC Question: The NRC raised questions about various aspects of document control for small bore pipe support design (Allegations 55, 79 and 84, SSER 21).

Response

The DCP QA Program requires formal control of implementing procedures. Detailed requirements are contained in Engineering Manual Procedure 5.2. Implementing procedures are required to be logged into a control system by title, date of approval and revision number. All holders of implementing procedures are required to formally acknowledge receipt of revisions by returning a signed acknowledgement.

Special implementing procedures, instructions and criteria for the small bore piping design verification effort were authored by the Project Team Piping Group, and the control of their distribution was managed by the Project Administration Group using a system of signed, returned receipts.

A master document distribution matrix was prepared to establish which manual holders receive specific documents in accordance with the requirements of their job assignment. A specific set of defined documents is assigned to a pipe support engineer; a different set of documents is assigned to a pipe stress engineer, and so forth.

a) Out-of-date Procedures

The staff identified three instances of out-of-date procedures contained within the controlled procedure manuals maintained in the OPEG. As a result, a discrepancy report (DR 83-47-S) was issued by Project Engineering. This DR addresses corrective action, impact on final design and actions to prevent reoccurrence.

A 100% review of all control procedures, instructions and criteria assigned to OPEG personnel was completed by December 15, 1983. Sixty-three (63) manuals containing 133 criteria documents, 412 procedures and 451 instructions were reviewed. The results showed that 90% of the documents assigned to the manuals were correctly in place. The review results have been evaluated to determine the possible impact on the small bore reverification work. Most of the instances found involved documents missing from certain controlled manuals, in which case the appropriate requirements are available to the engineer through other controlled manuals in the work area. Each instance of an outdated procedure or instruction was evaluated and determined to not impact the completed design work. The documents found to be outdated were characteristically documents that the assigned manual holder would not be using in performing his specific assignments.

All 63 controlled manuals have been brought up to date. They now contain only current copies of those documents specified by the master document distribution matrix.

The Staff also expressed the concern that since Piping Procedure Manual B-075 was presumably the only controlled manual assigned to the OPEG Stress Group, there was a possibility that Stress Group engineers had been without access to up-to-date procedures for an extended period of time. However, our investigation has shown that other controlled copies of the manual had been assigned and available to members of the Stress Group since the inception of the OPEG group. For example, the October 14, 1982 Distribution List for Piping Group Procedures, Instructions and Criteria for Diablo Piping Design shows that 11 members of the Stress group were assigned controlled manuals. Although the number of manuals assigned to the Stress Group has varied, at no time were there less than three controlled manuals assigned to this Group.

On a broader level, the Staff concern relates to Allegation 84 in SSER 21, dealing with lack of management responsiveness to an engineer's request for a copy of controlled design procedures. The allegation was discussed and resolved in SSER 21, with the Staff concluding that the "spirit of the allegation was substantiated" and that "management must improve its sensitivity in addressing safety concerns and improve communication with workers." In late 1982, there was an acknowledged shortage of copies of the manual, such that all engineers did not have individual copies. However, sufficient numbers of the controlled documents were available as discussed above and the engineers were able, and required, to use them. Additional copies have subsequently been made available, consistent with the goal of avoiding unnecessary complications in document control due to the distribution of more copies than necessary to accomplish the work.

Because the controlled design documents were, in fact, available to the alleging engineer, there was no violation of procedures or adverse affect on the small bore piping analyzed. Nevertheless, the Project has perceived the desirability of improvement in this area, and has taken several actions toward this end:

1. Document Control Procedures and practices are being reviewed with onsite Engineering personnel. They have been notified of the importance of complying with document control procedures and of their responsibility to update manuals and return acknowledgement forms.

2. Procedure P-1 was revised in Rev. 4 dated January 30, 1984 to require a monthly supervisory review of controlled manuals to assure that procedures, instructions and criteria are kept current.

3. For future revisions to design procedures, the supervisor will discuss the content of the revision with engineers under his supervision to be sure everyone is aware of changes and how they are to be implemented. Alternatively, procedure changes which are now routed to all manual holders will be formally routed to all engineers and will require an acknowledgment signature.

Also as a part of the resolution of DR 83-047-S, the possible effect of outdated design criteria documents on the final design has been reviewed. There were no instances found of out-of-date criteria in the manuals. All individuals, including those missing criteria documents, had access to current controlled copies of applicable criteria in order to correctly perform their design work.

As a separate effort, a Project QA review of configuration control of other manuals at OPEG (i.e., Engineering Manual, PEIs) has been completed. No deficiences were identified in this review.

b) Use of External Documents

The staff questioned whether references, such as the following, in the possesion of Pipe Support Engineering personnel were used in lieu of approved work procedures:

- An IOM dated March 21, 1983 "Guidelines for Calculating Design of Skewed Welds"
- Westinghouse Nuclear Technology Division Data for calculating double cantilever supports
- Bechtel GPD STRUDL II Computer Program Users Manual CE-901 November 3, 1983
- Bechtel GPD IOM dated November 11, 1980, "GPD Pipe Support Newsletter No. 5, Beta Angle"
- Control Data Corporation (CDC) Bechtel National Support Manager to Civil/Structural Projects staff, "Baseplate II User Aids."
- Midland "Pipe Deflection Formula"
- UE & C Pipe Support Design Standard, August 15, 1979.

Experienced engineers commonly have general reference material as a part of their personal and professional library. This type of material includes textbooks and handbooks, and typically provides standard formulas and tables, code discussions, example calculations, rules of thumb and other simplified, conservative methods in common use in the industry. As general reference material, they are not controlled and do not constitute acceptance criteria.

Project Engineering Procedures (EMP-3.3) provide for the use of references such as textbooks, catalogs, monographs and other such accepted industry techniques in specific calculations. The reference must be documented when necessary to provide details of the design sufficient to allow independent review. In such cases, it is required that they be documented as formal references with the calculation in which they are used. Their use then is

checked and approved via the calculation review and approval process. In the future, approvals of this material will be provided where general project standardization in their use is applicable. These materials will be formalized, controlled, and included in procedures manuals with appropriate instructions, qualifications and limitations.

The above identified documents are references of the type normally found in an experienced engineer's personal library. We know of no instances where the references were improperly used. In one instance, a non-project document was referenced as the source of a double cantilever deflection formula used in a calculation. It was a standard engineering formula, not unique to any particular project, and need not have been referenced in the calculation.

c) Out-of-date Procedure Listings

The staff also noted an instance of out of date procedure listings. An occurrence was observed where a controlled manual Table of Contents dated October 28, 1983 was in the possession of the Onsite Project Engineer, while other supervisors had the previous version dated September 15, 1983.

This specific instance, ironically, resulted from management's efforts to improve the methods for distribution of revisions to controlled manuals. Distribution of the October 28, 1983 revision was held by the Onsite Project Engineer upon receipt for two weeks while these improvements were being formulated. The revised practices have since been incorporated into Piping Procedure P-1.

NRC Question: The NRC questioned whether the use of interoffice memoranda issued by the Project may have reflected inadequate design change procedures.

Response

The Project has in place formal procedures for requesting and approving design changes. These procedures do not permit design changes to be made on the basis of an interoffice memorandum (IOM). The NRC's concern apparently relates to two identified IOMs issued by Project Engineering. As discussed below, however, neither of the two memoranda constituted design changes.

The first IOM involved the use of the welding code (AWS) for calculation of skewed welds. The Pipe Support Group Supervisor issued an IOM dated March 21, 1983, for the purpose of providing guidance in modeling skewed welds in conformance with the code. The IOM did not change any design documents, nor did it violate either good engineering precepts or approved QA procedures or requirements.

The second IOM of concern to the Staff was an IOM issued by Engineering on October 20, 1983, to General Construction, approving a request to revise a contractor's installation procedure. The change involved installation tolerances in the contractor's procedures which had been previously approved by Project Engineering in accordance with Project procedures for approval of contractor documents. General Construction and the contractor formally executed the change. Neither the request nor the IOM approving the change resulted in a change in the Project's approved design drawings or specifications, thus, the issuance of a Design Change Notice was inapplicable. Project actions, including the IOM from Engineering approving the change in the contractor's procedures, were consistent with Project procedures for review, approval, and amendment of contractor documents.

NRC Question: The NRC noted that design input had been received via telephone and used without written confirmation.

Response

Engineering Manual Procedure 6.1, Section 4.4, specifically provides that all design information provided verbally must be confirmed in writing. If the data are used prior to such confirmation, the calculations must be marked "preliminary," and cannot be finally approved without such confirmation. This requirement is an additional measure to assure that preliminary data are confirmed before the calculations are reviewed for final approval.

The calculations for Support 2156-200 noted the use of input loads received via telephone, but the originator failed to mark the calculation "preliminary". When written confirmation of the input loads was received and compared to the input used, an error was noted. The calculation was performed again with correct inputs, and the support design remained acceptable.

Investigation and review of past audits show this occurrence to be an isolated case which was clearly in violation of the engineering procedures.

NRC Question: The NRC has expressed a concern that errors detected in several calculations which had been checked and approved may indicate that checking has not been properly performed.

Response

The nature and significance of the errors found have been previously discussed. The broad responsibility of the checker is to assure that the calculation is sufficiently accurate and sufficiently free of errors to serve its intended purpose, i.e., to document that the support meets the design requirements. The minor nature of the errors detected and the fact that the calculations in question were corrected and still demonstrate support acceptability is a strong indication of the overall adequacy of the checking function.

Notwithstanding such a conclusion, the Project wishes to dispel the implication that discrepancies are "allowed" to exist or somehow disregarded, even though upon further analysis they do not affect the design adequacy. Therefore, two actions are underway and will be completed by March 1, 1984. First, it will be re-emphasized to Engineering personnel in writing, that calculational and documentation discrepancies will be dealt with seriously. Originators of documents are responsible for eliminating discrepancies. Accordingly, they may not depend on the checker to accomplish this.

Second, recognizing that, in some cases, it is not economically justifiable to reperform an extensive calculation because of a discrepancy which will not affect the results or conclusions derived from the results, the Engineering Procedure on calculations will be modified. This modification will require that if the checker of a calculation detects an error which, in his judgment, can be classified as described above, the checker will identify the error, designate it as such, and initial the designation. This action is consistent with the requirements of ANSI N45.2.11-1974 which requires that analyses be sufficiently detailed that an experienced person can review them and accept the results without recourse to the originator.

NRC Question: The NRC has raised a question regarding Licensee technical QA audits and surveillances with respect to the small bore piping support program.

Response

In implementing Criterion XVIII of 10 CFR Part 50, Appendix B, the NRC has endorsed, with certain exceptions, ANSI N45.2 and ANSI N45.2.12. The latter document provides requirements and guidance for establishing a system of audits of quality assurance programs, and provides definition of various types of audits. Criterion XVIII mandates audits to verify compliance with the QA program and to determine its effectiveness. None of the above-cited references establish requirements for the performance of technical QA audits.

On the Diablo Canyon Project, QA audits are conducted (in fulfillment of licensing commitments) to verify compliance with the project quality assurance program requirements.

The Project audit program has been developed and implemented to comply with requirements of the Project Nuclear Quality Assurance Manual. This program, in turn, has been approved as being in compliance with Project requirements and Criterion XVIII of Appendix B. It calls for a system of audits, the scope of which has been widely accepted in the nuclear industry, to assure that the QA program is properly functioning. Relative to the OPEG group, this audit scope has included all the major areas of design activity such as control of calculations, control of design drawings, indoctrination and training, and design change control. In addition, PGandE, as the licensee, has conducted a series of Activity Audits covering OPEG activities.

Since 1982 there have been some nineteen (19) audits of OPEG to verify compliance with Project QA requirements. Closeout and corrective actions related to audits is documented in the Project audit files.

The verification of technical requirements in design output documents is performed by Engineering as part of the design control process. The type of verification can vary from checking to independent review by the Chief Engineer or an outside agency, depending on the significance of the document.

Specifically, reference is made to Procedure No. 3.4 (Design Verification), Procedure No. 3.11 (Computer Programs), and other procedures related to specific design documents (e.g., design calculations and drawings). These are all the responsibility of Engineering, are part of the design control process, and are subject to Quality Assurance audit.

While the Project's audit program is in full compliance with QA requirements in implementation of Criterion XVIII, we believe that there is merit to the suggestion of formal, technical audits for OPEG. It is therefore planned that a program of such audits will be immediately developed for OPEG, on the following basis.

- The audits will be conducted by a team of technically qualified non-OPEG personnel (for technical aspects) and of QA personnel (for procedural aspects).

- The audits will be formally conducted and fully documented. They will include all the features normally associated with QA program audits, such as entrance/exit meetings, checklists, and reports to management.

- The initial audits will give special attention to those areas of most sophisticated analysis, use and understanding of codes, use and understanding of computer programs, independent checking, and technical review of conventional work.

PROFESSIONAL QUALIFICATIONS OF

RICHARD C. ANDERSON

My name is Richard C. Anderson. I am the Engineering Manager in the Diablo Canyon integrated project organization consisting of Pacific Gas and Electric Company and Bechtel Power Corporation employees. I am a Registered Mechanical and Nuclear Engineer in the State of California. I hold a BS degree in Mechanical Engineering from the University of California at Berkeley.

I have been with Bechtel for more than 26 years and for five years was assigned as an Engineering Manager in Bechtel's San Francisco Power Division, responsible for engineering work in the Pacific Northwest and Japan. I have been assigned since March 1982 specifically to the Diablo Canyon Project to act as the Project's Engineering Manager. Prior to these Engineering Manager assignments, I was the Chief Nuclear/Environmental Engineer for Bechtel's San Francisco Power Division, involved in nuclear power plant design, safety, and operation.

Prior to that, I was assigned as an Assistant Project Engineer on a proposed nuclear power plant project for PGandE and as Mechanical Group Supervisor, and later Project Engineer, on another large nuclear power plant project in the United States. These assignments included supervision and coordination of design, specification, procurement, and quality control activities.

I also served as Senior Mechanical Engineer for various other nuclear power facility projects in the United States and abroad, which included work in systems, safety, and equipment engineering.

I have been an instructor in Bechtel's power plant courses for over 10 years and have given numerous talks and lectures in California on nuclear power and energy issues.

PROFESSIONAL QUALIFICATIONS OF

FRED C. BREISMEISTER

My name is Fred C. Breismeister. I am Manager of the Research and Engineering/Materials and Quality Services (M&QS) group in Bechtel's San Francisco Area Office. In this position I supervise and provide consulting services to the Diablo Canyon Project. I am a Registered Professional Quality Engineer in California.

My educational background is as follows: BS, 1962, and MS, 1964, in Metallurgical Engineering, Rensselaer Polytechnic Institute, New York.

Prior to my duties as Manager in M&QS, I was supervisor of the Welding Engineering Section, where I was responsible for the development and technical content of Bechtel welding procedures and field fabrication standards, as well as technical support and direction to engineering and construction regarding welding, heat treatment, fabrication, inspection, and code problems.

I joined Bechtel in 1972 as a Metallurgical/Welding Engineer. I am an AWS D1.1 Certified Welding Inspector and a member of the American Welding Society, the Structural Welding Code Subcommittees 2 and 3, and the Preheat Task Force and Toughness Testing Task Group.

PROFESSIONAL QUALIFICATIONS OF

EDWARD M. BURNS

My name is Edward M. Burns. My business address is Westinghouse Electric Corporation, P.O. Box 355, Pittsburgh, Pennsylvania, 15230. I am employed as a Lead Engineer within the Nuclear Safety Department of the Nuclear Technology Division.

From 1967 through 1971, I attended the Milwaukee School of Engineering and received a Bachelor of Science Degree in Mechanical Engineering. Following graduation I entered the United States Army and served as an enlisted man, Lieutenant and Captain at several locations within the United States and Europe. From March 1977 to August 1979, I served with the US Army Armor and Engineer Board as a project officer responsible for the planning, conduct, analysis and reporting of operational tests of ground mobility, equipment, and ordnance.

I enrolled in 1977 in the University of Southern California night school program and received in March 1979 a Master of Science Degree in Systems Management. On leaving the Army in September 1979, I attended the University of Wisconsin and received a Master of Science Degree in Nuclear Engineering in December 1980. Additionally, from May to December 1980, I worked as assistant to the head of the University of Wisconsin Fusion Studies Program. In this capacity, I was responsible for coordinating parametric studies input for a conceptual heavy ion beam fusion reactor.

Following graduation, I was employed by Westinghouse Electric Corporation in the Nuclear Safety Department. From initial employment to November 1983, I was a Senior Licensing Engineer, responsible for evaluating the compliance of engineered safeguards fluid systems and components with applicable safety and design criteria. Specifically, I reviewed the implementation of cold shutdown design improvements for five domestic and three foreign nuclear power plants. During this period, I also acted as the Westinghouse coordinator of licensing and safety activities related to the US NRC draft Regulatory Guide 1.139 and Unresolved Safety Issue A-45 programs.

In December 1983, I was promoted to my current position of Lead Engineer, responsible for coordinating licensing services in support of nuclear power plants.

I am a member of the American Nuclear Society and the American Society of Mechanical Engineers.

PROFESSIONAL QUALIFICATIONS OF

DANIEL J. CURTIS

My name is Daniel J. Curtis. I am a Onsite Project Engineering Group (OPEG) Plant Design Group Supervisor for the Diablo Canyon Power Plant. I have held the position since November 1983. My responsibilities have included the supervision of the small bore piping qualification activities at the Diablo Canyon Jobsite under the technical direction of the San Francisco home office. Small bore piping qualification activities include small bore pipe stress analysis, small bore pipe support design, and piping isometric approval. I am a Registered Professional Civil Engineer in the State of California.

My educational background is a follows: BS in Civil Engineering, 1973, California State University, Chico.

I joined Pacific Gas and Electric in January 1974. From January 1974 to March 1976, I worked in the Design Drafting Department performing structural analysis and design of miscellaneous structures. From March 1976 to June 1980 I was assigned to the Mechanical and Nuclear Engineering Department. Duties have included review and approval of pipe supports, developing design criteria for supports, coordination of work with consultants, and performing piping analyses.

In July 1980, I joined Science Applications, Inc. My duties included the seismic qualification of equipment and performing time history and response spectra analyses of piping.

In February 1981, I joined Bechtel Power Corporation. From February 1981 to March 1982 I worked on the Pipe Support Staff. Duties included providing technical assistance to projects, performing employee interviews, review and approval of project criterias, and other routine supervisory duties. From March 1982 to November 1983, I worked on the Diablo Canyon Project as the Project Large Bore Pipe Support Group Leader. My responsibility was the overall supervision of the pipe support calculations being performed on-project.

In November, I was assigned to the Onsite Project Engineering Group.

PROFESSIONAL QUALIFICATIONS OF

KENNETH C. DOSS

My name is Kenneth C. Doss. As an employee of Pacific Gas and Electric Company since 1952, I am currently Senior Nuclear Generator Engineer participating in the systematic and independent review of Diablo Canyon Power Plant activities, which includes the review and evaluation of the technical adequacy of procedures and review and evaluation of design changes and modifications. I am also involved in the evaluation and assessment of Diablo Canyon's and similar plants' operating experience and performance as related to nuclear operating safety.

My educational background is as follows: AS in Electronics, Cuesta College, 1969.

I joined PGandE in 1952 as a member of a line crew in the Electric Transmission and Distribution Department.

In 1955 I was assigned to the Morro Bay Power Plant as an Instrument Repairman and participated in the Startup of Units 1 and 2. Subsequent assignments at the plant included Test engineer and Instrument Maintenance Foreman and participation in the startup of Units 3 and 4 and pre-startup check of plant control systems.

In 1970, I was transferred to the Diablo Canyon Project as a member of the Diablo Canyon Task Force engaged in startup preparation work at Humboldt Bay.

In 1971, I went to the Project jobsite as Instrument and Control Supervisor and was promoted as Senior Instrument and Control Supervisor in 1977.

Since September 1977 I have been a Senior Nuclear Generation Engineer Instrument and Control Supervisor on the Diablo Canyon Onsite Safety Review Group (OSRG). My responsibilities included preparation of training materials for operators and technicians, including description of training materials for operators and technicians, and instructions for control systems, nuclear instrumentation, and computers. I also participated in specifying test equipment and spare parts supplies for all instrument and control systems.

PROFESSIONAL QUALIFICATIONS OF

RICHARD D. ETZLER

My name is Richard D. Etzler. I am Project Superintendent at Diablo Canyon. I have held this position since September 1978. I am responsible for managing the onsite construction and startup activities at Diablo Canyon.

My educational background is as follows: BS in Mechanical Engineering, California Polytechnic State University, 1967.

Prior to my duties as Project Superintendant, I was Resident Mechanical Engineer. I held that position from March 1977 to September 1978. As Resident Mechanical Engineer, I was responsible for managing the mechanical type of construction activities such as installation of piping, ventilation systems, turbine/generator components and nuclear steam supply system components.

Prior to my duties as Resident Mechanical Engineer, I was a Field Engineer and Group Leader reporting to the Mechanical Resident Engineer. I held this type of position and level of responsibilities from 1971 to 1977. My responsibilities included supervising installation of the nuclear steam supply and turbine generator systems.

Prior to my duties as a group leader for the Mechanical Resident Engineer, I was a Startup Field Engineer beginning in December 1969. My duties as a Startup Engineer included preparing preoperational startup testing procedures and scheduling tests.

Prior to my assignment to Diablo Canyon, I was in training to be a startup engineer since October 1968. This training included approximately 9 months startup experience at the Robert E. Ginna nuclear power plant near Rochester, NY, and 6 weeks, reactor operator training at Westinghouse's Waltz Mill facility near Pittsburgh, PA.

Prior to October 1968, I was a field engineer at PGandE's Round Mountain 500 kV Substation for 3 months. Duties included planning construction activities, "as-built" drawings, and assisting in testing components.

My first assignment with PGandE was as a Field Engineer on the Construction of the Moss Landing Power Plant Units 6 and 7. This assignment started in June 1967 and continued to July 1968. My duties included assuring installation of piping systems was in accordance with engineering specifications and drawings.

PROFESSIONAL QUALIFICATIONS OF

HOWARD B. FRIEND

My name is Howard B. Friend. I have been employed by Bechtel since 1952. Since 1982 I have been employed by Bechtel Power Corporation as Project Completion Manager for the Diablo Canyon Project, an integrated effort between Bechtel Power Corporation and Pacific Gas and Electric Company. My responsibilities include managing the effort required for completion of the remaining services necesary to bring Units 1 and 2 of the power plant into commercial operation. The effort includes determination of manpower and other resources for engineering, licensing support, procurement, construction, startup testing, project cost and scheduling and related services, as required. I am a registered P[illegible]sional Engineer in the State of California.

My educational background is as follows: BS in Mechanical Engineering, Heald Engineering College, 1952.

From 1981 to 1982 I was employed by Bechtel as Manager of Projects for the San Francisco Power Division. I also served as Project Manager for the South Texas Project (two 1250 MW pressurized water reactor [PWR] units), responsible for the takeover of engineering, procurement, construction management, and related services.

From 1979 to 1981, I was employed by Bechtel as Manager of Division Engineering. In that position I was responsible for directing all engineering of the San Francisco Power Division, including the design of both fossil-fuel and nuclear power plants. My department was responsible for more than 22 major design projects.

From 1974 to 1979, I was employed by Bechtel as Engineering Manager. In that capacity, I was responsible for Bowline Units 1 and 2, Skagit Unit 1, Syncrude utility plant and other utilities for the Syncrude Tar Sands Project, among others.

From 1972 to 1974, I was employed by Bechtel as Project Engineer on other major projects, including Peach Bottom Units 1, 2, and 3.

Earlier assignments covered a variety of fossil-fired and nuclear power plants in supervisory and technical capacities and in field assignments.

PROFESSIONAL QUALIFICATIONS OF

JOHN M. GISCLON

My name is John M. Gisclon. I am the Technical Manager at the Diablo Canyon Power Plant. I have held this or equivalent positions since February 1979. I am responsible for plant staff review and approval of plant modifications. I am a Registered Professional Mechanical Engineer in Nevada and a Registered Professional Mechanical and Nuclear Engineer in California. I hold an NRC Senior Reactor Operator's license on Diablo Canyon Unit 1.

My educational background is as follows: BS in Mechanical Engineering, University of Nevada, 1961.

After graduating from the University of Nevada, I served four years in the U.S. Navy as an officer. I joined PGandE in 1965 and was assigned to the Pittsburg Power Plant as Engineering Trainee.

In 1966, I was tranferred to Humbolt Bay Unit 3 with assignments in nuclear power plant nuclear engineering, testing, and technical operations.

In 1968, I joined Westinghouse Electric Corporation (NRF - Bettis Atomic Power Laboratory) as a Plant Engineer. I held various assignments in maintenance and modification of equipment and systems and served as design liaison for the liquid radwaste disposal system.

In 1970, I rejoined PGandE and was assigned to Humboldt Bay for startup preparation as a member of the Diablo Canyon Task Force. As a member of the Westinghouse startup team, I was assigned to the H.B. Robinson Power Plant for three months.

I was a Power Production Engineer (Nuclear) from 1971 to 1974. I participated in the preparation and review of licensing material for Diablo Canyon Units 1 and 2, including the FSAR, Technical Specifications, equipment description and operating instructions, testing procedures, administrative procedures, and operational quality assurance manual.

Prior to my current duties as the Technical Manager, I was a Senior Power Production Engineer (Nuclear) from 1974 to 1979. I participated in the startup testing program and was responsible for supervising a staff of engineers (including persons experienced in nuclear engineering instrumentation, radiation protection, and chemical engineering) engaged in preparation of material required for plant startup, and in performing tasks related to startup.

I have completed the following formal training courses: Reactor Physics for Engineers and Nuclear Reactor Engineering (University of Idaho NRTS Graduate Education Program), Nondestructive Testing (General Dynamics/Convair), Nuclear Power Plant Opera*r Simulator Training (Westinghouse Nuclear Training Center, Zion, Illinois), Diablo Canyon Design Lecture Series and Station Nuclear Engineering Applications (Westinghouse), and Management for Excellence Program (University of Santa Clara).

PROFESSIONAL QUALIFICATIONS OF

JOHN B. HOCH

My name is John B. Hoch. Since January, 1982, I have been employed by PGandE as Diablo Canyon Project Manager. My responsibilities include managerial and supervisory duties, and providing coordination and direction of the Diablo Canyon Project organization. I am a Registered Professional Engineer (Mechanical and Nuclear) in the State of California.

My educational background is as follows: BS degree in Mechanical Engineering from the University of Idaho, 1959; graduate studies in Engineering, University of California, Berkeley, 1961 to 1962; MBA, University of San Francisco, 1969.

From 1980 to 1982, I was employed as Manager of the Nuclear Projects Department at PGandE. My responsibilities included managerial and supervisory duties, and providing coordination and direction of the Nuclear Projects Department in matters related to PGandE's nuclear power plants.

From 1977 to 1980, I was employed in PGandE's Engineering Department as Project Engineer for Diablo Canyon. My responsibilities included coordination of all Diablo Canyon Engineering activities.

From 1962 to 1977, I was employed as a Mechanical Engineer and as a Senior Mechanical Engineer in PGandE's Engineering Department. My responsibilities included engineering design and analysis work for both fossil-fueled and nuclear power plants. In addition, I was responsible for NRC licensing activities for PGandE's proposed Mendocino Power Plant and for the Diablo Canyon Power Plant.

From 1959 to 1961, I was employed by PGandE in its Department of Electric Operations with responsibilities which included engineering analysis, supervision of instrument maintenance activities, and start-up activities associated with new fossil-fueled generating units.

PROFESSIONAL QUALIFICATIONS OF

MICHAEL J. JACOBSON

My name is Michael J. Jacobson. I am the Project Quality Assurance (QA) Engineer for the Diablo Canyon Project consisting of the integrated organization of Bechtel Power Corporation and Pacific Gas and Electric company. I am a Registered Professional Quality Engineer in the State of California.

My educational background is as follows: Sacramento State College, BS in Civil Engineering, 1970; and Golden Gate University, Business Management Certificate in Management, 1979.

I joined Bechtel Power Corporation in 1970 as a Quality Assurance Engineer responsible for various aspects of the design phase quality assurance on a nuclear power plant project. I was subsequently responsible for performing structural design and seismic analysis activities on the project. Later, I was assigned as Project Quality Assurance Engineer responsible for supervising project QA activities, including direction of quality audits of construction activities.

Subsequently, I was assigned as Project QA Engineer on various other nuclear power plants, where I was responsible for directing project QA programs. I was responsible for ensuring that project construction and site activities, as well as quality control aspects, met applicable QA regulatory requirements.

I was assigned to the Diablo Canyon Project in 1982 to direct and control the DCP QA program.

1270A

PROFESSIONAL QUALIFICATIONS OF

MYRON E. LEPPKE

My name is Myron E. Leppke. I am the Onsite Project Engineer on the Diablo Canyon Project consisting of the integrated organization of Bechtel Power Coorporation and Pacific Gas and Electric Company responsible for direction and control of the multidiscipline Onsite Project Engineering Groups at the Diablo Canyon jobsite. Prior to that, I was the Assistant Onsite Project Engineer of the same organization with the primary responsibiltiy for the Plant Design, Record Management, and Document Control Groups. I am a Registered Professional Mechanical and Nuclear Engineer in the State of California.

My educational background is as follows: BS in Mechanical Engineering, University of Wyoming, 1970; and MS in Nuclear Engineering, University of Wyoming, 1971.

In August 1971, I became a Mechanical Systems Design Engineer employed by Pacific Gas and Electric Company on the Diablo Canyon Nuclear Project.

In September 1977, I was transferred to the Diablo Canyon jobsite to become the onsite Quality Assurance Supervisor. I had responsibility for monitoring quality assurance activities in Construction and Operations.

In August 1979, I was transferred to the Diablo Canyon Construction Organization and assumed responsibility for direction and control of the mechanical and piping construction activities.

In June 1981, I was transferred to the Nuclear Power Generation Department with responsibiltiy for formation of the Onsite Safety Review Group. This group was formed in order to provide independent review of operational activities and plant design with a view towards engineered safety improvements.

In March 1982, I was transferred to the Onsite Engineering Group as a Senior Piping Engineer responsible for the Small Piping Design Reverification Program.

In September 1982, I became the Assistant Onsite Project Engineer.

PROFESSIONAL QUALIFICATIONS OF

LEO MANGOBA

My name is Leo Mangoba. I have been employed by Bechtel since 1976. Since October 1982 I have been a pipe support group leader at Diablo Canyon where I have been responsible for managing the design of small bore piping supports.

I graduated with a Civil Engineering degree from Feati University, Manila, 1972.

Prior to 1974 I was an engineering estimator with Calderon Construction Company.

From 1974 to 1976 I held a variety of assignments working in pipe support engineering.

In 1974 I began working as a job shopper for Bechtel in the capacity of Pipe Support Engineer where I worked on design calculations for both large and small bore pipe supports. In 1976 I was hired directly by Bechtel to perform the same function. In this capacity I was involved with the Fast Flux Test Facility and the Limmerick and Skagit projects.

From 1977 to 1979 I was an Assistant Pipe Support Group Leader working on the design of large and small bore pipe supports. In 1979 I became the Pipe Support Group Leader, managing the design of small bore pipe supports for the Monticello, Point Beach and Susquehanna projects. In October 1982, I accepted an assignment in the same capacity with Diablo Canyon.

PROFESSIONAL QUALIFICATIONS OF

GARY H. MOORE

My name is Gary H. Moore. I am the Unit 1 Project Engineer of the Diablo Canyon Project consisting of the integrated orgnaization of Pacific Gas and Electric Company and Bechtel Power Corporation. I have held this position since January 1982. I am responsible for the project engineering work related to the design and analysis of Diablo Canyon Power Plant Unit 1. I am a Registered Professional Mechanical and Control Systems Engineer in the state of California.

My educational background is as follows: BS in Mechanical Engineering, San Jose State University, 1968; and MS in Mechanical Engineering, San Jose State University, 1969.

I joined PGandE in 1969 as a Mechanical Engineer in the Mechanical and Nuclear Engineering Department, designing instrumentation and control (I&C) systems for conventional fossil plants.

In 1977, I was named a Senior Mechanical Engineer supervising the I&C Group assigned to the Potrero Unit 7 Project.

In 1979, I was named Supervising Mechanical Engineer, supervising the Mechanical and Nuclear Engineering Department's entire I&C Group, including responsibility for the I&C design of the Diablo Canyon Power Plant.

I have completed the following formal training courses: Simulator Training, Westinghouse Nuclear Training Center, Zion, Illinois; and Westinghouse PWR Information Course.

PROFESSIONAL QUALIFICATIONS OF

ROBERT G. OMAN

My name is Robert G. Oman. I am an Assistant Project Engineer on the Diablo Canyon Project consisting of the integrated organization of Bechtel Power Corporation and Pacific Gas and Electric Company, responsible for the direction and control of the mechanical, electrical, instrumentation, and HVAC engineering groups. Prior to that, I was the Onsite Project Engineer with responsibility for overall direction of multidiscipline engineering group at the Diablo Canyon jobsite. I am a Registered Professional Mechanical and Nuclear Engineer in the State of California.

My educational background is as follows: BS in Naval Science, U.S. Naval Academy, 1966; and U.S. Navy Nuclear Power School, 1968.

After qualification as a supervisor of operations of Westinghouse PWR reactors, I served for three years as an engineering officer aboard a nuclear-powered submarine where I was responsible for the operation and maintenance of various reactor plant electrical and fluid systems.

I joined Bechtel in 1972 as a Nuclear Engineer on the Trojan Nuclear Project, becoming Nuclear Group Leader a year later, and Mechanical Group Supervisor a year after that. My duties included performing and supervising mechanical system design, licensing activities, and field coordination through startup to commercial operation.

My next six years were spent in Spain as Nuclear Group Supervisor, Mechanical Group Supervisor, and Assistant Project Engineer on the Vandellos Nuclear Project. My duties included supervision of systems design, technology transfer, and assisting my Spanish counterpart in implementing project management tools and production controls, and developing procedures for engineering interface with construction.

In 1982 I was assigned to the Diablo Canyon Project.

PROFESSIONAL QUALIFICATIONS OF

ROBERT PATTERSON

My name is Robert Patterson. I am Plant Superintendent and Assistant Plant Manager at Diablo Canyon. I have held this position since April 1980. I am responsible for directing all activities of the Maintenance, Operating, and Chemistry and Radiation Protection Departments at Diablo Canyon.

Prior to my duties as Plant Superintendent, I was Supervisor of Operations. I held that position from 1971 to 1980. As Supervisor of Operations I was responsible for supervising the operating staff in the preparation of equipment operating procedures and related material prior to the startup of the plant. I participated in the preparation and review of licensing material for Diablo Canyon Units 1 and 2 including PSAR, FSAR, and Technical Specifications. I was also responsible for directing the operating staff in performance of preoperational tests and three separate hot functional test programs. For the Unit 1 startup, I received an NRC Senior Operator's License.

Prior to my duties as Supervisor of Operations, I was a member of the Diablo Canyon Task Force from 1970 to 1971 engaged at Humboldt Bay in Diablo Canyon startup preparation. My duties included preparing training materials, initial loading, and low-level testing procedures for pre-startup activities.

From 1969 to 1970 I was assigned to Pacific Gas and Electric Company's (PGandE) General Office in license preparation for Diablo Canyon. During this period, I was assigned for seven months to the R. E. Ginna Power Plant. There I conducted a training program for operators taking the AEC Operator License examination and participated in the preoperational testing program and review of test results for acceptance of systems. During my R. E. Ginna assignment, I also participated in initial loading, low-level physics testing, and power operation testing programs.

Prior to this I was on special assignment for preparation of PGandE power plant operator's training program and related manual. I served in this capacity from 1968 to 1969.

Prior to special assignment, I was assigned to the Potrero Power Plant for startup of a 220 MWe conventional unit. I held various other assignments in power plant engineering and other technical operations at Potrero. During this period, 1964 to 1968, I was also reassigned to Humboldt Bay Power Plant during refueling outages to participate as a Shift Nuclear Engineer. At Humboldt Bay I participated in prestartup activities including preparation of training materials, initial loading, and low-level testing procedures. I directed the preparation of reactor refueling procedures

subsequent to initial fueling and directed the preformance of this work on shift. I was responsible for the theoretical analyses of reactor core nuclear and thermal-hydraulic performance plus evaluation of the performance of plant safeguard and other auxiliary equipment. From 1961 to 1964, I was assigned to other technical operations at Humboldt Bay and served in various assignments in power plant nuclear engineering.

Prior to my Humboldt Bay assignments, I was a staff engineer from 1959 to 1961. In this capacity I was assigned to both the Vallecitos and Dresden projects. At Vallecitos I observed various phases of plant operation including the initial startup of the AVBWR. At Dresden I participated in initial loading and low-level testing and half-power to full-power testing.

Prior to Vallecitos and Dresden, I had various assignments from 1955 to 1959 involving power plant engineering and technical operations. I was involved in a conventional power plant startup.

I graduated from Cooper Union School of Engineeing, New York, in 1953 with a BME. I am a registered Professional Nuclear Engineer in California.

PROFESSIONAL QUALIFICATIONS OF

R. KEITH RHODES

My name is Keith Rhodes. I am Technical Services Supervisor with the General Construction Station Department Instrument and Control (I&C) Group. I have held this position since January 1, 1980. I am currently assigned to the Diablo Canyon Project Startup Department and am responsible for directing activities of the Instrument and Control Group.

My educational background is as follows: AS degree in electronics, Cuesta College, California, 1976.

During the period from June 1980 until May 1983 I was assigned to the Technical Services I&C Group in Emeryville, California. I was responsible for supervising the I&C personnel at various job sites on work assigned to General Construction Station Department, including the Diablo Canyon, Geysers, and Helms Projects.

I was made a Field Engineer in 1975 and was responsible for supervising activities of the Diablo Canyon General Construction I&C Group. I was also responsible for directing contractor instrument installation and valve maintenance work.

In 1972 I was made a General Construction Technical Subforeman and assigned the responsibility of directing the contractor, S&Q Construction performing instrument installation work.

From 1967 until 1970 I was self-employed.

I initially joined PGandE's East Bay Division in 1962 and was an Apprentice Instrument Repairman at the Pittsburg Power Plant.

PROFESSIONAL QUALIFICATION OF

JAMES D. SHIFFER

My name is James D. Shiffer. I am the Manager, Nuclear Plant Operations, and as such provide line management support to the Diablo Canyon Power Plant. My organization is responsible for all operations, maintenance, operational engineering, training, security, quality control, emergency planning, and radiation protection activities at the plant. I am a Registered Professional Mechanical and Nuclear Engineer in California.

My educational background is as follows: BS in Chemical Engineering, Stanford University, 1960; and MS in Nuclear Engineering, Stanford University, 1961.

I joined Pacific Gas and Electric Company in 1961 as a Nuclear Engineer assigned to the startup preparations for Humboldt Bay Unit 3. My duties included preparation of training material, initial and low-level testing procedures; training of operating personnel for AEC license examinations; directing initial loading and testing programs as Shift Nuclear Engineer, and various other operational engineering assignments during the period between 1961 and 1969.

In 1969, I was transferred to the startup preparation for the Diablo Canyon plant which included a seven-month assignment to the startup and initial testing of the R.E. Ginna PWR plant.

In 1971, I was assigned to the Diablo Canyon plant as Power Plant Engineer and became Technical Assistant to the Plant Superintendent in 1978.

In 1980, I was appointed Manager of the newly formed Nuclear Plant Operations Department.

PROFESSIONAL QUALIFICATIONS OF

LAWRENCE E. SHIPLEY

My name is Lawrence E. Shipley. I am a Technical Consultant to the piping program at the Diablo Canyon Project. I have held this position for sixteen months. My primary responsibility is in the review of piping systems to licensing commitments and newly developed seismic criteria.

My educational background includes the following: BS in Mechanical Engineering, U.S. Merchant Marine Academy, New York, 1965.

I joined Bechtel Power Corporation's San Francisco Power Division in 1967 in the field of piping stress analysis. My responsibilies included technical direction of 150 engineers and designers on projects that included nuclear and fossil-fired power plants and the liquid metal fast breeder reactor at the Fast Flux Test Facility at Richland, Washington.

In 1981, I became the Assistant Project Engineer on the Susquehanna Steam Electric Station in Pennsylvania, responsible for engineering in the civil-structural, architectural, and piping and plant design areas. The work I directed included: structural analysis review of all Seismic Category I buildings, piping/stress analysis review of all Seismic Category I buildings, piping/stress analysis and pipe support design, valve qualification, welding and NDE, and materials selection and qualification.

In 1982, I was appointed Technical Consultant to the Diablo Canyon Project for the piping program.

In 1983, my duties were expanded to include those of Assistant Chief Engineer for Plant Design in the San Francisco Power Division.

PROFESSIONAL QUALIFICATIONS OF

AZR[illegible] SHUSTERMAN

My name is Azriel Shusterman. I have 23 years of experience as a mechanical engineer, the majority of it in the design of piping and pipe supports. Since August 1982, I have been employed by Bechtel's San Francisco Power Division and have worked on Diablo Canyon Unit 2. In October 1982, I worked with the jobsite's small bore piping design group in a supervisory capacity.

I graduated with a Mechanical Engineering degree from the University of Riga, Latvia, in 1961.

From 1961 through 1964 I was a Mechanical Engineer employed by the Diesel Manufacturing Plant of Riga, Latvia.

From 1964 through 1978 I worked at Riga's Special Project Institute of Oil and Industry where I was responsible for the engineering and design of piping, piping layout, pipe supports, and pipe stress analyses as well as the fabrication and installation of pipe supports. I also had interim assignments as a Senior Engineer in a plant that manufactured special tools, molds, and dies.

From 1980 to 1982 I was employed by Quadrex as an engineer on the Zimmer and Susquehanna projects. In this capacity, I was responsible for pipe

support design and piping walkdown inspections. At Susquehanna, I was also responsible for the technical review of small bore pipe support designs.

I accepted employment with Bechtel on the Diablo Canyon Project in August 1982.

PROFESSIONAL QUALIFICATIONS OF

ROBERT C. THORNBERRY

My name is Robert C. Thornberry. I am Plant Manager of the Diablo Canyon Power Plant. As such, I am responsible for ensuring that the plant is operated in a manner consistent with the safety of the plant personnel and the general public and in accordance with the license granted by the Nuclear Regulatory Commission. I am also responsible for direct supervision of all administrative functions. I am a Registered Professional Nuclear Engineer in California.

My educational background is as follows: BS in Chemical Engineering, 1962, and MS in Nuclear Engineering, 1963, Georgia Institute of Technology.

I joined Pacific Gas and Electric Company in 1980 as Project Design Coordinator for the Diablo Canyon Power Plant, responsible for the project design activities.

Prior to that, in 1979, I was an engineer with Atomic Energy of Canada, Ltd., responsible for safety studies for 600 MW CANDU reactors.

In 1976, I was employed by the San Diego Gas and Electric Company as Supervisor of Nuclear Licensing responsible for all aspects of licensing, including directing the support efforts of the NSSS supplier, architect-engineer, and other project consultants in the licensing process.

In 1972, I joined the General Atomic Company where I worked on high-temperature, gas-cooled reactor safety analysis reports.

After graduation in 1963, I joined the E. I. Dupont Company where I spent four years at the Savannah River Plant, monitoring the daily performance and safety of heavy water reactors, investigating unusual operating conditions, reviewing operating procedures, and calculating core operating parameters. For the five years subsequent to this, I was assigned to the Savannah River Laboratory where I worked on the design and analysis of fuel and target assemblies and directed a study and redesign of the emergency core cooling system.

PROFESSIONAL QUALIFICATIONS OF

MICHAEL R. TRESLER

My name is Michael R. Tresler. I am the Assistant to the Unit 1 Project Engineer on the Diablo Canyon Project, consisting of the integrated organization of Pacific Gas and Electric Company and Bechtel Power Corporation. In this position I am responsible for assisting the Project Engineer in directing all engineering on the unit with the exception of licensing-related efforts and other special activities. I have also been associated with the Project as Resident Mechanical Engineer, Project Superintendent, Assistant Station Construction Superintendent, Project Control Engineer, and Piping Design Coordinator.

My educational background is as follows: BS in Mechanical Engineering, California Polytechnic State University, 1964.

I joined PGandE in 1964 and performed pipe analysis and support design, and construction inspection, design, and startup of large fossil-fired units.

In 1969, I spent a year participating in the startup and initial testing of the R.E. Ginna PWR Plant in Rochester, New York.

In 1970, I became PGandE's Lead Engineer in the piping design and quality assurance areas.

I joined the Diablo Canyon Project in 1972 as Resident Mechanical Engineer, becoming Project Superintendent in 1977.

In 1979, I spent a year as Assistant Station Construction Superintendent with responsibility for Diablo Canyon and miscellaneous fossil-fired construction work.

In 1980, I returned to Diablo Canyon as Project Control Engineer and was appointed Piping Design Coordinator in 1981 with the responsibiliy for controlling all piping and support design work on the Project.

I assumed my present duties in October 1983.

PROFESSIONAL QUALIFICATIONS OF

WILLIAM N. WHITE

My name is William N. White. I am an Assistant Project Engineer in the Diablo Canyon integrated organization consisting of Pacific Gas and Electric Company and Bechtel Power Corporation employees. My responsibilities include supervision and direction of seismic-related engineering analyses for the Diablo Canyon Unit 1 Project Engineering Organization. I am a Registered Professional Civil Engineer in Oregon and member of the American Society of Civil Engineers.

My educational background includes: BS, Civil Engineering, University of Idaho; MS, Civil Engineering, University of Colorado; PhD, Civil Engineering, University of Colorado.

For the past seven years, I have been an engineering specialist with Bechtel's San Francisco Power Division working with the Chief Civil Engineer's staff in the area of seismic analysis for several Bechtel projects.

Earlier, I was a Structural Engineer with the Tennessee Valley Authority where I was responsible for seismic analysis of all Category I structures for a twin-unit nuclear power plant, including seismic input for the design of the nuclear steam supply system.

I was an Assistant Professor at Oregon State University where I taught undergraduate and graduate courses in structural mechanics and analysis and computer applications. I performed a special study for Bechtel on soil-structure interaction for the proposed Mendocino nuclear power plant while teaching at Oregon State University.

While employed at the Bettis Atomic Power Laboratory, I was a Senior Engineer working on shock analysis of nuclear reactors aboard submarines and was involved in programs to assess the shock resistance of reactor internals subjected to long-term irradiation damage.