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 F. C. BREISMEISTER, D. J. CURTIS, M. J. JACOBSON, M. E. LEPPKE,
G. H. MOORE, R. G. OMAN, L. E. SHIPLEY, AND W. H. WHITE

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

The above, being duly sworn, depose and say:

I, Gary H. Moore, am Project Engineer (Unit 1) for the Diablo Canyon Project.

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

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

I, Robert G. Oman, am Assistant Project Engineer (Unit 1) for the Diablo Canyon Project.

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

I, Daniel J. Curtis, am Onsite Plant Design Group Supervisor for the Diablo Canyon Project.

I, Fred C. Breismeister, am Manager of the Research and Engineering/Materials and Quality Services Group for the Bechtel Group.

I, William H. White, am Assistant Project Engineer, Seismic, for Diablo Canyon Project, Unit 1.

I. It is alleged that:

> There was only minimal training; initial assignments were received on the first day with an example of Bechtel calculations. (Stokes, 11/17/83, p. 2)

1. As Mr. Stokes has acknowledged, pipe support engineers are a select group with specialized knowledge and nationwide experience which makes them uniquely qualified to do their job. As a result, minimum technical indoctrination and training are necessary.

2. Indoctrination and training of pipe support engineers assigned to the Onsite Project Engineering Group (OPEG) began with the process of selecting experienced, technically qualified engineers whose professional qualifications for properly performing pipe support design work were already established.

3. To ensure technical competence, pipe support engineers are hired in large part on the basis of interviews, educational qualifications, and previous experience. For both permanent and temporary or "casual" employees, the professional credentials of all are required to be verified by either the Engineering or the Personnel Departments of Bechtel or PGandE. For contract employees, such verification is a

contractual requirement for the contract firm. A thorough review of the engineer's work experience is confirmed by senior engineering personnel.

4. A thorough 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. 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.

5. In order to indoctrinate newly assigned engineers in project procedural requirements, the Project provides formal training in the Engineering Manual Procedures (EMP) which implements project QA requirements. Those requirements meet Criterion II of 10 CFR Part 50, Appendix B, and are set forth in the 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. The training emphasizes the procedures on design criteria memoranda, design calculations, design changes, drawing control, discrepancy reports, and nonconformance reports.

6. 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 those discrepancies. Since May 1983, only five OPEG design engineers have exceeded the 30-day training requirement by more than a few weeks.

7. In addition to these organized training sessions, working familiarity with DCP calculational procedures and pipe support design criteria was acquired by new engineers through the practical experience gained in originating preliminary calculations. Newly assigned engineers were given copies of completed example calculations to use as models for calculation format. Copies of project procedures, instructions, and criteria were made available for reference and adequate opportunity was given for the engineer to gain familiarity with project calculation format and methods. Supervisory personnel were available to answer individual questions and provide clarifications for points of uncertainty. Newly assigned engineers were assigned more experienced checkers to review their work for adequacy and correctness prior to its being issued.

II. It is alleged that:

> Controlled documents were not immediately received for work assignments. Field engineers were working to unverified xerox copies which were incomplete. Management was not responsive to requests for controlled documents. (Stokes, 11/17/83, pp. 2, 4, and 5)

8. It is true that not every support engineer had an individual copy of controlled design documents assigned to him. No such requirement exists and such a policy or requirement would create far more problems than it might alleviate. However, an adequate number of controlled copies were available in the specific work area for reference use by all engineers.

9. Mr. Stokes was assigned to the small bore pipe support group of OPEG as one of 11 engineers in November 1982. At the time of his assignment, three controlled copies of the project piping design criteria were assigned to the support group which was located together in one trailer.

10. By January 1983, the number of engineers assigned to the pipe support group in the trailer had increased to 35. Steps had already been taken to obtain additional copies of controlled documents for use by the expanded piping group. Additional controlled copies of design documents were requested from San Francisco. These documents were received in December 1982, and were distributed for use by the expanded pipe support group. It was soon realized that the documents received, although identical, were not controlled documents, and therefore a further request was made in January of 1983 for additional controlled documents. Consequently, while there may have been some inconvenience, copies of controlled and identical uncontrolled design documents were available within easy reach of every pipe support engineer. Thirteen

additional controlled copies were received and distributed in February 1983. Mr. Stokes was assigned his own individual controlled copy in February 1983. In April 1983, all controlled copies were replaced by a complete reissue of new controlled copies of the design documents.

III. It is alleged that:

> Field engineers were working to records of calculations they brought from other nuclear plants. Use of other plants' documents results in assumed load ratings for other manufacturer's equipment that may not be applicable to DCPP. Assumptions used differed from those on controlled documents. Unique conditions of DCPP were not accounted for. (Stokes, 11/17/83, pp. 2 and 3)

11. Questions have been raised as to whether references, such as the following, in the possession of pipe support engineering personnel were used in lieu of approved work procedures:

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

12. Reliance on one's past experience is not uncommon in the profession and especially for pipe support engineers who, as Mr. Stokes acknowledges, have specialized talents based on past experience. 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, more importantly, they do not constitute acceptance criteria.

13. Project Engineering Procedures (EMP 3.3) require that calculations be sufficiently detailed so that qualified technical personnel can verify their adequacy without consulting the originator. References such as textbooks, catalogs, monographs, and other such accepted industry techniques must be documented in the calculation when necessary to provide details of the design sufficient to allow an independent review. Their use then is checked and approved via the calculation review process.

14. 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.

15. Prior to May 1983, design calculations originated by OPEG were preliminary in nature since they were based on preliminary assumptions due to the absence of final thermal and seismic design data at that time. All such preliminary calculations have been subsequently reviewed and revised as the final design data have become available. These revisions of the calculations to final status were completed using the latest revision of project criteria and were subjected to Independent Design Verification Program (IDVP) review.

IV. It is alleged that:

> Supplier's ratings for U-bolts were one-third to one-fourth more stringent than claimed on DCPP drawing 049243. This drawing represents a false statement. PGandE relied on a series of suspect assumptions in order to exaggerate the load ratings. The 1978 PGandE U-bolt test program was biased by not reflecting actual plant conditions. Stokes was allowed to use load ratings which failed some of the U-bolts. Even if load ratings of U-bolts were accurate, the hangers to which they are attached would not meet design requirements. (Stokes, 11/17/83, pp. 5 to 8)

16. A U-bolt is used in conjunction with other structural members to provide lateral restraint to a piping system. It restrains the piping in directions perpendicular to the pipe centerline and provides both thermal and seismic restraint, The ASME B&PVC, Section III, recognizes and provides detailed rules for the qualification of pipe supports by three different methods. They are analysis, testing, or experimental analysis.

17. ITT Grinnell qualified the U-bolt by analysis. To analytically represent the load/deflection relationship between the pipe and the

U-bolt becomes a very complex problem. To provide this qualification, Grinnell simplified the relationship between the pipe and U-bolt to produce very conservative results from a model that can be handled analytically.

18. Testing provides a more accurate representation of the pipe/U-bolt interaction by including elements such as the distribution of the load on the U-bolt, the frictional resistance between the pipe and the U-bolt, and the pipe's influence on the U-bolt's deformation.

19. DCP Standard Drawing 049243 for small bore pipe supports uses load ratings that were derived in accordance with the intent of the ASME B&PVC Section III rules for qualification by testing and does indeed give higher load ratings than given by ITT Grinnell. These tests were conducted at the DCP site in 1978. It is true that these two methods, analysis and testing, can yield a factor of 4 difference. However, the test results are closer to reality, whereas the analytical results are only a very conservative approximation.

20. 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%.

21. 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 are considered to be at least equivalent to a derating of allowables by 10%. The following is a summary of conservatisms:

22. 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-inch and 3/8-inch diameter rod U-bolts, respectively.

23. 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.

24. 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.

25. 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 meets all design criteria.

26. Interaction equations for tension and shear are used in bolting applications. The form that the equation takes is dependent on the

application. In accordance with ASME Section III, Appendix XVII, paragraph 2461.3, the capacity of a bolt in a bearing type connection is determined using the following expression:

$$\frac{f_e^{\,2}}{F_e^{\,2}} + \frac{f_s^{\,2}}{F_s^{\,2}} \leq 1$$

where f_e = computed tension stress

f_s = computed shear stress

F_e = allowable tensile stress at temperature

F_s = allowable shear stress at temperature

27. This is exactly the equation appearing on DCP Drawing 049243 which was used for the qualification of U-bolts. Because no guidelines are given in NF-3261 for the combination of load ratings established for a particular restrained direction, tension and shear loads were combined in accordance with ASME Section III, Appendix XVII, paragraph 2461.3(a). This equation is used when stresses are calculated for bolts. Accordingly, it is considered appropriate to use this equation for load ratings as stress and load ratings are directly proportional.

28. Although the interaction equation given in Section III, Appendix XVII, 2461.3 may not have been specifically intended to address bolts with combined tension, bending, and shear, the results of test loading indicate that it is appropriate and conservative for this application.

29. The assertion that because Schedule 160 pipe was used in the test, any thinner wall piping could be damaged or "buckle" due to the U-bolt capacity is illogical. The maximum capacity of the U-bolt and stress

analysis of the piping at any particular support location are two independent issues. Piping stress at any location in the piping system is a function of the moment in the piping component. The magnitude of this moment is determined by the seismic acceleration at the given plant location and is therefore independent of the maximum capacity of the U-bolt. The U-bolt allowable on the other hand, or maximum capacity as derived from the tests, is independent of the location in the plant or the piping to which it attaches. This concern seems to stem from a lack of understanding of the total design process, both stress and pipe support, and ASME requirements. The analysis of the piping and subsequent satisfaction of all code requirements ensures that buckling of the piping will not occur.

30. The fact that the tests were not performed at elevated temperatures has no bearing on the load capacities developed in accordance with ASME Section III, Appendix XVII, paragraph 2460. Allowables for bolts are derived based on Ultimate Tensile Strength (SU). This value does not change between the ambient test temperatures and 650°F which qualified the U-bolts for all Seismic Category I supports at the Diablo Canyon site. U-bolts have <u>not</u> been used in Seismic Category I applications where they would be on lines above 650°F.

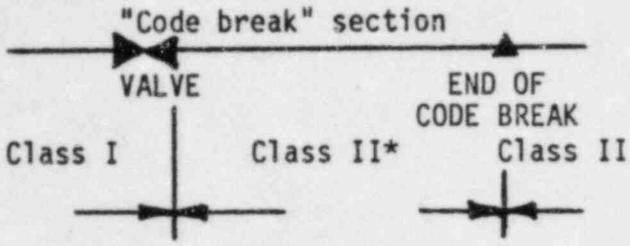
31. During construction some U-bolts may have been slightly bent to align the U-bolt legs with predrilled holes. Any such bending would be of a cold forming nature. It is common practice to form materials by cold bending and this would tend to increase the yield strength properties of the U-bolt, This would create an even stronger material through cold

working. It should be noted that the original forming of the "U" shape is done by cold forming during the manufacturing process. In any event, this practice does not reduce the load capacity of the U-bolt.

V. It is alleged that:

> For code breaks, boundaries of Class I seismic systems, there was not enough offset or space between the valves and the large bore piping to avoid unacceptable stress on the small bore pipeline branches. The vendor had not received correct instructions since they were told to install the piping at room temperature. DCPP requires seismic supports, and has to endure temperatures in excess of 650°F. (Stokes, 11/17/83, pp. 8 and 9)

32. 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 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 PGandE 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

33. 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 and meet all licensing criteria.

34. 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.

35. Independent of the vendor procedures for original installation, the recent reverification effort has considered 100% of the code break issues as well as all systems with high temperatures. Therefore, we are confident that sufficient offset or space exists between valves and large bore piping to avoid unacceptable stress on small bore pipe branches.

36. The allegation that the offset is insufficient to avoid unacceptable stress on the small bore branch lines evolves from a misunderstanding. It apparently comes from a belief that ME-101 analysis of offset is less reliable than M-40. ME-101 is a computer program that performs static and dynamic response spectra modal superposition solutions. M-40 is a hand calculation technique based upon simply supported spans. Either technique is acceptable.

VI. It is alleged that:

> Engineers who questioned suspect assumptions were transferred to Unit 2. Cooperative engineers plus new recruits were assigned to Unit 1. (Stokes, 11/17/83, p. 9)

37. Contrary to statements in the affidavit, no attempt was made to determine personnel assignments on the basis of objections or questions raised regarding Unit 1 activities.

38. When the OPEG small bore piping group was established in the fall of 1982, all efforts were directed to Unit 1 activities. At the time, there was no specifically defined scope of work or schedule for Unit 2 activities. Consequently, the entire OPEG small bore piping group was assigned to Unit 1. By early 1983, the Unit 2 scope and schedule were

defined and it became necessary to increase OPEG manpo r to support Unit 2 work in addition to the ongoing Unit 1 effort. Accordingly, additional trailer space and engineers were obtained for that purpose. The decision to establish physically separate teams for the two efforts was based on the desire to assure proper management of the two activities. The separate teams within OPEG facilitated independent scheduling, production control and output tracking, control of manhour expenditures against separate project budgets, coordination with the two separate and independent Unit 1 and 2 project teams in San Francisco, and prevented intermixing of calculations, calculation files, support drawings, and other potential administrative problems.

39. The basic consideration in establishing the makeup of the two teams was to provide each with an essentially equivalent mix of new assignees, engineers with more project experience and appropriate supervisory personnel, such that each project effort could be supported equally. Security clearance for access to the plant was not a consideration in these assignments since the relaxation of plant security procedures effective in March 1983, allowed all pipe support engineers equal plant access to Units 1 and 2.

VII. It is alleged that:

> These Unit 1 engineers redid calculations entirely for all failed systems. The original calculations vanished with no mention of the failure. The calculation logs were also rewritten and falsified. Unit 1 would have failed the reevaluation program and required complete reanalysis. (Stokes, 11/17/83, pp. 9 to 11)

40. In verifying the adequac[illegible]g designs at Diablo Canyon, engineering design practic[illegible]ent with both nuclear and non-nuclear applications were followed. These engineering practices utilized iterative engineering calculations to verify a design that is consistent with the acceptance criteria. It is common practice to do initial calculations using conservative data and simplified methods. This can save the time and expense associated with more detailed, time consuming, sophisticated calculations (such as computer analyses). When an initial calculation using conservative data demonstrates one or more acceptance criteria are not met, an engineer performs additional trial calculations that use more precise input data. Input data can be modified by removing unnecessary conservatism or by selecting more appropriate boundary conditions as an alternative to using progressively more sophisticated approaches.

41. Typically, engineers are trained to employ the use of more sophisticated analytical techniques if initial conservative analyses are not acceptable. For example, a hand calculation might be replaced by a static computer run, then by a dynamic linear-elastic computer run, and finally by an inelastic time history analysis. All of these increasingly sophisticated analytical methods yield results that are entirely acceptable in accordance with the design criteria.

42. The net result of this engineering process is a completed analysis which must be in full compliance with the design criteria and which meets all design parameters. The documentation of such an analysis constitutes support and verification of the final design. Intermediate calculations

which are not part of the final calculations need not be retained. Quality procedures do not require retention of these unapproved, intermediate calculations.

43. 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. Superseded calculations are not required to be retained by regulation, regulatory guide, standard, or any procedure to which Diablo Canyon is or has been committed to. 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." This allows an accurate reconstruction of each calculation. The cover sheet of each calculation package contains a change sheet which shows the history of all revised calculations. A review of these records indicates that more than 70 calculations contain Mr. Stokes' signature in one of their versions. The calculation logs may, however, be changed to reflect only the latest revision and signatory engineers. This normal practice does not constitute falsification of records as alleged.

VIII. It is alleged that:

> Management's first approach to make Unit 1 look good was to reduce code break spans. This was not done because there was no plausible explanation for it. Management decided to use new assumptions that would change the results from fail to pass by assuming gaps that did not exist or vice versa. (Stokes, 11/17/83, pp. 11 and 12)

44. Since Mr. Stokes did not perform any computer piping stress analyses at Diablo Canyon, he was probably unaware of the applicable specific design requirements. However, he is correct in noting that 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) when performing small bore piping stress analysis for thermal expansion or thermal anchor motion. 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.

45. 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.

46. As a result of the NRC Staff's question emanating from this allegation, 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 approximately 3% of the supports analyzed. As

reported in the Project's supplemental letter to the Staff dated December 28, 1983, 16 of 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 involve 16 supports which is less than 1% of all the small bore pipe supports analyzed.

47. 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 accomodate 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.

48. 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 ignoring as-built gaps results in excessive thermal loads.

IX. It is alleged that:

> Management assumed joint releases for rigid connections which means that welds which were in place were assumed to be nonexistent. (Stokes, 11/17/83, p. 11)

49. "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 rotational 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.

50. 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 evaluations of frame structures.

X. It is alleged that:

> Hangers still failed and management requested designers to perform reverse calculations to determine the maximum loads that each hanger could support. After maximum loads were established, results were returned to the stress group. (Stokes, 11/17/83, p. 12)

51. Different methods exist to qualify a piping system to design criteria. These methods often require interaction 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 the given 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 several times before the support is qualified. Such an approach is a logical and orderly method of qualifying small bore piping systems and does not violate any design or licensing criteria or regulatory requirement.

52. 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 interactions 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 may be able to perform a reanalysis iteration without requiring the pipe support engineer to recalculate stress in the support. This method 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. This reverse calculation technique is often used in the industry and is analogous to calculating an acceptable "load rating" of a support.

53. This question also conveyed the implication that intermediate or iterative calculations were being improperly destroyed. Such an implication is erroneous. Pursuant to procedure 3.3 contained in the PGandE Engineering Manual, all final (i.e., approved) calculation packages are retained and permanently filed. There is no regulatory or project requirement to retain the intermediate or iterative analyses.

XI. It is alleged that:

> Another technique of adding new supports within six inches of failed existing supports was used. The stress group then modeled new support gap assumptions so that the new supports would handle most of the load. Instead of making necessary repair for a pipe resting on a unistrut, this unintentional restraint was modeled as a pipe support instead of being removed. The solution was to remove the unistrut and add a full-sized support. (Stokes, 11/17/83, pp. 12 to 14)

54. 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, in the case of a design modification, 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 requirements.

55. 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).

56. 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 installed piping system and is not unique to this plant. All applicable procedures were followed in this process and all design criteria were met. In fact, it would appear that this situation clearly demonstrates good communication between Construction and Engineering, sound engineering practice, and a proper solution that resulted in a system that meets the design criteria.

XII. It is alleged:

> There was a coverup of defective materials from Pullman associated with a 50,000-pound bracket on a 20-inch line. The bracket was deformed and failed testing. Management instructed that only visual inspections be performed on replacements. (Stokes, 11/17/83, pp. 14 and 15)

57. The alleged material deficiency discussed in the affidavit was investigated. It involved support 1029-5CS, which is a constant rate spring support used as a dead load support on a 28-inch steam line (not 20-inch as alleged in the affidavit). The "cracks" mentioned in the affidavit were in fact laminations as determined by ultrasonic testing which commonly occur in this type of SA-36 plate, and it is not surprising that ultrasonic or magnetic particle testing would indicate this condition existed. These laminations do not detract from the component's load capacity. In addition, the pieces exhibited punching marks which the component manufacturer has certified do not affect the component's capacity or function.

58. To be conservative, the contractor returned four of the ten brackets included in the order while the two on 1029-5CS were scrapped.

XIII. It is alleged that:

> Pipe stress and support engineers were normally not allowed to prepare Discrepancy Reports. Foley and Pullman, however, regularly prepared these documents. (Stokes, 11/17/83, p. 15)

59. Training is required of all engineering personnel shortly after assignment to the project which includes indoctrination in the purpose and use of a Discrepancy Report (DR), as well as a Nonconformance Report (NCR), and a Design Change Notice (DCN). Project training records indicate that Mr. Stokes attended this training on November 8, 1982, shortly after his arrival onsite. NCRs are addressed in Engineering Manual Procedure 9.1 and DRs are addressed in Engineering Manual Procedure 10.1.

60. Procedure 10.1 provides that any individual can identify a potential discrepancy and bring the matter to the attention of the responsible Engineering Department group leader or supervisor. The supervisor is responsible for determining, after investigation, whether the identified item is a non-conformance, a discrepancy, or neither, and directs that the appropriate report be prepared. During the course of the OPEG piping design effort, there were numerous instances identified by engineers which required discussion and clarification of the design basis for items which were unclear to specific engineers. This is not unexpected in the normal course of design engineering activities where solutions to engineering problems are developed. Identification of

"potential discrepancies" which, upon further investigation, proved to be of no concern were not frequent, but did occur from time to time.

61. A DCN is a document used by engineering to effect a modification to an approved specification, drawing, or supplier document that results in a plant modification or revises any other design document or license requirement. Contrary to the allegation, it is not a document for engineers to initiate modifications in response to QC inspections unless the inspection should result in a redesign modification. Procedures controlling the use of DCNs are addressed in Engineering Manual Procedure 3.60N for Unit 1 and Project Engineers Instruction No. 16 for Unit 2. Contrary to statements in the affidavit, numerous DCNs have been initiated by OPEG pipe stress and pipe support engineers to modify pipe routing and pipe support designs as required by their engineering analysis. Between January and October of 1983, over 200 such DCNs were initiated by OPEG engineers. How Mr. Stokes could be unaware of this fact and yet have the knowledge of how the process worked that he alleges he has is, at best, curious.

62. Numerous controlled copies of the Engineering Manual were provided as reference documents within the various OPEG office spaces and were easily available for use in clarifying any questions which might arise concerning DRs or DCNs.

63. Contrary to statements in the affidavit, neither Foley nor Pullman activites are controlled by the PGandE Engineering Manual and they consequently do not prepare Engineering DRs or DCNs. Documents used by Foley and Pullman which are called a DR or a DCN are different documents from those described in the Engineering Manual.

XIV. It is alleged that:

> In the three DRs written by Mr. Stokes, flare bevel, flare V and other partial penetration groove welds for pipe supports were deficient. However, management insisted AWS standards did not apply to DCPP. (Stokes, 11/17/83, pp. 16 and 17)

64. The effective throat of flare bevel and flare-V groove welds are in accordance with AWS D1.1 Structural Welding Code prequalified condition. In the case of flare bevel welds, the effective throat is taken as 5/16R, where R is the corner radius. This approach is very conservative and AWS D1.1 recognizes the conservatism of this approach by not requiring qualification. Had the project desired, even larger effective throats could have been justified per AWS D1.1.

65. In accordance with AWS D1.1., Section 2.1.3.1 and documented understandings between Engineering and Construction, dimensions are not required on flare groove welds. If dimensions are not provided, the meaning of the symbol is to weld the flare groove joint out flush with the corners. ESD 223 Section 6.8.2.6 D requires a visual inspection to ensure that the weld is acceptable. The design of welds does conform to the requirements of AWS D1.1. The requirement to completely fill groove joints flush provided the most simple and conservative instruction to construction and inspectors. This eliminated the need for a dimension and related field measurements.

66. Bevel angles are not required to be placed on the design weld symbols as these are included with the Weld Procedure Specification (WPS) which provides direction to both the welder and weld inspectors. Flare groove joints do not have bevel angles and bevel angles cannot be shown on the

design weld symbol. It is not necessary to limit the bevel angles to those given for prequalified welds in AWS D1.1 Figures 2.9.1 and 2.10.1.

67. Dimensions, such as the depth of bevel (S) and effective throat (E), are not required to be placed on the weld symbol per AWS D1.1 Section 2.1.3.1 for complete penetration welds. For partial penetration joints, AWS D1.1, paragraph 2.1.2.1 recommends, but does not require, S and E dimensions on drawings. In the case of intersecting members creating weld joints which AWS D.1.1 considers partial penetration welds (for purposes of qualification), but which have no weld groove bevel edge preparation, it is meaningless for the designer to specify S (bevel groove depth) because there is no bevel groove preparation. EDS-223 provided an effective and simple alternative to measuring (S) and (E) dimensions. For the joints between skewed intersecting members, it is impossible to directly measure dimension (E) (effective throat). ESD-223 provided an instruction which specified the simple measuring gauge to be used and a conversion table relating the design drawing dimension to an easily measured dimension. The use of the gauge and the table means that the Pullman inspectors did not need effective throat (E) on the drawings, and it was appropriate to take that dimension off drawings because it cannot be measured.

68. It is not necessary to adjust the fillet weld leg size to have all the welds in a joint have the same effective throat. Adjustments are made in the weld calculations to account for the varying effective throats and the consideration of the local dihedral angle has been made in the calculations. Even though fillet weld symbols have been used for

dihedral angles less that 60°, calculations are performed to ensure that the weld qualifies as a partial penetration weld with the proper throat reduction. This reduction is in accordance with the requirements of AISC and AWS.

69. Pullman Power Products procedures reference the PGandE specification to which pipe supports are to be installed and the codes to which the weld procedures specifications (WPS) are qualified. For the WPS which are qualified, it is not necessary, and inappropriate for Pullman QC to inspect the welds to the AWS D1.1 prequalified joints. The weld procedure specification, ESD-223, and the design drawings contain everything needed to inspect the welded joint. Flare groove welds are inspected in accordance with the requirements of ESD-223.

70. It is not necessary for Attachment I of ESD-223 to provide limitations for the minimum dihedral angle for intersecting structural shapes. The limitations on the dihedral angle would be governed by the design drawings used. Throat adjustments are reflected in the weld design calculations. The calculation adjustments have taken into account the effect of skewed dihedral angle rather than perpendicular connections, and have considered that acute angle connections will not have complete fusion to the weld root, due to possible slag inclusions.

XV. It is alleged that:

> The second Stokes DR stated that angle members were two-to-three times too long for the allowable bending stress standard used under the AISC code. The angles could buckle under pressure. One hundred frames of 300 checked contained violations. (Stokes, 11/17/83, pp. 17 and 18)

The M-9 computer analysis for angles omitted the relevant provisions of the American Institute of Steel Construction (AISC) code for allowable bending stress, contrary to licensing commitments. (Stokes, 1/25/84, Tr. 15-21)

71. In paragraphs 71 thru 78, 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

72. 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 $b_f/\sqrt{Fy}$. The term 76.0 $b_f/\sqrt{Fy}$ 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 $b_f/\sqrt{Fy}$. 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 $b_f/\sqrt{Fy}$. 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."

73. 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 develop criteria. In late 1977 it was found that a theoretical solution to the design of laterally unsupported angle beams was available. The theory had also been verified with extensive testing. The theory and the testing were completed in Australia (Reference 3, 4, and 5).

74. 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.

75. For all the various angle sections and load cases investigated, Reference 4 recommends that an allowable bending stress of 0.66 Fy may

IMAGE EVALUATION
TEST TARGET (MT-3)

1.0 1.1 1.25 1.4 1.6 1.8 2.0 2.2 2.5 2.8 3.2 3.6 4.0

150mm

6"

IMAGE EVALUATION
TEST TARGET (MT-3)

150mm

6"

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.

76. DR 83-042-S, written by Mr. Stokes, questioned the acceptability of certain unbraced angle members because the unsupported spans of those members are greater then 76.0 $b_f/\sqrt{F_y}$ per section 1.5.1. 4.6b of Reference 1.

77. It should also be pointed out that the 18 pipe supports identified in the DR 83-042-S as discrepant have been reviewed. All of the angle beam spans are found within the Project Design Criteria.

78. It is concluded that the Project Design Criteria on the design of laterally unsupported angle beams has adequately covered the length greater than 76.0 $b_f/\sqrt{F_y}$.

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.

XVI. It is alleged that:

> The third Stokes DR stated the distance between the center of Hilti bolt holes was not verified as the same length required and specified on the drawing. QC had measured the distance between the centers of plates attached to the bolts whereas location of the bolts is supposed to be control for the location of the plates. As a result, whole packages could be in the wrong location. (Stokes, 11/17/83, pp. 18 and 19)

79. The capacity of a concrete anchor bolt is a function of the bolt length (embedment), bolt material, and concrete strength. Anchor bolt capacity relates to a shear cone of concrete originating at the end of the anchor bolt embedment. This cone projects at a 45^{0} angle to the surface. If two anchor bolts are placed close enough together that their shear cones overlap, some of the strength of the anchor bolts may be lost. The 10d (bolt diameter) criterion between anchor bolts was established to assure this would not occur.

80. All shell type anchor bolts on Diablo Canyon have an embedment of less than five bolt diameters. Since the anchor bolt center lines are ten bolt diameters apart, the shear cones can never overlap. Hence the anchor bolts retain their full capacity. The capacity of an anchor bolt is determined by test. The test for a shell anchor is normally

performed on one anchor at a time. The anchor bolt will develop that full capacity so long as no adjacent anchor bolt is less than then 10 bolt diameters away. In other words, the criteria that determines the required spacing is solely a function of concrete failure theory and test results which are categorized by bolt diameter.

81. Tests to validate this premise were conducted in 1962 on a Phillips shell type anchor. The results reported no reduction in capacity for ten bolt diameter spacing. It is true that the recommendation in the Hilti catalogue is to space the bolts 10 hole diameters apart. However, when the actual shear cone is developed, the results are bounded by the 10d bolt criterion,

82. The allegation as to the measurement of the centers of plates rather than the location of bolts is difficult to understand. The design location of a base plate is defined on the hanger detail and is dimensioned to the building structure, i.e., elevations and column lines. On the other hand, the required anchor bolts are defined with respect to the base plate, not the building structure. During the installation, the design location of the base plate is marked on the wall and an instrument is employed that locates reinforcing bar within the concrete. The rebar locations are also marked on the wall. Anchor bolt locations are then selected that most closely approximate their design locations without cutting the rebar.

83. If anchor bolt locations relative to the base plate are within established construction tolerances from the design location, construction proceeds. If the location is outside of tolerance, the

Pipe Support Design Tolerance Clarification (PSDTC) group would be asked for approval to deviate and upon completion of the installation an as-built drawing would be transmitted to Engineering for final approval as required by procedure. In the manner described above, both the plate locations relative to the building and the bolt holes relative to the plate are known, documented, and receive Engineering approval resulting in all licensing criteria being met.

XVII. It is alleged that:

Access to Quality Control and NRC personnel by employees was restricted. (Stokes, 2/8/84, p.1)

84. Diablo Canyon Project written procedures stress bringing potential problems to the attention of engineering supervision in a timely manner so that appropriate steps can be taken to identify and implement any corrective action necessary to resolve the concern and prevent future recurrence.

85. Engineering Manual Procedures covering Discrepancy Reports (Procedure 10.1, paragraph 3.1) and Nonconformance Reports (Procedure 9.1, paragraph 4.1.1) both specifically state that anyone who believes he has identified a potential engineering discrepancy or nonconformance should bring the matter to the attention of the appropriate Engineering Department group leader or supervisor for resolution.

86. These clearly written project procedures do not restrain or prevent engineers from discussing potential problems with representatives of quality control or the NRC. These procedures recognize that many concerns raised by engineers are of a nature that may easily be resolved

by the supervisor who possesses a broader knowledge of the project. If needed, the supervisor may involve staff specialists or engineers from other disciplines to assist. In no event does management discourage engineers, or any other person, from raising legitimate concerns. (See Exhibit 1, dated March 22, 1982, and referencing previous policy statements dating back to the 1970s.)

87. Quality Assurance and Quality Engineering personnel have been physically located within OPEG and have been available at any time to discuss and assist with the resolution of quality problems. Training sessions were held in support of the written procedures. The training sessions on the Engineering Manual procedures, which are mandatory for engineering personnel, specifically include a description of Discrepancy Reports and Nonconformance Reports. Project records indicate that Mr. Stokes received this training in November 1982.

88. During the course of quality audits or NRC inspections of engineering work, auditors may ask questions about which individual engineers may not be well enough informed to provide accurate, comprehensive responses. An individual engineer might be questioned about work he is not directly involved with and therefore not be specifically familiar with in detail, or about more general program aspects of which the individual engineer may not have an overall perspective. An excellent example is Mr Stokes' lack of knowledge as to the justification (Australian test data) for use of angle-shaped members (see January 25, 1984 transcript, p. 126). To minimize a misinformed response to auditor questions, a knowledgeable supervisor normally participates during

audits of these kinds. If questions are raised that cannot be answered by those present during the audit or inspection, they should be presented to a supervisor or someone else to assure that the responses are complete and accurate. This policy is intended to ensure that accurate information is provided during audit activities and does not restrain or prevent engineers from discussing problems with "quality control" or the NRC.

89. Additionally, the Bechtel Power Corporation, San Francisco Power Division Instruction 3-17, "10 CFR Part 21, Reporting of Defects and Noncompliances," applies to and is implemented by the Diablo Canyon Project. This instruction defines responsibilities, establishes requirements, and provides guidance for actions necessary to meet the reporting requirements of 10 CFR 21. Procedural requirements to initiate evaluation and reporting pursuant to 10 CFR 21 are also contained in this instruction. The instruction is posted in Diablo Canyon Project work areas for reference. Also, PGandE has posted 10 CFR 19 reporting instructions and a copy of Form NRC-3 which gives guidance for contacting the NRC and the regional NRC phone numbers and addresses. These documents have been posted in all PGandE facilities (i.e., PGandE headquarters, construction offices, and operating facilities as well as in the OPEG offices).

90. The methods described above have been available to project personnel to process a design issue which they felt could potentially affect the safe design, construction, or operation of the Diablo Canyon Power Plant.

XVIII. It is alleged that:

> Alien engineers (green card holders) were employed and intimidated by fear of dismissal, to approve incorrect design practices. (Stokes, 2/8/84, p. 2)

91. Management has not and does not practice intimidation in order to supervise engineers in the performance of their work. Only U.S. citizens or Green Card holders were employed as pipe support engineers in OPEG. Further, permanent residency (green card holders) in the United States allows a person the rights of a U.S. citizen except the right to vote. (8 U.S.C.S. Secs. 1101, 1251)

92. If an employee on green card status is laid off or terminated for any reason, this termination has no influence on their permanent residency status. They are free to stay in the United States and seek other employment in exactly the same manner as a U.S. citizen. It is obvious that even the means to intimidate an alien engineer as alleged by Mr. Stokes simply do not exist.

XIX. It is alleged that:

> The Quick Fix or Pipe Support Design Tolerance Clarification (PSDTC) program was not subjected to controlled documents, the engineers and QC inspectors were not provided clear instructions, those instructions that did exist (the June 16, 1983 memo) were insufficient to define the authority of the PSDTC engineers, there was no formal review of the Quick Fix work, and the Quick Fix program bypassed the formal QA reporting requirements which prevented reporting of serious hardware deficiencies. (Stokes, 2/8/84, pp. 2 to 4)

93. In January 1983, a special team of pipe support engineers was established within OPEG whose assignment consisted of direct engineering liaison with General Construction resident engineers and Pullman Power

Products craft personnel. The purpose of this group was to provide expeditious resolutions of minor construction difficulties in the installation of large and small bore pipe supports in order to minimize construction delays. The responsibilities and authorities of this group were originally provided in Onsite Project Engineering Guide 4.0 on January 7, 1983. This guide was superseded by Project Engineer's Instruction (PEI) 12 on March 11, 1983, which defined the PSDTC program. The practices defined by these two documents were based upon an identical philosophy and intent, and all guidance previously provided to construction under OPEG Guide 4.0 was again reviewed by engineering for compliance with the requirements of PEI 12 upon its issuance.

94. As provided in the procedure, field construction problems were defined as pipe support installation problems which could not be resolved using the relatively restrictive construction tolerances explicitly stated in Pullman Power Products document ESD-223, "Installation and Inspection of Pipe Supports". Construction tolerances contained in ESD-223 were those that could be applied to any pipe support in the plant without additional engineering justification. Changes beyond those tolerances may be permitted based upon the criteria contained in Diablo Canyon Design Criteria Memorandum (DCM) M-9, "Guidelines on Design of Class I Pipe Supports and Restraints." Field construction problems were referred to PSDTC team engineers who, based on their engineering judgment and knowledge of DCM M-9, would, on a case-by-case basis, determine whether use of expanded tolerance limits could be authorized to resolve the construction problem while maintaining an acceptable support design.

95. Where field resolutions could be made, in the judgment of the PSDTC team engineer, they were documented on individual PSDTC forms provided in Attachment A to PEI 12. Field construction problems which, in the judgment of the PSDTC engineer, could not be resolved without a design change, were returned to General Construction for formal referral to Engineering as a DP report requesting hanger redesign in accordance with other project procedures. Pre-existing pipe support configurations found to be in noncompliance with appropriate design and construction documents were referred for disposition as a Pullman Discrepancy Report or Discrepant Condition Notice in accordance with Pullman procedures.

96. The PSDTC engineers were selected from experienced engineers at the jobsite. It was felt that they, Mr. Stokes included, would be in the best position to know whether qualification of the supports could be demonstrated. In no case, however, was the modification made by the PSDTC engineer allowed to be the final design qualification. Notwithstanding Mr. Stokes' apparent lack of knowledge, all the PSDTC group's modifications received final engineering review and approval as part of the as-built acceptance, as required by procedures P-10, I-37 and I-40 discussed below.

97. When a PSDTC form was completed, a copy was attached to the pipe support design package and was treated exactly like the original design package in order to assure that standard quality control procedures were applied to all work accomplished by General Construction. Upon completion of construction of the support, the complete as-built package, including any PSDTC forms associated with that support, was forwarded by

Construction to Engineering for final acceptance in accordance with project engineering procedures. These procedures are P-10, "OPEG Small Bore Piping and Hanger Review Procedure;" I-37, "Instructions for Incorporation of Field Correction Transmittals;" and I-40, "Instructions for the Disposition of As-Builts Associated with Design Change Notices." During the period of Mr. Stokes' employment, final large bore support as-built acceptance was completed by the project engineering team in San Francisco, while final small bore pipe support as-built acceptance was completed by OPEG.

98. The as-built acceptance process involved review of the revised support design and performance of necessary calculations for qualification of the design. Where qualification could not be shown, a new design was prepared and issued for Construction.

99. The PSDTC program was neither a substitute for nor a deviation from the formal design and construction quality assurance processes for pipe supports. As stated in paragraph 2.2 of PEI 12, the procedure was specifically not authorized for use in lieu of a Discrepancy Report or a Design Change Notice. The program was reviewed and approved for use by both Units 1 and 2 project engineering as well as the project quality assurance organization, all of whom signed PEI 12 when it was issued for implementation. In August 1983 an audit was conducted by the PGandE QA Department which resulted in the overall conclusion that the control of design changes by OPEG appeared to be effectively implemented. One finding was identified with respect to use of the PSDTC forms. In response to this finding, special training sessions were held in October

1983 for all PSDTC engineers to emphasize the limitations on the use of PSDTC forms and to assure that Design Change Notices would be initiated when required by DCP procedures.

100. Uncontrolled documents were not used to promulgate PSDTC program procedures. These procedures were defined in PEI 12 as supplemented in ESD-223, copies of which were provided to the PSDTC team. The details of the program implementation were emphasized with PSDTC engineers in periodic discussions and training sessions. The June 16, 1983 memo, referred to by Mr. Stokes as an illustration of inappropriate communication of program procedures, was, in fact, written by General Contruction to the piping contractor to reiterate construction procedural requirements already well established. Summarized, the memo states that the PSDTC program is not a corrective action program and may not be used in lieu of construction discrepancy reports (DRs and DCNs). This memo was not applicable to the PSDTC engineers and as such did not receive distribution to them.

101. As stated previously, a discrepancy report rather than a PSDTC form was used to document a pre-existing pipe support configuration which was found to be in noncompliance with appropriate design documents. The PSDTC form is not a discrepancy report and does not take the place of one. It may, however, be used to provide disposition for a discrepancy report written by construction. The PSDTC engineer is not, however, required to monitor writing of discrepancy reports by construction. This would explain why Mr. Stokes did not always see them. Construction discrepancy reports are produced as required by construction procedures.

XX. It is alleged that:

> Final calculations do not include assumption sheets which would allow specific errors to be tracked. (Stokes, 2/8/84, pp. 4 and 5)

102. In the small bore piping qualification program, important input information for the pipe stress analysis, e.g., nozzle load acceptance, was 'ect to revision since additional changes in seismic response spectra and other related analyses were in progress. However, preliminary data were available to allow initial "assumptions" in the analysis to be made. Such calculations were noted as preliminary on the calculation log and in the calculation itself.

103. We believe that Mr. Stokes is referring to these "assumption" sheets that were used to track this preliminary information. As data were finalized, the sheets were revised to reflect the updating of preliminary information to a final resolution. When all data were final, the sheet was no longer required. The calculation was approved as final, and these assumption sheets were discarded. When the calculation reached final status, the calculation master log was updated to show that all preliminary assumptions had been resolved by noting the calculation as final in the log.

104. An after-the-fact "paper" trail of all the various changes to preliminary input data is not required. Final documentation includes only the final input data as required by ANSI N45.2.11 (1974). The final input data is retained in the form of input sheets and assumption sheets for all calculational packages.

XXI. It is alleged that:

> Expansion anchor bolts have not been evaluated with respect to I&E Bulletins 79-02 and 79-14. Information in PGandE's January 27, 1984 letter is incomplete and of suspect accuracy. Expansion anchors would fail during Hosgri and DDE. (Stokes, 2/8/84, p. 5).

105. Initially, design of all expansion anchors installed at Diablo Canyon was in conformance with PGandE's engineering standard drawing 054162. Subsequently, pipe support base plates and expansion anchors were requalified to comply with the NRC's design recommendations in I&E Bulletin 79-02*. Expansion anchors used in other applications (e.g., raceway supports and HVAC duct supports) remain in conformance with Drawing 054162 requirements.

106. The NRC specifically limited the applicability of the somewhat more stringent recommendations in I&E Bulletin 79-02 to large bore and computer analyzed small bore pipe supports. As stated in the bulletin, operational problems had been experienced in expansion anchors installed in pipe supports. These problems were attributed to factors that primarily apply to pipe support designs (e.g., cyclic loads and flexible baseplates).

107. PGandE's January 27, 1984 letter addressed expansion anchors used in applications other than pipe supports. The January 27 letter provided an overview of the basis of the Drawing 054162 design criteria and included tabulations of the factors of safety achieved by using the Drawing 054162 criteria. In addition, this letter addressed testing and

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* Mr. Stokes' references to I&E Bulletin 79-14 are erroneous, as the I&E Bulletin does not address expansion anchors, but addresses as-built piping.

evaluations performed to confirm the adequacy of expansion anchors whose installation was not in complete conformance to Drawing 054162 requirements.

108. As reported in the January 27, 1984 letter, design factors of safety are almost always well above 3 for Hosgri and DDE load cases. A factor of safety of 3 is considered to be fully acceptable by the industry. The January 27, 1984 letter reported that certain hypothetical limiting conditions might result in a few anchors having a factor of safety less than 3. However, an expansion anchor random sampling program, which was performed subsequent to submittal of the January 27, 1984 letter, found that out of more than 100 electrical supports, having more than 400 anchors, there was no case in which an anchor had been installed such that its factor of safety was below 3. These results were reported to the NRC Staff by a letter dated February 16, 1984. Further, contrary to the statement made by Mr. Stokes, this encompasses all load cases including Hosgri and DDE. Expansion anchor design, including actual safety margins and redundancy, is reasonable, conservative, and meets all licensing criteria.

XXII. It is alleged that:

> Due to deficient design drawings for welding, inconsistent and incorrect assumptions were made about certain welds. (Stokes, 2/8/84, p. 6)

109. Contrary to the allegation, there were no deficiencies in the design drawings. The Diablo Canyon design groups use a corner radius (R) equal to 2T (where T is the thickness of the tube steel) for tube steel with a

perimeter of less than 14 inches. A corner radius of 2-1/2T was used for perimeters greater than 14 inches. In no case was a corner radius of 3T used. These conditions are reiterated by a March 4, 1983 memo from Dan Curtis to Diablo Canyon Unit 1 pipe support group and a March 21, 1983 memo from Leo Mangoba to OPEG pipe support engineers.

110. Mr. Stokes alleges that Japanese tube steel with a radii of 1.5T was used at Diablo Canyon. That allegation is false. Pullman Power Products purchase orders indicate that material shall be domestically manufactured as required by the contract. We have researched all structural steel mill certificates to determine origin and have confirmed that no Japanese tube steel has been received. We have determined that two purchases of a small amount (3000 ft) of Canadian tube steel has been used; however, the manufacturing was per U.S.A. requirements.

111. Fifty pipe supports with tube steel members with perimeters greater than 14 inches were chosen at random and the corner radii were measured. In a few cases radii insignificantly less than 2-1/2T were measured. The testing described below has shown that for the radii slightly less than 2-1/2T, an effective throat of 5/16R is obtained and the design requirement met. The tests also show that the 5/16R requirement is met when the radii are 2T.

112. AWS D1.1 Structural Welding Code Section 2.3.1.4, allows the use of an effective throat of 5/16R (where R = outside corner radius of tube steel) for single flare groove welds without performing a weld procedure qualification test. The 5/16 R dimension is accepted as being a

conservative effective throat that can be increased if additional verifications are made in accordance with Section 2.3.1.4 (2) of AWS D1.1.

113. Test programs have been conducted which substantiate the effective throat assumption of 5/16R as conservative. One test program was performed at Diablo Canyon by Pullman and a second test program was conducted by Pullman and United Engineers at Seabrook Station.

114. The tests at the Seabrook Station were conducted using standard Pullman Welding Procedures for carbon steel materials. The technical report describing the tests is attached as Exhibit 2. The purpose of this test program was "To verify, as a minimum, that the effective throat thickness for a flare-bevel-groove weld when filled to the solid section of the bar will equal 5/16R, where R is equal to the radius of the bar." Four sizes of structural tube steel were welded using 3/32" and 1/8" diameter E7018 electrodes in the flat, vertical, and overhead welding positions.

115. The results from the Seabrook Station tests showed that the actual effective throat equalled or exceeded 5/16R (where R is 2T for tubing with a perimeter less than 14 inches and 2-1/2T for perimeters greater than 14 inches) by as much as a factor of 1.0 to 1.92, with an average factor of 1.4. The minimum effective throat occurred when 3X3X1/4 tube steel was welded using a 3/32" electrode in the flat position. In that case, the effective throat equaled 5/16R.

116. Tests at Diablo Canyon were conducted using Pullman's Diablo Canyon Project welding procedures. A brief summary is attached as Exhibit 3.

The tests were performed to verify that the actual effective throat met or exceeded the 5/16R for the worst case identified by the test program performed at Seabrook Station. Six tests were conducted to determine the typical effective throats which would be achieved for flare bevel joints when welding 3X3X1/4 tube steel using 3/32" and 1/8" E7018 electrodes in the flat position.

117. All tests done at Diablo Canyon indicated that the amount of effective throat exceeds 5/16R by a factor of 1.4 to 1.7.

118. In conclusion, field investigations and tests at Seabrook and Diablo Canyon demonstrate that the design requirements concerning effective throat are consistent with as-built conditions.

XXIII. It is alleged that:

> Weld procedures and techniques failed to compensate for weaknesses in design drawings. (Stokes, 2/8/84, pp. 6 and 7)

119. As discussed above, the design drawings had no deficiencies or "weaknesses" that required welder or welding procedure compensations.

120. All weld procedures are written and qualified to ASME Section IX and/or AWS D.1.1. The weld procedures were not intended, and do not allow, welders to compensate for "deficiencies in design drawings."

121. Weld procedures assure that a completed weld will develop the required strength for the type and size of the welds specified in the design drawings. For example, the qualification tests for a full penetration weld would ensure that the specified strength of the material is developed or exceeded.

122. The engineer specifies a weld type and size as determined by comprehensive weld size calculations. The welding is controlled by procedures and is performed in a manner that ensures the strength of the weld as specified by the designer is obtained.

123. Weld procedures are most definitely not written to allow the welder the flexibility to select weld electrode sizes to compensate for what a welder might perceive as a shortcoming in design. Contrary to the Stokes implication that only 3/32-inch diameter or smaller welding electrodes were acceptable to compensate for design deficiencies, and that 1/8" diameter electrodes were incorrectly used, the tests referenced above have shown that the 1/8-inch diameter electrodes are acceptable.

XXIV. It is alleged that:

> Weld procedures, specifically Pullman ESD-223, did not require joints to be welded flush for flare or bevel welds. (Stokes, 2/8/84, pp. 6 and 7)

124. Pullman Power Products Specification ESD-223 establishes the procedures for the installation, inspection and documentation of the final assembled configuration, i.e., as-building of pipe supports. The current version of ESD-223 does not permit flare groove welds to be installed without the weld profile at least flush with the flat portion of structural tubing. Past revisions to ESD-223 have had provisions for measuring flare groove welds which were not welded flush. However, these provisions of ESD-223 were not used at Diablo Canyon because the Unit 1 design drawings did not permit less than a flush weld.

125. The Diablo Canyon Unit 1 pipe support design groups did not specify dimensions along with the flare groove weld symbol. The flare groove weld symbol alone requires that the flare groove weld be filled at least flush.

126. Because the flare groove weld symbols on the design drawings did not specify or permit flare groove welds as being other than flush, Construction was required to provide welds which were flush. This was verified by QC inspection. If Construction had provided flare groove welds that were not flush, Engineering would have detected and not accepted the weld during the as-built review program.

127. To verify that this was done consistently, a random sample of flare bevel welds was inspected to determine if they were welded flush. A total of 233 welds were examined. All were found to be welded flush, except for minor variations in five instances. Four welds were 1/16" under flush and the fifth one was 1/32" under flush over a part of its length. The effective throat on each of these five cases was, however, within the design requirements.

128. In summary, all flare groove welds were intended and specified to be flush. The design engineers had control over final accceptance of the welds through the as-built approval process. Verification, through a sample reinspection, has assured that the welds are, in fact, adequate.

XXV. It is alleged that:

The allowable angle of skewed fillet welds is unacceptable. (Stokes, 2/3/84, p. 8)

129. Contrary to the allegation, the angles, bevels, and weld configurations specified by Pullman in their procedures were qualified in accordance with ASME Section IX and/or AWS D.1.1 and were compatible with design assumptions.

130. ESD-223 did not provide dihedral angle limitations for skewed fillet welds. Limitations for dihedral angles, where applicable, were provided in the design drawings. ESD-223 does not and need not limit the application of skewed fillet welds since such limitations are a design concern, not an installation concern. For buildings, there are no specific limits on the dihedral angle to which a fillet weld can be applied. The AWS D1.1 Code limits the prequalified status and the method of qualification of skewed fillets. Skewed fillets for angles less than 60 degrees are considered by AWS D1.1 as partial penetration welds for purposes of qualification. Mr. Stokes has confused the ESD-223 provisions for partial penetration welds with skewed fillet welds. ESD-223 has a requirement for measuring skewed fillet welds by using a special gauge.

131. The fact that the partial penetration weld table includes a 15^{o} angle for this type of weld is only of academic note, since an angle that shallow was never specified by Engineering on the design drawings.

XXVI. It is alleged that:

37-1/2^{o} groove welds were improperly used. (Stokes, 2/8/84, p. 7-8)

132. Mr. Stokes is correct in stating that the 37-1/2^{o} weld preparation angle for groove or partial penetration welds does not satisfy the

requirements for prequalified joints in AISC/AWS. However, these Codes do not require exclusive use of these prequalified weld joint configurations. The codes simply state that these prequalified joint configurations may be used without further testing. The codes also provide that other joint configurations are allowed, but they first must be tested to demonstrate acceptability. The groove welds made prior to June 23, 1983 were qualified by testing based upon a 37-1/2^{0} weld preparation angle as set forth in paragraph 146 below.

XXVII. It is alleged that:

> ESD-223 and welding procedures were not available to welders. (Stokes, 2/8/84, p. 8)

133. ESD-223 addressed installation and inspection requirements for pipe supports. The document is not a welding procedure specification (WPS) and there would be little reason for a welder to have a copy of ESD-223. Welders need not have copies of a WPS in their possession. They need only be familiar with and have access to WPSs. WPSs for pipe supports are so fundamental and basic that the qualified welders would not need copies in their possession during welding activities. As set forth in the affidavit of Richard Etzler, filed contemporaneously herewith (paragraphs 6 and 7) welder qualification, testing, and certification ensure welder knowledge of proper weld procedure.

XXVIII. It is alleged that:

> The ESD-223 fillet weld table is inaccurate and does not use the same effective leg as San Francisco design engineers assumed. (Stokes, 2/8/84, p. 8)

134. Attachment I to ESD-223 has a table which converts the design weld symbol dimensions to convenient working dimensions for construction and inspection personnel to use, because the direct measurement of the design dimension required on the weld symbol is not possible for skewed weld joints. The use of a table converting design dimension to a working measurable dimension is a fairly common practice and improves quality control functions by making measurements easier and more direct. Mr. Stokes has confused this table for partial penetration welds as being a fillet weld table.

XXIX. It is alleged that:

> Inspection personnel were not qualified to the AWS Code and were not issued weld symbols. (Stokes, 2/8/84, p. 8)

135. The AWS Structural Welding Code did not, when Diablo Canyon started, and does not today, require AWS qualified inspectors. Inspectors need not be issued the AWS weld symbols. Knowledge of these symbols, like much other material, is part of an educational, experience or training background. These symbols are commonly available in references and need not be issued to inspectors.

XXX. It is alleged that:

> The Quick Fix pipe support engineers removed illegible weld symbols to improperly receive approval by QC inspectors. (Stokes, 2/8/84, p. 8)

136. The purpose of the PSDTC group was to assist in clarifying, on a case-by-case basis, pipe support design tolerances which were not explicitly included in Pullman Power Products Specification ESD-223,

"Installation and Inspection of Pipe Supports." This activity was controlled by PEI Number 12. An integral part of this activity was the interpretation and clarification of weld symbols.

137. As construction workers encountered weld symbols about which they had some questions or as they encountered welds which could not be performed due to inaccessibility, the drawing was referred to a PSDTCG engineer for interpretation or adjustment. During that process it is very possible that PSDTC engineers may have substituted welds which provide effective throats sufficient to meet design criteria for welds which are inaccessible or impractical. In these cases, the PSDTC engineer would eliminate the old weld symbol and provide a new weld symbol. An example would be when two sides of a flange are required to be welded with fillet welds, but where only one side is inaccessible. A PSDTC engineer may substitute a groove weld with the same or greater effective throat and the same sectional properties as the fillet welds originally specified. The PSDTC engineer making this kind of change would not require access to the support calculations because there is no decrease in the support capacity. Such changes are common and are documented in the appropriate PSDTC forms. A complete calculation package, including the as-built hanger drawing is reviewed for final acceptance as set forth in paragraph 139 below.

138. No welds which are necessary for the structural integrity of a support have been eliminated by PSDTC engineers without one of the following alternatives being taken:

(a) Substitution of a weld which provides at least an equivalent effective throat;

(b) Modification to the weld pattern to compensate for the removed weld;

(c) Reference being made to the design calculations to ensure that the structural integrity of the support was maintained;

(d) Providing other mechanical connections to achieve equivalent strength.

139. The engineering decisions of the PSDTC engineer are verified during the as-built review process. At that time the as-built drawing would reflect the final weld configuration, as specified by PSDTC, and this configuration would be evaluated by another design engineer to assure the qualification calculations were compatable with the revised weld configuration.

XXXI. It is alleged that:

> QC was not provided with proper instructions and calibrated tools to measure radii of flare and flare bevel welds on an as-built basis. (Stokes, 2/8/84, pp. 8 and 9)

140. There are no specific Diablo Canyon or general code requirements existing for field measurement of the radius of outside corners for structural tubing. Dimensional and mechanical requirements are controlled through purchase specifications. Pullman Power Products purchase orders required that material be domestically manufactured to ASTM A-500 specification required tolerances.

141. Flare welds (flare bevel and flare groove) are performed on tube steel components. Design documents indicate where such flare welds are to be installed. Pullman Power Products approved standard ESD-223 requires

such welds to be flush with the face of the tube steel. Pullman Power Products Quality Control Inspectors verify acceptability by applying this criteria. Weld gauges are issued to Pullman Power Products Quality control Inspectors to facilitate their inspections.

142. As discussed in paragraph 127 above, a recent random sample of flare bevel welds was reinspected to assure flush welds.

XXXII. It is alleged that:

> Pullman changed its procedure to standardize weld bevel for partial penetration welds to 45° in June 1983. However, welds prior to that date did not meet this requirement. (Stokes, 2/8/84, p. 9)

143. There was a procedure change in June 1983, by Pullman that standardized the weld bevel used for partial penetration welds on pipe support components to 45°. This action, however, was not the result of any action on the part of Mr. Stokes. A large influx of QC inspectors around that time made it necessary to develop a more standardized approach to the pre-weld fit-up measurement. Hence, the 45° angle was chosen as a standard with which most inspectors were familiar, not to provide a more acceptable method of welding. As described below, the 37-1/2° bevel angle has been qualified by tests and it was and still remains an acceptable bevel angle.

144. In a recent inspection, the NRC Staff questioned what bevel angle was used on <u>carbon steel</u> support members. The review showed that current and recent practice has been to use 45° bevels. This was based upon a June 28, 1983, memo to QC inspection, observations in the field, and interviews by the NRC Staff with several QC inspectors. The reference

by Mr. Stokes to a June 23, 1983, memo by Russ Noble does not appear to be related to the allegation as described, but refers to stainless steel weld procedures 15/16 and 129 to be used for welding butt joints in the pressure boundary of piping. The memo did not apply to partial penetration welds for pipe supports.

145. Notwithstanding the above, PGandE has reviewed welds prior to June 1983. Conversations with QC inspectors and production personnel who have been onsite from the early stages of the Project indicate that the practice was to provide a 45^{o} bevel angle. However, the weld procedure, 7/8, which is applicable to pipe support installation, allows bevel angles of both 45^{o} and 37-1/2^{o} and therefore, one might assume there are welds with bevel angles of 37-1/2^{o}.

146. To qualify the 37-1/2^{o} bevels, Pullman performed tests to determine the amount of effective throat that would be obtained using their welding procedures in a tee joint, welding 3/4" plate with a 5/8" deep partial penetration weld bevel at 37-1/2^{o} using the shielded metal arc process. This joint configuration is a limiting configuration because it does not provide the accessibility of a butt joint. In this case, the design engineer would have assumed a 1/8" reduction in the 5/8" weld size which would give an effective throat of 1/2". The actual measured throat on the test weld exceeded that required by the designer (1/2").

147. In addition to the tests performed by Pullman, existing partial penetration welds were examined from previously installed material which had been removed from the plant. One had a bevel angle of 37-1/2^{o} (plus or minus construction tolerances) on a 3/4" base plate to support

77/19SL. Its effective throat was measured in two places (5/8" and 43/64"). Both these measurements met or exceeded the value required by design (5/8" which is 1/8" less than the depth of bevel preparation).

148. In summary, the designer specified partial penetration welds that were compatible with single bevel weld preparation angles used by construction. The designer derated these partial penetration welds by 1/8" to account for the lack of fusion at the root. Further, sectioning and measurement of actual test coupons of typical joints demonstrate that the procedures used by Pullman on partial penetration welds with bevel angles of 37-1/2° produced effective throat dimensions that were compatible with the designers' requirements.

XXXIII. It is alleged that:

> As a result of Mr. Stoke's inquiry, incorrect building movements were changed to reflect proper building movement. (Stokes, 1/25/84, Tr. 11-13).

149. The seismic displacement of the buildings is provided in DCM C-28 which was originally issued on October 7, 1982. In this design criteria memorandum, deflection of the base of all the structures for the Hosgri evaluation is considered as zero since, as it always has been, the seismic evaluation was based on a fixed base model. The fixed base model is, of course, an idealization of the actual case, but for all practical purposes it is a reasonable idealization for the relative deflection between adjacent buildings at Diablo Canyon. Contrary to Mr. Stokes' allegation these deflections have never been changed as a result of Mr. Stokes' comments, or for any other reason, since they are correct and meet all criteria.

150. For the DE/DDE evaluation, a model was used for some structures which had soil or rock springs at the base. For this type of model, an actual deflection was determined and, for the case of the Auxiliary Building and Containment, these deflections, to the nearest 1/100 of an inch, were 0.00 and 0.05 inches, respectively. These deflections were reported in Rev. 0 of DCM C-28 and in every subsequent revision. The models used for the other two structures for which DE/DDE analyses were performed, Turbine Building and Intake Structure, need fixed base models. These deflections were, therefore, zero. Regardless of the calculated value of deflection, from a practical point of view, no safety problem exists since the movement is extremely small for any earthquake motion.

XXXIV. It is alleged that:

> In 1983 a management representative from San Francisco, Mr. Dan Curtis, refused to answer numerous questions and challenges from site engineers who believed that Document 049243 was not a conservative basis for the seismic redesign program. (Stokes, 1/25/84, Tr. 13-14)

151. Drawing 049243 contains eleven standard support details with associated allowable load ratings. The authorized standard supports and acceptable parametric limits are prequalified by a worst case analysis, the calculations for which are located in San Francisco. So long as the qualified load ratings are not exceeded, use of a prequalified support results in an acceptable design. The very nature of the worst case analysis and the establishment of acceptable limits results in a conservative but efficient method of qualifying small bore pipe

supports. While PG&E did send an engineer to the site to discuss drawing 049243, his purpose was only to explain recent changes in the procedure and not to discuss or "defend" small bore criteria as inferred by Mr. Stokes. (See Affidavit of Daniel J. Curtis.) The presence of such person should not be taken to mean that the project at any time considered the use of 049243 to be inappropriate or unconservative.

XXXV. It is alleged that:

> Management did not freely distribute professional codes that supposedly paralleled computer analyses relied on by engineers in the seismic design review. In some cases the only reference materials to guide the engineers were the computer analyses. That is improper, as management effectively conceded in the fall of 1983 through instructions that the computer analyses were merely a guide and not meant to replace the professional codes. Unfortunately, the program had officially been completed when management disclosed the non-binding nature of the computer analysis. (Stokes, 1/25/84, Tr. 16-17, 120-31)

152. This allegation is unclear and not true due to Mr. Stokes' confusion between industry codes and computer codes (the referenced transcript pages do not discuss computer analysis). A proper reading of Mr. Stokes' transcribed comments, together with his other allegations, leads one to relate this issue to his disagreement with Diablo Canyon Project criteria (DCM M-9) for angle sectioned members and U-bolt load ratings. Mr. Stokes alleges that only the AISC code specified bracing criteria for long "angles" and ITT Grinell's U-bolt load ratings should have been allowed instead of the criteria in DCM M-9. This is but one example of Mr. Stokes' limited understanding of why project specific requirements are used. Mr. Stokes' lack of knowledge as to the basis for these

project requirements has led him to allege that industry codes and standards were not used. In actuality, industry codes do allow the use of testing or other more sophisticated methods to develop project specific standards which are then used in lieu of code specified values.

153. The transcript (Tr. 121-2) indicates Mr. Stokes' confusion and disagreement with code provisions that allow for more sophisticated methods or, in these cases, test data as discussed earlier in paragraphs 16-31 and 76-81. In fact, in the technical discussion with Dr. Hartzman, Mr. Stokes summarized the basic cause of his disagreement:

> "I would like to make a statement: that I have never professed to be a PhD in one specific area of all the allegations I have brought up. I only profess to be a practicing engineer with reasonable knowledge of industry practices, as any other engineer, and more in some cases. Anything that is new research, unaccepted as an industry whole, has no point being in a new plant, in my opinion." (Stokes, Tr. 129-30)

154. Therefore, Mr. Stokes rejected, as not meeting code requirements, project criteria that were based on testing or more sophisticated methods. Such judgments regarding licensing criteria are beyond Mr. Stokes' specific job and overall professional experience.

155. The technical adequacy of the project requirements (DCM M-9) for U-bolt load ratings and angle section numbers has been described previously in paragraphs 16-31 and 76 to 81.

XXXVI. It is alleged that:

> The M-9 computer analysis for angles omitted the relevant provision of the American Institute of Steel Construction ("AISC") code for allowable bending stress, contrary to

> licensing commitments. Management officials stopped engineers from using that section of the code, because compliance required angles to be cut out and replaced with tube steel, or at least reinforced through braces. (Stokes, 1/25/84, Tr. 15-21)

156. The technical aspects of this allegation are addressed in paragraphs 76 to 81 above. The basis for the management direction for use of the Project specific criteria is discussed in paragraphs 152 to 155 above.

XXXVII. It is alleged that:

> Management imposed inconsistent standards for modifications in the seismic design review: as the number of modifications approached the limits beyond which PGandE had committed to expand the sample, management refused to fix deficiencies, even if obvious and more severe than those previously corrected. Instead, engineers conducting the first round of calculations were told to make assumptions contrary to fact, such as restraints that did not exist. (Stokes, 1/25/84, Tr. 23-24)

157. This statement is inconsistent with the small bore piping sample plan and results identified in the PGandE Phase I Final Report for the Design Verification Program. The plan consisted of a commitment to review a specific size sample for certain design considerations and to evaluate the results of this review. A specific acceptance criteria established for evaluation of the review results, such as the 5 percent limit alleged by Mr. Stokes, was never set. The details of the small bore reverification program are set forth in the History of Onsite Engineering Affidavit filed contemporaneously herewith. (Attachment B).

158. All modifications found to be required during the review of the sample were identified by cause. The cause was then related to a design consideration and the Generic Small Bore Program was expanded to address

this consideration for all affected piping and supports. The following issues, initially a part of the sample program, were transferred to the generic program when it was determined that the existing design did not meet all licensing requirements:

1. Computer thermally analyzed small bore piping and associated seismic analysis,
2. Equipment seismic and thermal anchor movement,
3. Unusual concentrated mass configurations, e.g., numerous valves or equipment in a concentrated configuration,
4. Nozzle loads on equipment which were upgraded to show compliance with seismic criteria, and
5. Vents and drains.

159. All piping and supports have been reviewed and are shown to be qualified for those design considerations related to the generic program.

160. No modifications were found to be required for those design considerations addressed and qualified by the sample program; therefore, it was not necessary to set an acceptance criterion, such as the 5 percent Mr. Stokes alleged.

XXXVIII. It is alleged that:

> Bechtel issued out-of-date computer STRUDL manuals to engineers in the seismic design review. Inexplicably, the office at Diablo Canyon was not on the route slip for updated materials on the computer, and even after that deficiency was corrected the materials consistently were outdated. The manual provides backup information to engineers who wanted to check or go beyond the program. Engineers in the seismic design review did not have written procedures to guide their use of the STRUDL computer program. As Mr. Stokes explained, "All we had

was the form handbook of a STRUDEL [sic] program minus the pertinent information such as the model load points." (Stokes, 1/25/84, Tr. 27, 29, 146-47)

161. For static analysis used by pipe support designers, the Bechtel STRUDL user's manual consists of two documents:

1. MIT STRUDL II, The Structural Design Language Engineering User's Manual, Volume 1, Frame Analysis, MIT Research Report R68-91.
2. STRUDL III User's Manual.

162. Bechtel's Data Processing Library issues the revisions and user information bulletin to the controlled copy holders. Contrary to Mr. Stokes' allegation, three OPEG engineers had controlled copies of the STRUDL user's manuals.

163. The first document is essentially the basic user's manual which has not been revised since its first edition in November 1968. This document is not a Bechtel controlled document. It was originally issued by MIT, Cambridge Massachusetts. The complete STRUDL input can be prepared from this manual.

164. The second document provides specific instructions, such as how to run STRUDL on Univac; STEEL DATA code, and other enhancements to make it easier for the user.

165. Knowledge of the first document allows the user to prepare INPUT files correctly for running STRUDL. Experience in the use of the STRUDL program and a minimum of three years of nuclear pipe support experience were requirements for hiring OPEG job shoppers or casuals in pipe support design. Therefore, it was not necessary to prepare written procedures on the use of STRUDL. In addition, because the basic STRUDL

user's manual has not changed in 16 years, Stokes' concern about uncontrolled copies of the manual is largely academic.

166. Input forms were also established for OPEG to ensure: (1) uniformity of input, (2) consistent consideration of maximum load combinations and (3) increased efficiency by eliminating rewriting the mandatory STRUDL commands. More load cases and other commands for the analysis of the pipe support frame could be added as required by OPEG engineers, including Mr. Stokes.

XXXIX. It is alleged that:

> Engineers in the stress group relied on outdated seismic data that was necessary for their calculations. It took up to six months to receive updates, by which time the newly-arriving material was out-of-date. (Stokes, 1/25/84, Tr. 29)

167. Design of small bore piping relies upon seismic spectra inputs from DCMs C17, C28, and C30 developed by the Civil discipline and seismic anchor movements (SAM) of large bore piping to which the small bore piping connects. It is normally desirable to delay the analysis of small bore piping until all such inputs are finalized. However, the Project recognized that some schedule advantages could be gained by beginning with preliminary seismic input assumptions for the analysis of small bore piping, with final analysis being completed as final seismic input became available. The use of this initial preliminary input data is not of concern since subsequent finalization of the calculation would have corrected any differences in the input information. The process of ensuring that the latest seismic input was used in calculations was

controlled by Piping Procedure P-27. This procedure required documented review of all calculations affected by C-17, C-28, and C-30, to perform new analyses where required, and to respond, in writing, when all actions were complete. While it was recognized that response spectra and structural movements were undergoing a complete review, controlled copies at the seismic input criteria were assigned to OPEG in early 1983. As C-17, C-28, and C-30 were finalized, the reviews required by piping procedure P-27 were performed thus assuring that all final input information was included in the calculations.

XL. It is alleged that:

> Bechtel's computer program did not have an adequate "memory" for engineers to conduct full analyses of complex hangers. As a result, engineers had to ignore relevant factors as the worst case scenarios for force on the support frame. (Stokes, 1/25/83, Tr. 27, 29, 38-39)

168. In performing pipe support work on various nuclear power plants, Bechtel has never experienced a case where STRUDL memory limitations prevented the analysis of any pipe support frame.

169. Bechtel's STRUDL computer program allows the analysis of problems which require up to 262K memory. Analysis of a support with fifty joints and more than 45 loading cases should not require more than 80K memory. In fact, a STRUDL analysis performed on a pipe support for another project had more than 200 joints and 45 load cases and only required 120K of memory. At Diablo jobsite, calculations of 155 joints and 32 load cases and 57 joints and 49 load cases have been successfully run.

170. The 80K memory limitation at Diablo Canyon is one that is imposed by the type of output being requested. If it is desired to have results immediately printed on the same terminal that the input was prepared, then a limitation of 80K must be imposed. However, if the engineer does not require immediate response, a batch mode of operation can be selected and full 262K memory can be used.

171. The problems encountered by Mr. Stokes in performing computer analysis seem to stem from his lack of knowledge of the efficient application of the STRUDL computer program, rather than a limitation on program memory.

172. An onsite STRUDL specialist was available for consultation who provided guidance, as needed, to the pipe support personnel, including Mr. Stokes, for the efficient application of the STRUDL.

173. Mr. Stokes also expressed concern (Tr. 87-88) about not being allowed to perform all aspects of the calculation process. At Diablo Canyon, two groups were involved in STRUDL analyses. STRUDL input data were prepared by pipe support engineers who are skilled in the application of STRUDL for pipe support frame analysis. The second group consisted of computer operators who did not do any engineering work. The computer operators are skilled in the computer operation of the STRUDL program. This division of effort has resulted in an efficient operation because the engineers were relieved of non-engineering effort, such as typing in their own input files. Mr. Stokes is apparently complaining about not being allowed to perform the clerical function of typing in the STRUDL input.

XLI. It is alleged that:

> There was no consistent procedure or criterion to guide engineers who checked calculations in the seismic design review: they could check whatever they wanted through any method. (Stokes, 1/25/84, Tr. 31-32)

174. Mr. Stokes is simply mistaken in this allegation. Engineering Manual Procedure 3.3, "Design Calculations", Section 4.2, identifies the requirements for checking calculations. As shown in the following quotation from the procedure, the procedure identifies the items to be checked, acceptable methods to perform the check, and the checker's actions if the calculation is unacceptable:

> "Checking of the calculations shall include:
>
> a) Checking the basis of the design, such as the design method, design concept, proper use of design criteria, and assumptions.
>
> b) Checking the design loads, forces, flows, currents, voltages, material properties, foundation conditions, etc.
>
> c) Checking the results.
>
> d) Comparing the results with the drawings to assure conformance of dimensions, materials, etc.
>
> Manual calculations shall be checked using an alternate calculation method if possible. When alternate calculations are not feasible, the calculations may be checked by a detailed review of a copy of the originals. This copy shall be clearly marked to indicate that it is the calculation check.
>
> Computer calculations shall be checked for:
>
> a) appropriateness of the program to the design or analysis
>
> b) correctness of inputs

c) reasonableness and application of outputs

d) completeness of Computer Calculation Index Sheet information.

When the checker has determined that calculations require correction, the calculations shall be presented to the originator for correction. The checker shall check the corrected calculations."

175. In addition, the Piping Group developed an implementing procedure P-6, "Procedure for Assembling Pipe Support Calculation Packages." This procedure includes an additional checklist of specific items to be included in each calculation.

176. Experienced engineers at Diablo Canyon are utilized in both an originating and checking function for pipe support calculations, as Mr. Stokes states in the transcript, page 31, from the January 25, 1984, meeting with the NRC. Therefore, engineers who have the experience necessary to originate a calculation and provide the documentation package for that calculation are certainly capable of checking similar calculations by another engineer without additional detailed procedures. No additional training or instruction in how to check a calculation is required beyond the training in the Engineering Manual Procedures.

XLII. It is alleged that:

After the NRC obtained certain work packages at Mr. Stokes' suggestion on December 8, 1983, management directed a purge of relevant files to remove any evidence of previously destroyed or censored work by engineers who failed hangers but were later overruled. (Stokes, 1/25/84, Tr. 41, 81-82)

177. We categorically deny ever purging files or records. As stated before, no approved calculations or approved revision to a calculation have been destroyed, altered, or purged. The Diablo Canyon Project does not retain calculations that have not been approved. This practice is standard industry practice as confirmed by discussion with other individuals on Bechtel nuclear projects as well as other architect/engineering firms.

178. Mr. Stokes has grossly exaggerated the number of small bore piping calculations that he produced. In fact, from our records, Mr. Stokes was the originating engineer on 59 calculations and the reviewing engineer on 39 calculations. Of these 98 calculations, 56 of them related to Unit 1, including 13 involving pipe stress analysis, and 42 of them related to Unit 2. The discrepancy between the 300 he estimates (Tr. 83) can be explained rather easily when one considers that there was not a requirement to produce calculations at the rate of 1.5 hangers per day. In fact, the assumed rate for work scheduling was actually 16 hours per support (see paragraphs 192-193). Coincidently, Mr. Stokes' time sheets for the two month period from mid-March to mid-May 1983 indicate that he averaged 16.25 hours per support calculation. Additionally, Mr. Stokes was assigned to the PSDTC group, where he would not produce calculations, for about four months out of his eleven month employment history and about 1 month of this history on Unit 1 involved piping stress analyses and not hanger calculations. Therefore, one would have expected Mr. Stokes to have produced about the same number of calculations that appear in our records for the 6 months he worked in hanger calculations.

XLIII. It is alleged that:

> When assumptions of loads were changed for preliminary calculations on pipe supports that previously had failed, typically no one redid or checked the entire calculation. This step was necessary to determine that the new combination of variables in its entirety would support a conclusion to pass the pipe support. In Mr. Stokes' judgment, this allowed hangers to pass which should have failed. (Stokes, 1/25/84, Tr. 50-51)

179. Design data for a pipe support calculation, such as loading information and piping movements, are supplied to the pipe support engineers by the piping stress engineers. However, these design data may have been derived from assumptions or preliminary information. This process is described in detail in paragraphs 102 to 104 above.

180. Once revised preliminary design data is received, all pipe support calculations are reviewed to assure qualification to current pipe loads, displacements, and acceptance criteria. These reviews cause various degrees of calculation revision. The extremes of the revision are: (1) simply documenting compliance to revised load and displacement input in cases of inputs that are less severe than those used in the previous analysis, and (2) complete recalculation, including support modification.

181. In cases of partial calculation revision, the previous calculation is retained to complete the design qualification calculation.

XLIV. It is alleged that:

> Mr. Stokes was unaware of the nomenclature for calculation revisions. (Stokes, 1/25/84, Tr. 51).

182. The small bore piping portion of the Corrective Action Program began in the Fall of 1982. It involved review and analysis of the installed

piping and pipe supports to show qualification or to develop modifications where necessary that would result in qualification under the program.

183. The pipe support modifications issued under the verification program involved either changes to existing supports or the addition of entirely new supports. In the case where modifications to existing supports were necessary, the documentation of the pre-existing support configuration was designated as Revision 0. This included all approvals granted under the jurisdiction of pre-1982 procedures.

184. The initial version of calculations completed for such supports under the reverification program was designated Revision 1 of that support calculation, with subsequent revisions numbered sequentially thereafter. In the case of the addition of an entirely new support, the initial version of the reverification program calculation was designated Revision 0, with subsequent revisions numbered sequentially thereafter. Letter revisions of calculations were not used.

XLV. It is alleged that:

> Mr. Leo Mangoba, the Bechtel official who supervised engineers in the pipe support group, approved the seismic review calculations _en masse_ over several days without studying and properly reviewing the work. Mr. Mangoba did not even get to the calculations until a few days before the end of the program. Supposedly Mr. Mangoba's approval was one of the checks and balances on the quality of the calculations, but it was _pro forma_. (Stokes, 1/25/84, Tr. 52.)

185. It is true that at the end of the program Mr. Mangoba approved approximately 100 calculations in a several day period. However, to state that they were not properly reviewed is incorrect. Mr. Mangoba

had instructed five other senior experienced engineers to perform a detailed technical content review prior to providing the final calculation package for his approval. These reviews were done in addition to the normal checking of the calculations.

186. Mr. Mangoba then approved the calculations as required by Engineering Procedure Manual. This final approval authority was assigned to only two individuals in OPEG pipe support group in order to provide consistancy in the final documentation package.

XLVI. It is alleged that:

> Management did not have necessary documents from vendors and manufacturers to guide calculations on required supports for vendor purchases such as valves. The omission helps to explain why engineers based their analysis on "past experience" at other plants brought in from previous jobs. Management at Diablo Canyon did not send drawing details and support conditions to valve manufacturers and other vendors for approval. The vendor's review and approval is necessary to assure that the component is being used as intended. This omission was unique in Mr. Stokes' experience in the nuclear industry. It represents more necessary information that was missing from the seismic design review program. (Stokes, 1/25/84, Tr. 54-55.)

187. The design of valve supports and qualification of the valves for support location and forces was not performed based on "past experience" as alleged but, instead, was based upon specific approved criteria, procedures, vendor supplied data, and review and design standards.

188. Piping qualified by computer analysis includes the modeling of each remotely operated valve. These models include the location of the valve and operator center of gravity (C/G) and mass. The C/G location, mass, and allowable accelerations are provided by the vendor and are

documented in Design Criteria Documents and drawings. In a very few cases, presumably the omissions alleged, the valve supplier was no longer in business and therefore could not provide the location of the valve C/G. In these cases the valve C/G was assumed to be two-thirds the distance from the valve center line to the top of the operator based upon previous experience. This instruction is contained in Piping Procedure P-11. The calculated valve acceleration provided by the computer analysis is compared to the vendor allowable to show qualification. If support of the valve is required to meet criteria, the analysis is reperformed with the added restraint included. The analysis results provide forces on the support and valve. These forces are then converted to equivalent valve accelerations and compared to supplier allowables to demonstrate qualification.

189. Piping designed by manual methodology, as directed by Design Criteria Memorandum M-40, required supports to be installed on all remotely operated active valves. The supports were installed in pairs: one on the pipe at the valve and one on the operator. This methodology ensured that there was no differential movement between the pipe, valve, and valve operator and assured valve qualification for both stress and operability considerations.

190. Guidance for design of valve supports was provided by design standards. However, all valves restrained by valve supports were reviewed by either the supplier or an independent project engineering group to ensure that valve integrity, operability, and accessability for maintenance were provided. The review was directed by written procedure and the results are documented.

XLVII. It is alleged that:

> Management's production schedule for the seismic design review made it impossible for engineers to think clearly, let alone produce consistently high-quality calculations. For extended periods, they were instructed to complete 1.5 hangers per day on a schedule of seven days and 84-120 hours per week. (Stokes, 1/25/84, Tr. 62-63, 89-91).

191. As Mr. Stokes himself states in the transcript (Tr. 89), 1-1/2 hanger design completions per day was not a minimum standard for continued employment. The unit rate for support design calculations used in scheduling work was assumed to be 16 hours per support as an average for all supports. Some simple supports would require less time while more complex supports would take longer.

192. During one period from December 1982 through January 1983 there were two three-week periods when abnormally high overtime was worked to support unusual schedule demands. These periods were broken up by the two week Christmas holiday period when a substantially reduced level of overtime was worked by those engineers not on vacation. During these two periods, there were only eight instances when an individual engineer's weekly time charges exceeded 100 hours, with the maximum being 114 hours. With the exception of these two abnormal periods, time charges for OPEG pipe support engineers averaged approximately 65 hours per week.

XLVIII. It has been alleged that:

> In some instances engineers approved hangers solely on the basis of conclusions in file 049243 for similar pipe supports, without any independent evaluation. This was known as the "cookbook" approach. (Stokes, 1/25/84, Tr. 75-76, 91.)

193. We agree that certain small bore pipe supports were designed based solely on the drawing 049243.

194. It is common practice in the nuclear industry to provide conservative prequalified load rated design standards to be used in the design of small bore piping. Extensive calculations or testing results provide the necessary documentation to show qualifications of these standards to all applicable licensing criteria. The drawing 049243 describes many of these pre-qualified standard pipe supports used on Diablo Canyon.

195. It is not necessary or required for each engineer who uses drawing 049243 to review all the backup documentation to ensure that the calculations or tests do indeed meet the licensing criteria. However, these documents are available for inspection by the NRC.

196. When a prequalified standard design was used to qualify an existing support or to design a new support, all aspects of the appropriate support parameters were compared to the requirements of Drawing 049243. If any parameters did not meet these requirements, the supports would be designed by individual analysis and fully documented.

XLIX. It is alleged that:

> Early in the seismic design review, management instructed engineers to check a blank on the form that the calculation results would not affect the Final Safety Analysis Report ("FSAR"), despite the engineers' protests that they did not know what was in the FSAR. Eventually, blank forms were just xeroxed with the "X" filled in and distributed to the engineers for their calculations. The only way the engineer could ensure accuracy was by whitingout what was already there. (Stokes, 1/25/84, Tr. 96-97).

197. The calculation cover sheet referenced in the allegation is the standard cover sheet required by Engineering Manual Procedure No. 3.3, Design

Calculations. The sheet contains the requirement to check if the calculation affects the FSAR.

198. The Diablo Canyon piping procedures, themselves, ensure that the design and analysis methodology and criteria comply with all licensing requirements including those contained in the FSAR. Therefore, implementation of these procedures by pipe support designers assures that the requirements of the FSAR are met. This process provided the basis for supervisors' instruction to subordinates to check the "SAR change required 'No' box". Pipe support design engineers activities are directed by these written criteria and procedures, so that engineers, including Mr. Stokes, need not be familiar with the FSAR.

L. It is alleged that:

> Engineering calculations that called for field modifications were altered after complaints from construction, without the knowledge or approval of the originator. Tampering with calculations in this manner was highly improper. The significance is that in an unknown number of cases, corrective action required on the basis of documented engineering analysis was informally circumvented. The basis for revising the modifications is unknown. (Stokes, 1/25/84, Tr. 98A)

199. A careful reading of Mr. Stokes' transcribed remarks indicates that his complaint involved the modification of a support sketch to resolve construction interferences. This, of course, is the process involved in or the PSDTC program for which Mr. Stokes, himself, volunteered.

200. There is nothing improper with minor modification of a support sketch by a qualified support engineer to resolve a construction problem. Such modifications would be subsequently reviewed by other qualified engineers as part of the as-built approval process.

201. It was impractical to have each support design engineer always provide the solution to construction problems and to review the as-built drawings to approve the changes to the specific supports that they had originated. Engineers in the PSDTC program, including Mr. Stokes, developed solutions to construction problems and modified the design support sketch to reflect this solution. These changed as-built drawings were subsequently reviewed and approved by support design engineers.

LI. It is alleged that:

> Multiple engineers independently produced preliminary calculations on the same hangers. Besides being wasteful, this practice gave management the option to throw out the calculations that failed hangers and keep those that passed. (Stokes, 1/25/84, Tr. 99-100.)

202. The same hanger support was not intentionally assigned to multiple engineers to perform qualification calculations and, therefore, provide an option for management to accept only calculations showing qualification.

203. Small bore pipe supports were assigned to design engineers by support identification numbers. This process normally assured that each engineer was assigned a different support from that assigned to other engineers.

204. Occasionally several supports, each having different identification numbers, are "ganged" together with interconnected structural members.

205. Such a "ganged" support cannot be analyzed correctly by different engineers separately analyzing each support since loads from one support may be transferred to another support.

206. When the approving supervisor discovered that a "ganged" support was assigned to several engineers due to the multiple identification numbers for individual supports, individual support calculations were superseded and the "ganged" support, with all connected individual supports, reassigned to one engineer for calculation. Therefore, while aspects of the allegation are correct, the mischevious intent alleged is false.

LII. It is alleged that:

> Management officials overruled engineers who attempted to calculate the effects and stresses of torsional loads, created when pipe supports were twisted to tighten them during installation. This is an obsolete technique in the nuclear industry, and according to a former engineer in the seismic design review, it is hardly ever used unless totally qualified by structural calculations. Engineers were told not to calculate for torsion and were overruled when they did. The stated reason was that "the hanger would fail." (Stokes, 1/25/84, Tr. 103-04, 123.)

207. Contrary to the allegation, a check for torsion in angles is required, where applicable. Piping Procedure P-6, "Procedure for Assembling Pipe Support Calculation Packages" provides standard forms to be used in the preparation of calculation packages. Attachment F to P-6 provides a checklist for STRUDL frame analysis. One of the items requiring entry is a check for torsion. This check evaluates the shear stresses that result from torsion in the angle sections.

208. Mr. Stokes further alleges that induced warping or bending effects as a result of torsion in angle sections have not been considered. Warping is not a phenomenon that occurs in angles. The only stresses induced in members where all plane sections remain plane are shear stresses. Sections which remain plane after twisting include open sections comprising two thin rectangles, such as angle or tee sections. In these

sections the only stresses resulting from torsion are shear stresses and, therefore, warping or bending effects are not considered since they do not exist.

209. Two textbooks which explain in more detail the phenomenon of torsion in angles and the resulting stresses are the "Steel Designers Manual",[1] pages 105 to 116 and the Bethlehem Steel Handbook entitled "Torsion Analysis of Rolled Steel Sections"[2] page 72.

210. It is true that some computer programs, such as GTSTRUDL, do consider the effects of warping due to torsion. However, these programs do not, for the reasons mentioned earlier, address additional normal stresses created by warping effects of torsion on angles.

211. On the Diablo Canyon Project, the shear stresses resulting from torsion in angles are added to other shear stresses and compared to AISC allowables for shear. In the case of angles, no increase on bending stresses due to torsion was included, nor is it necessary for the reasons described above.

References:

1) Steel Designers Manual
4th Edition
Granada Publishing Limited
1221 Avenue of the Americas
N.Y., N.Y. 10020

2) Torsion Analysis of Rolled Steel Sections
Bethlehem Steel Corporation

LIII. It is alleged that:

> Engineers onsite had to wait up to a week to obtain information on the telephone from San Francisco that would normally be on the drawings and was necessary to draw engineering conclusions. Combined with scheduling requirements, this system created pressure on engineers without the benefit of data on which they would normally rely. There was no system or procedure to verify the accuracy of design information received on the telephone from the San Francisco offices. In the absence of any such procedures, the data was unverifiable despite engineers' doubts about its accuracy in some cases. (Stokes, 1/25/84, Tr. 110-112)

212. It is possible that, during certain periods, onsite personnel may have had a delay in obtaining information from San Francisco. To minimize this inefficiency, onsite engineering personnel were temporarily relocated to the home office in order to provide data to onsite engineers. This information was transmitted in some cases by phone in order to expedite the performance of preliminary calculations. Engineering Manual Procedure 6.1, Section 4.4 specifically states that all design information provided verbally must be confirmed in writing. Engineering Manual Procedure 3.3, Section 4.1.2 provides that data requiring verification at a later design stage be identified and the calculation cover sheet marked "Preliminary" until verified. This was the procedure used for such circumstances throughout the reverification program. While this practice is allowed, it was not commonly used except for brief periods or special cases. In all cases, data was subsequently provided by normal document control procedures and verified prior to finalizing affected calculations.

LIV. It is alleged that:

> The initial records for hanger calculations later covered by the seismic design review are totally unprofessional and unacceptable due to the inadequate underlying documentation, as well as the lack of signatures and evidence of a checker or other approval for the great majority of calculations. The records are so deficient that the seismic design review must be expanded from a sample to cover 100% of relevant hardware. Reliance on a sample assumed the existence of a comprehensive, if questionable, base of professional engineering calculations. In Mr. Stokes' professional judgment, such a base did not exist. The plant cannot be licensed on the basis of a sample base of minimally-acceptable engineering calculations. (Stokes, 1/25/84, Tr. 113-15)

213. At the time that the original design of small bore piping was undertaken, the small bore pipe support design, including support spacing, was specified by design standards. These standards included prequalified, load rated standard support details in PGandE Drawing 049243, the calculational basis of which were prepared by PGandE's Mechanical and Nuclear Engineering Department in San Francisco. Pullman Power Products detailed and installed supports as specified by this standard.

214. Engineering authority was delegated to General Construction to approve minor modifications to these details where required to facilitate installation, provided that the original design intent was maintained. In some cases, simplified calculations were performed to justify these deviations from the standard details. In some cases, supports were found by inspections to have been installed at variance with specified standards, and contractor discrepancy reports were written to document these problems. In order to resolve the DRs, calculations were performed to qualify the installed condition.

215. In summary, every small bore support was documented by an individual support drawing which had received engineering acceptance based upon the prequalified standard of Drawing 049243 or authorized deviations from 049243 justified by calculations where required. The complete records of the drawing 049243 calculations were maintained in the San Francisco engineering offices, which would explain Mr. Stokes' lack of familiarity with them.

LV. It is alleged that:

> At the time of Mr. Stokes' departure, plant operators did not have access to a centralized document center with all information necessary to respond to conditions in the plant. This could compromise operators' ability to make all decisions from the control room in an emergency. (Stokes, 1/25/84, Tr. 115-16)

216. Document systems, controlled by procedures, are in place, which ensure that plant operators have immediate access to all drawings and documents necessary to safely operate and maintain the plant.

217. The Design Control Procedure, Engineering Manual Procedure 3.60N, requires review of all safety-related design changes by the Plant Staff Review Committee (a plant operations committee) prior to release for construction. The procedure also requires the operations organization to be informed upon construction completion of each design task. The operating organization has procedures which interface with 3.60N to ensure that this current information is distributed to all document control centers and individuals identified in their drawing distribution lists. Upon completion of construction and as-builts submitted to

Engineering, the permanent plant record drawings important to safe operation and maintenance are revised to incorporate the changes and issued within one month.

218. The PGandE Records Management System (RMS) provides a computer-based multiple cross-index listing of all important plant records. This listing provides reference to the location of records on microfilm. This system is accessible from the plant, and all microfilm required for safe operation and maintenance is available to the operating organization.

LVI. It is alleged that:

> Mr. Stokes reported errors in the M-9 computer analysis, which incorrectly instructed engineers to consider small-bore baseplates and non-computer analysed piping lines as rigid. In fact, the baseplates and lines are flexible. The assumption was inconsistent with other instructions to calculate displacement for the bolts on the baseplate. (Stokes, 1/25/84, Tr. 138-41.)

219. Design Criteria Memorandum M-9, "Guidelines for Design of Class I Pipe Supports," states in paragraph 6.8.1.1;

> "Small bore pipe support base plates on non-computer analyzed lines may be considered rigid for purposes of pipe support evaluation."

This assumption is in agreement with the requirements of NRC I&E Bulletin 79-02 for pipe supports on piping systems that were qualified by conservative alternate analysis rules or "span tables."

220. In instances where baseplate flexibility could significantly affect the frequency of the pipe support, it has been considered. An example is the inclusion of baseplate flexibility when calculating the natural

frequency of a simple cantilever beam. Accordingly all simple cantilever beams with baseplates included consideration of base plate flexibility in the natural frequency calculation. In more complex structures, the moment resistance of the frame reduces the effect that any baseplate flexibility would have. As a result, baseplate flexibility is ignored since its effect is insignificant to the overall support natural frequency. However the flexibility is considered in calculation of anchor bolt loads in accordance with I&E Bulletin 79-02 and Diablo Canyon licensing commitments.

221. The Bechtel procedures referenced by Mr. Stokes (Tr. 141) require consideration of baseplate flexibility for calculation of natural frequency of cantilever beams. This was precisely the practice at Diablo Canyon.

222. In discussions with the NRC Staff (Tr. 148, 149), Mr. Stokes indicated that the STARDYNE computer code was not used for Diablo Canyon. Instead, the program BASEPLATE II was used when "flexible plate theory" was required. Mr. Stokes is apparently unaware that BASEPLATE II is merely a preprocessor for STARDYNE. BASEPLATE II transforms the relatively simplified input information required for baseplate analysis into more complicated STARDYNE input format. It seems ironic that an engineer who apparently probed with such attention to minute detail in some areas of support design was unaware of this computer program application.

LVII. It is alleged that:

> Similar to the experience of Mr. Stokes and others in the pipe support group, engineers in the stress trailer were transferred after challenging suspect changes -- such as eliminating eccentricities -- in the models for the seismic design review calculations. The reluctant engineers were replaced by personnel who cooperated with questionable manipulation of models. In fact, there were considerably more personnel shifts in the stress group than the pipe support group. (Stokes, 1/25/84, Tr. 151)

223. As with the pipe support group, the stress group experienced reassignment of some personnel to the Unit 2 small bore effort in the Spring, 1983. However, this did not involve physical transfer of personnel since almost all stress group personnel could be located in the one trailer which they already occupied. Contrary to statements in the allegation, no attempt was made to transfer personnel in the piping stress group on the basis of objections raised regarding analysis modeling techniques. It is true that, as with pipe support analyses, a difficult or troublesome stress calculation might be reassigned to a different engineer to take advantage of greater experience or familiarity with acceptable alternate calculation techniques. We reject the implication that reassigning calculations for this purpose is inappropriate.

LVIII. It is alleged that:

> Contrary to management assertions at the December 15, 1983 meeting with NRC staff, the calculations that replaced those rejecting pipe supports were not more refined and sophisticated. In fact, the opposite was true: less sophisticated analysis was used. The models for subsequent calculations eliminated the unique eccentricities relevant for particular pipe supports. (Stokes, 1/25/84, Tr. 85-86, 152-53.)

224. We are aware of only two situations which, upon initial observation, might appear to support Mr. Stokes' allegation. In one case, as outlined in Mr. Stokes' meeting with NRC, hanger 100-132 was analyzed with less sophisticated modeling techniques to demonstrate its qualification. To the best of our knowledge, including the rereview of over 100 support design calculation packages, this was a unique case. (Also see the Affidavit of Alex Shusterman)

225. A second situation which could have led to this allegation. Mr. Stokes believed (Tr. 134) that if a support component exceeded AISC criteria for bending of angles or ITT Grinnell's U-bolt load capacity, the support was not qualified, even though it would be acceptable under the less conservative Diablo Canyon Project criteria. Mr. Stokes was willing to accept only the AISC and Grinnell load ratings as qualification criteria.

226. In such a situation, engineering supervision would then give the calculation to an equally qualified engineer to review in accordance with project criteria, whereupon it was qualified. This sequence might lead one to believe:

(1) Since Mr. Stokes failed the calculation, it was given to another engineer to qualify.

(2) Less conservative rules were used when the support would not qualify.

While both these statements are literally true, they are the result of perfectly acceptable techniques for resolving a problem.

227. However, in a more general sense, the calculations were, in fact, based on more sophisticated methods, since the project specific criteria for angles and U-bolts were based upon detailed evaluations and test results.

Dated: March 5, 1984

FRED C. BREISMEISTER

DANIEL J. CURTIS

MYRON E. LEPPKE

ROBERT G. OMAN

LARRY E. SHIPLEY

WILLIAM H. WHITE

GARY H. MOORE

MICHAEL J. JACOBSON

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

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

SEAL

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

List of Exhibits

Exhibit No. 1

FOR INTRA-COMPANY USES

PACIFIC GAS AND ELECTRIC COMPANY

OFFICE OF THE
CHAIRMAN

March 22, 1982

TO: PGandE OFFICERS, ENGINEERS, TECHNICIANS AND OTHERS DIRECTLY INVOLVED IN THE COMPANY'S NUCLEAR FACILITIES

This letter is to reemphasize the Company's long-standing commitment to design, build, and operate safe nuclear power plants and in achieving this commitment to require all employees to practice fundamental honesty and to adhere to Nuclear Regulatory Commission ("NRC") rules and regulations.

This is also to reemphasize that our communications with the NRC must be open and allow a free flow of information. We must be ever alert to any possible misleading or ambiguous statements made either in oral or written communications. Any such misstatements must be corrected immediately upon discovery. Nothing less than full and open communication between the Company and the NRC can be tolerated.

In October 1975, PGandE formalized its general policy concerning employee conduct (Standard Practice 735.6-1). The statement of policy establishes a Company philosophy regarding work conduct emphasizing that:

> "It is the policy of this Company that employees shall at all times continue to practice fundamental honesty. Employees shall not, nor attempt to: deceive, defraud, or mislead the Company, other employees, or those with whom the Company has business or other relationship; ... misrepresent the Company or its employees; ... withhold their best efforts to perform their work to acceptable standards; ... violate applicable laws; or conduct themselves at any time dishonestly or in a manner which would reflect discredit on the Company."

This policy is particularly important to all employees engaged in work concerning nuclear power.

In April 1976, Mr. J. D. Worthington, and again in 1980, Mr. J. O. Schuyler, issued a memorandum to all personnel involved in the Company's nuclear power work which described a program to permit such personnel to discuss their concerns regarding nuclear power. The August 1980 letter stated that:

> "[Our] purpose is to again reaffirm the Company's strong commitment to the protection of its employees and the general public against any unsafe situation with respect to these nuclear facilities and, further, to assure that you have every opportunity to communicate freely to your Company any views you might have on the safety of nuclear facilities.
>
> "We believe that you appreciate your right and obligation to express yourselves on matters of safety and that you have the dedication and individual initiative, insofar as your responsibilities are concerned, to see that our nuclear facilities are designed, constructed, and operated in a safe manner.
>
> "To give you added opportunity to ask questions or to express your views on any aspect of the safety of nuclear facilities, including those outside your own sphere of responsibility, we encourage you not only to talk to your supervisor, but also, if you wish, to any one of the following people who have been designated a review team to answer questions and to evaluate the views of any employee who wishes to express any concern whatever about the safety of nuclear facilities:"

We are proud that the application of these policies of openness in finding and evaluating safety issues led directly to the discovery by PGandE personnel of the "mirror image" error at Diablo that otherwise might have gone undetected.

Recently, in February of this year, Mr. R. C. Thornberry issued a separate memorandum to Diablo Canyon Power Plant employees which reiterated the Company's policy concerning adherence to government rules and regulations.

We must strive for perfection in design, construction, and operation of our nuclear units. To attain this goal, it is necessary that we all exercise our best efforts to resolve problems we encounter in our work. When problems are encountered, they must be immediately identified, clearly defined, and brought to the attention of your supervisor. This approach should facilitate the evaluation of, and formulation of timely and effective solutions to, any problem. Constructive recommendations are encouraged at all levels.

Our goal is to design, construct, and operate our nuclear facilities with full margins of safety and full compliance with NRC requirements. Strict adherence to the above policies will provide added assurance that this goal will be met.

F. W. Mielke, Jr.
F. W. MIELKE, Jr.

B. W. Shackelford
B. W. SHACKELFORD

cc: Officers
Department Heads
Division Managers
All Concerned Personnel

Exhibit No. 2

SM: 4579A
Date: May 20, 1983
File No: 31.E.1

UNITED ENGINEERS & CONSTRUCTORS INC.

TECHNICAL REPORT

Date: May 20, 1983

Purpose of Report: Qualification and Verification of Flare-Bevel Groove Welds - Square Tube

Distribution:

M. P. McKenna	UEC591	W. J. Duffy	UEC589
D. C. Turnquist	UEC589	W. C. Leithead	UEC294
S. J. Pattison	UEC262	A. Bandopadhyay	UEC589
R. W. Gregory	UEC585	M. B. Lasota	UEC589
K. E. Berg	UEC196	P. K. Jathavedam	UEC787
S. C. Sethi	UEC288	B. Basu	UEC589
V. M. Alsan	UEC196	S. C. Madaras	UEC589
S. N. Caruso	UEC290	C. W. Mourar	UEC392
J. P. Whoriskey	UEC296	R. A. Mills	UEC392
J. R. Slotterback	11U0	B. J. Huselton	UEC589
D. E. Rhoads	07U4	O. P. Kalani	09U4
L. M. Reyes	UEC143	J. M. Benenati	09U9
R. R. Bryans	UEC262	S. K. Guha	UEC282
M. A. Edgar	UEC164	J. E. Julian	UEC262
R. C. Sevotty	UEC786	M. J. Konopka	07U8
G. A. Gallant	UEC262	DCC Field	UEC185
P. A. Leone	UEC591	DCC - PA	06U1
G. F. Rigamonti	07U4	SM File	UEC164
B. G. Levine	UEC262		
J. P. Cannon	14U3		
H. J. Kaplan	17U4		

Report Prepared By: S.R. Frelo

T. R. Frelo

Report Approved By: TPVassallo/RXP

T. P. Vassallo, Jr.

SM: 4579A
Date: May 20, 1983
File No: 11.8.1

QUALIFICATION AND VERIFICATION OF FLARE BEVEL GROOVE WELDS

Purpose - To verify, as a minimum, that the effective throat thickness for a flare-bevel-groove weld when filled to the solid section of the bar will be equal 5/16 R, where R is equal to the radius of the bar.

Materials - Tubular steel sizes 3" x 3" x ¼", 4" x 4" x 3/8", 6" x 6" x ½" and 8" x 8" x ½" ASTM A500 was used.

Welding Process - The shielded metal arc welding process was used, utilizing SFA 5.1, E7018 electrodes with multiple passes.

Preheat and Interpass - The minimum preheat and interpass temperature was in accordance with ANSI/AWS D1.1, Table 4.2.

Procedures for Shielded Metal Arc - The welding was done in the vertical, overhead and flat planes utilizing 3/32" and 1/8" diameter electrodes in each position. The welding parameters were as follows:

3/32" - DCRP, 70-120 amps, 20-27 volts, 2 ipm min. travel.
1/8" -DCRP, 115-165 amps, 21-27 volts, 2 ipm min. travel.

Qualification - The samples were sectioned for visual examination. The welds were free from cracks and there was thorough fusion between adjacent layers of weld metal and the base metals. The welds, in general, were visually acceptable.

Conclusion - In general, 3/32" Ø electrodes showed good penetration exceeding the minimum throat thickness by approximately 50% except there were some problems with the 3" x 3" x ¼" tubes. The small radius did not permit the depth of penetration. The 1/8" Ø electrodes showed excellent penetration for exceeding the minimum throat thickness for the flare-bevel-groove welds. It is recommended that the Contractors be directed to utilize 1/8" Ø electrodes for the first pass to insure adequate penetration.

FORM-3015

GENERAL COMPUTATION SHEET

united engineers & constructors inc.

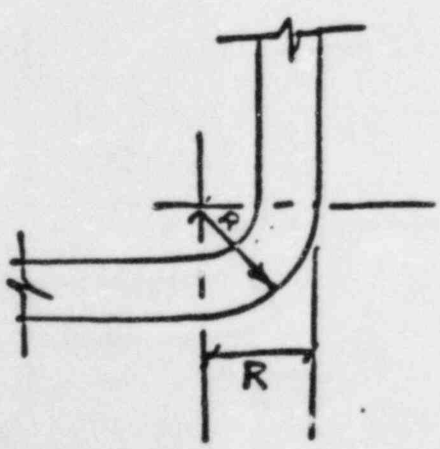
SM: 4579A
Date: May 20, 1983
File No: 11.8.1

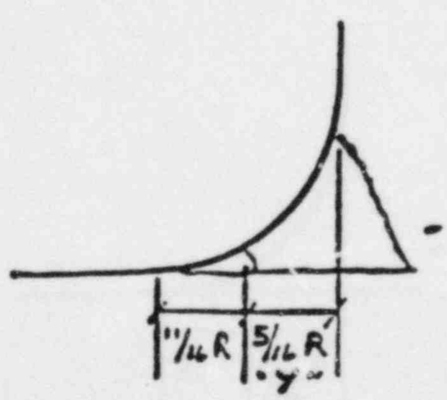
NAME OF COMPANY

SUBJECT: QUALIFICATION AND VERIFICATION OF FLARE- BEVEL GROOVE WELDS - SQUARE TUBE

J.O. NO. ______
SHEET NO. ______ OF ______
DATE ______
COMP. BY ______ CHK'D BY ______

TUBE SIZE	WELDING POSITION	TUBE CORNER RADIUS	MIN. REQUIRED 5/16 R	"Y" ACTUAL 3/32" ELECTRODE	"Y" ACTUAL 1/8" ELECTRODE		
8" x 8" x .500" WALL	FLAT	1.000	.3125	17/32" (.5312)	11/16" (.6875")		
	VERT		5/16"	5/8 (.625[illegible])	5/8" (.6250")		
	OVERHEAD			5/8 (.6250)	3/4" (.750")		
6" x 6" x .500" WALL	FLAT	1.000	.3125	7/16" (.4375")	19/32" (.5938)		
	VERT		5/16"	15/32" (.4688)	21/32" (.6562)		
	OVERHEAD			7/16" (.4375)	23/32" (.7188)		
4" x 4" x .375" WALL	FLAT	.750	.234	7/16" (.4375)	7/16" (.4375)		
	VERT		15/64"	3/8 (.3750)	3/8" (.4375)		
	OVERHEAD			15/32" (.4688)	13/32 (.4062)		
3" x 3" x .250" WALL	FLAT	.500	.1563	5/32" (.1562)	3/16" (.1875")		
	VERT		5/32"	3/16" (.1875")	7/32" (.2188)		
	OVERHEAD			3/16" (.1875)	1/4" (.250")		





Pullman Power Products Corporation

Diablo Canyon Nuclear Project
Post Office Box 367
Avila Beach, California 93424
Telephone (805) 595-2356

DATE: DECEMBER 9, 1983

TO: D. ROCKWELL, PG&E

FROM: H. KARNER, QA/QC

SUBJECT: NPS BEAM ATTACHMENT BBD-18 AND FLARE BEVEL WELDS

The NPS beam attachment BBD-18, which was in the possession of the NRC, has been examined by M.T. and U.T. Please find copies of the results of these examinations attached.

The NRC discussed with Pullman Power Products weld penetration for flare bevel welds on tube steel as used at Diablo Canyon. An investigation had previously been conducted by Pullman Power Products and United Engineers and Constructors, Inc., at Seabrook Station on this subject. This information was presented to the NRC at Diablo Canyon for their review.

Their review revealed that the minimum required throat was most difficult to obtain on small size tube steel (3" x 3") when using 3/32" electrode in the flat position.

As a result of this determination and discussions with Mr. Sam Reynolds of the NRC, Pullman Power Products prepared several sample welds at Diablo Canyon using 3" x 3" tube steel in the flat position with 3/32" electrode. Measurements were taken in the presence of Mr. Reynolds. The formal results of these sample welds are attached.

If you have any questions, please do not hesitate to call.

Harold Karner
QA/QC Manager

HK:sam

Attachments (originals)

cc: A. A. Eck w/attachments
P. Stieger
File

Pullman Power Products Corporation

Diablo Canyon Nuclear Project
Post Office Box 367
Avila Beach, California 93424
Telephone (805) 595-2356

December 8, 1983

RESULTS OF FLARE BEVEL PENETRATION TEST

On December 8, 1983, Pullman Power Products conducted tests to determine the typical penetrations which will be achieved for flare bevel joints. The material used was 3" square tube steel to 1/4" thick plate. All welding was performed in the flat position with 3/32" and 1/8" E7018 electrodes. Results are as follows:

Minimum Required Throat (5/16 R)	Actual Throat	
	3/32" Electrode	1/8" Electrode
5/32"	- 2732" 15/64", 17/64" 7/32"	7/32" 15/64"

C.M. Neary
C.M. Neary
QEC Welding Engineer

cc: E. Karner
File

ATTACHMENT D

Pullman Power Products Corporation

Diablo Canyon Nuclear Project
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Avila Beach, California 93424
Telephone (805) 595-2356

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TO: D. ROCKWELL, PG&E

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Harold Karner
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C.M. Neary
QEG Welding Engineer

cc: H. Karner
File