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

HISTORY OF ONSITE ENGINEERING SMALL BORE PIPING PROGRAM DESCRIPTION

AFFIDAVIT OF M. TRESLER, R. OMAN, AND M. LEPPKE

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

The above being duly sworn, depose and say:

I, Michael R. Tresler, am Assistant to the Unit 1 Project Engineer for the Diablo Canyon Project.

I, Robert G. Oman, am an Assistant Project Engineer for the Diablo Canyon Project, and from August, 1982 to October, 1983 acted as Onsite Project Engineer at Diablo.

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

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PDR ADOCK 05000275
G PDR

ONSITE ENGINEERING

1. In the early 1970s, the design and location of small bore pipe supports was dictated by design standards produced by the PGandE Mechanical and Nuclear Engineering Department. These standards provided information for location and spacing of pipe supports and standard support details. Pullman Power Products detailed and installed supports as dictated by these standards. Early in the construction process, it was found that the standard support details often required modifications to facilitate installation. Because the majority of modifications were minor in nature, Mechanical and Nuclear Engineering delegated design authority to General Construction for approval of minor modifications to these details, providing the original design intent was maintained.

2. Initially, this work load required only one to two engineers. Eventually it increased so that approximately five engineers were involved in this effort. Engineering also delegated authority to General Construction to approve minor changes to large bore piping hangers provided the intent of the original design was maintained, and Mechanical and Nuclear Engineering personnel performed reviews to verify that the changes were properly implemented. The minor changes made to all of the large bore piping hangers were reviewed as part of the as-built hanger review, and compatibility with existing engineering calculations or reanalysis was performed. This review was dictated by the quality assurance procedures and the Engineering Manual Procedures 3.6, 3.6 ON, and 3.7.

3. In early 1980, the combination of the large and small bore design adjustment activities required approximately 20 engineers. In addition, approximately 20 to 25 drafters were added to the organization to assemble final support as-built configurations. In early 1982, the decision was made to establish this group as a part of the Engineering Department. Thus, on April 19, 1982 this organization, termed the Onsite Engineering Group (OSEG), was placed under the technical direction of the Mechanical and Nuclear Engineering Department, specifically, Mr. M. R. Tresler, Diablo Canyon Piping Coordinator. Mr. M. E. Leppke was placed in charge of the group at the site. Effective April 19, 1982, OSEG began operating in accordance with the Engineering Department Manual. The change is detailed in the attached letter, (Exhibit 1). Mr. Leppke actually assumed his position in mid-March, prior to issuance of this letter.
4. In September 1982, Project Engineer's Instruction PEI-9 (Exhibit 2) was issued, which further detailed the requirements of this group's activities. It changed supervisory responsiblity to the Project Engineer and established the Onsite Project Engineer position which was filled by Mr. R. G. Oman. It established the Onsite Project Engineering Group (OPEG) as a multi-discipline engineering group which was located at the jobsite and served as an extension of the Home Office Project Engineering Group in San Francisco. OPEG operated under the same procedures and criteria as Home Office Engineering. OPEG was comprised of representatives and lead engineers from each of the major discipline groups of the Diablo Canyon Project: civil, mechanical, electrical, instrumentation, and piping, and included representatives of project quality assurance and quality engineering.

5. One of the major tasks assigned to OPEG was design and, in the case of Unit 1, reverification of, small bore piping. The small bore verification effort was assigned to OPEG because (1) DCP small bore pipe design had historically been done onsite, (2) onsite work facilitated field confirmation of the installed conditions of the plant, and (3) onsite work facilitated checking the feasibility of proposed modifications in such a way that the physical impact to other plant installations would be minimized.

6. The size of OPEG grew from approximately 20 people in August 1982 to a peak of approximately 270 in the Spring of 1983. At the peak, the group was comprised as follows:

Approximate Number	Type	Function
6	Civil Engineers	Design
6	Mechanical Engineers	Design
5	Electrical Engineers	Design
2	Instrumentation Engineers	Design
20	Administration	Clerical, typing
30	Drafting	Drafting
60	Walkdown Engineers	Walkdown and feasibility checks in support of Home Office engineering
20	Pipe Support Engineers	Units 1 and 2 pipe support design tolerance classification teams
85	Pipe Support Engineers	Small bore piping support design
40	Piping Stress Engineers	Small bore piping stress engineering

7. Design of small bore piping relies upon seismic spectra inputs developed by the Civil discipline and piping thermal modes developed by the

Mechanical discipline, and the seismic and thermal anchor movements (SAM/TAM) of large bore piping to which the small bore piping connect. Ordinarily, small bore piping design is delayed until all these other inputs are received. The Project recognized that some schedule advantages could be gained by parallel preliminary analysis of small bore piping, with final analysis after the other inputs were received.

8. Late in 1982, OPEG Management was planning for the staffing requirements for the entire year of 1983. It was then anticipated that an increase in personnel for the small bore piping effort would be required commencing in November 1982, building to a peak in April 1983, and subsiding to a minimum work force in mid-year 1983 when the work for Unit 1 was scheduled to be completed and Unit 1 personnel would be available for transfer to Unit 2. (Exhibits 3 and 4). To accomplish this temporary demand for personnel, we relied upon the hiring of job shoppers and agency people like Mr. Stokes.

9. In approximately November of 1982, OPEG started to increase its personnel in support of the start of the significant work in the small bore reverification effort for Unit 1. Mr. Stokes was among the first pipe support designers hired to facilitate this manpower buildup and arrived early in of November 1982. By January of 1983, the pipe support group reached the size of about 35 pipe support engineers. Through February 1983, this group worked entirely on the Unit 1 small bore piping

reverification effort. Unit 2 small bore design activities began in March, 1983.

10. In order to ensure proper management of the small bore design activities for the two Units, separate teams within OPEG were established in March, 1983. This facilitated independent management, scheduling, production, and control of the work for the two units and facilitated coordination with the two independent Unit 1 and Unit 2 project teams in San Francisco. Separation also prevented intermixing of calculations, calculation files, and support drawings.

11. Engineering personnel to staff the two separate pipe support groups came from both newly hired individuals and from the existing OPEG personnel. The basic consideration in establishing the makeup of the two separate teams was to provide each with an essentially equivalent mix of new assignees, engineers with more project experience and supervisory personnel such that each project would be supported equally. At the time of the division, the four supervisors who were to be the principal leadership in the new Unit 1 and Unit 2 organizational structure held discussions to establish which of the more experienced engineers were to be assigned with the newer engineers in each of the squads of the new organization. Contrary to Mr. Stokes' claim, there was no discussion or consideration of any factor other than as discussed above in the assignment of personnel to the two teams. The Unit 1 effort through this

period of time continued reverification and finalization of piping stress and pipe support calculations as the necessary input data was finalized for such items as seismic spectra, thermal modes, SAM and TAM. The Unit 2 effort was directed primarily to original design because design and construction of Unit 2 was not as advanced as Unit 1.

12. Another responsibility of OPEG, which was developed in December 1983, involved the creation of a pipe support design tolerance clarification team (PSDTC). Engineers in this team worked directly with construction engineers and Pullman Power Products crafts in resolving construction difficulties in the installation of pipe supports, both large and small bore, in order to minimize delay. There was a team of engineers located at each unit.

13. In June of 1983, Mr. Stokes volunteered for assignment to the Unit 2 pipe support design tolerance clarification team.

14. In August 1983, Mr. Stokes came forward with concerns regarding welding, the spacing of expansion anchors, and the use of angle members in design of supports. These were submitted by Mr. Stokes in handwritten form on August 12 and August 16, 1983 (Exhibit 5). In August and September, the concerns that Mr. Stokes raised were reviewed and a determination was made that the concerns did not amount to discrepant situations or, in the case of the welding issue which was already under review by the Project, that there was a resolution for proper acceptance of previously installed welds

through an as-built procedure, (Exhibits 6, 7, 8 and 9). The Discrepancy Reports (DRs) were assigned DR numbers and typed in October, 1983. (Exhibits 7, 8 and 9).

15. In carrying out previously established personnel staffing plans, a force ranking was made in May, June, and July, 1983 by the support group leaders to establish the relative standing of engineers based on assessment of work performance. That ranking was not intended to indicate unsatisfactory performance but rather, the relative standing within the group. When the manpower reduction was undertaken, this force ranking was used as one guideline for determining the order of engineers to be separated. Mr. Stokes' standing in that force ranking was in the bottom third of his group.

16. As an additional guideline for determination of the order of separation, employment status was considered. A decision was made to reduce manpower cost by releasing agency personnel first. This was not related to level of performance but rather to economic considerations. Agency employees are generally more expensive than permanent or casual employees. Generally, a premium is paid for agency employees largely in compensation for the uncertain nature of their employment duration. Use of agency personnel is a common industry practice to accommodate rapid adjustments in manpower level in response to changing schedule priorities, and the uncertain nature of their employment is understood by those so employed to be one of the conditions of their assignment.

17. The force reduction of OPEG began in June of 1983, from a total pipe support group manpower level of 104 engineers. Fifteen engineers were released in June and July, 9 engineers in August and September, and Mr. Stokes was one of the 3 engineers released effective October 14 at which time the total reduction had reached 27 pipe support engineers and the group manpower level was at 77 pipe support engineers.

18. Contrary to Mr. Stokes' allegations, his release was not precipitated by his submittal of three Discrepancy Reports but was part of the planned force reduction that took place in OPEG, (Exhibits 3 and 4). While we cannot state with certainty that the earlier reductions in force of June and July caused Mr. Stokes to draft his three DRs in August, 1983, in attempt to obtain job security, we are certain that Mr. Stokes was aware that a reduction in force was taking place and that there was a likelihood that the end of his employment was drawing near.

19. Project engineering procedures governing the use of Discrepancy Reports (DR), as well as Nonconformance Reports (NCR), are contained in the Engineering Manual Procedures. Training on the Engineering Manual is required of all engineering personnel shortly after assignment to the project. This training includes indoctrination in the purpose and use of DRs as well as NCRs. 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 the DRs are addressed in Engineering Manual Procedure 10.1.

20. These procedures provide that any individual, who may or may not be an employee of Engineering, 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 nonconformance, a discrepancy, or neither, and directing 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.

21. The following is a brief description of the small bore piping program for Unit 1. Upon discovery of the original annulus frame diagram error in September 1981, review of large and small bore piping was initiated to assess impact. During this review, and others promulgated by discovery of other deficiences in the annulus spectra, certain aspects of small bore design were found to be deficient. These findings were documented in a series of discrepancy reports which were reported to the NRC as Open Items. In addition, Robert L. Cloud and Associates performed an independent design verification which included small bore piping. Our findings and the Cloud findings were reviewed and that review resulted in the Corrective Action Program identified in the first issue of the Phase I Final Report. This report was submitted to the NRC in September 1982.

22. The small bore piping and pipe support program consisted of two components, a Generic Program and a Sample Program.

23. The Generic Program addressed all design considerations which were identified to have the potential to cause modifications due to exceedence of acceptance criteria. The design considerations were:

Piping

Original Generic Program

1. Computer seismically analyzed small bore piping and associated thermal analysis
2. Valve qualification
3. Seismic and thermal piping anchor movement (SAM/TAM)
4. Design class change boundaries
5. Hot piping designed by spacing criteria

Added From Sample Program

1. Computer thermally analyzed small bore piping and associated seismic analysis
2. Equipment seismic and thermal anchor movement
3. One unique concentrated mass configuration
4. Nozzle loads on equipment which were upgraded to show compliance to seismic criteria
5. Vents and drains

Pipe Supports

Original Generic Program

1. Standard support details
2. Loads from seismic and thermal piping anchor movement (SAM/TAM)

3. Code boundaries

4. Lug stress and lug local effect on pipe stress

24. All piping and supports were reviewed to identify that piping which included one or more of these design considerations. Generally, the piping or supports identified were reanalyzed and accepted or modified to gain acceptance. However, for a few design considerations (equipment and piping SAM/TAM, vents and drains, and lug stress and lug local effect on pipe stress), a worst case analysis methodology was used to show qualification of all installations in that design consideration category. This approach required the analysis to either address the worst case in the plant or sequential analyses of worst cases until a level was reached which resulted in acceptance of all remaining cases.

25. The Generic Program caused reanalysis of approximately 28,000 ft. of piping. The plant contains approximately 43,000 ft. of small bore piping. Most of this analysis, 25,000 ft., was performed by computer using the Bechtel ME-101 program. The rest was analyzed by manual methodology using the M-40 criteria.

26. The small bore Sample Program consisted of review of 5000 ft of pipe and the results allowed acceptance of 15,000 ft (including 5000 ft contained in the sample analyzed) of pipe which did not contain generic design considerations.

27. The sample program addresses all remaining design considerations and no deviations from acceptance criteria were anticipated to be found in this review. This position was based on previous analysis and reviews performed by PGandE and the IDVP coupled with the conservatism contined in the span criteria methodology used for the initial design. The following considerations were addressed:

<u>Piping</u>

1. As-built piping accuracy
2. Revised seismic spectra
3. Concentrated masses
4. Effect of piping and insulation weight
5. Spans exceeding spacing criteria
6. Anchor and equipment loads
7. Equipment and building seismic and thermal anchor movement
8. Thermal analysis
9. Integral valve bypass
10. Vents and drains

<u>Pipe Supports</u>

1. As-built piping accuracy
2. Revised spectra
3. Concentrated masses
4. Effect of pipe insulation weight

5. Spans exceeding spacing criteria

6. Equipment and building anchor movement

7. Thermal loads

28. As the review of the sample progressed, certain design considerations were found to require modifications. Therefore, rather than performing additional sampling, those design considerations were transferred to the Generic Program for a 100% review. These design considerations are listed in the description of the Generic Program under the heading "Added From

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Sample Program." The cause of all modifications to piping or supports was identified to a design consideration to assure none resulted from a consideration which was not a part of the Generic Program.

Dated: March 5, 1984

MYRON E. LEPPKE

ROBERT G. OMAN

MICHAEL R. TRESLER

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

SEAL

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

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

PACIFIC GAS AND ELECTRIC ...

COPY

Exhibit No.1

MECHANICAL & NUCLEAR ENGINEERING
GENERAL CONSTRUCTION
1.21

Plant Site Design of Piping and
Pipe Supports - Diablo Canyon

April 19, 1982

MESSRS: C. K. MAXFIELD
M. R. TRESLER
R. D. ETZLER
M. E. LEPPKE

The General Construction Department is performing design work as assigned by letter of delegation from the Mechanical & Nuclear Engineering Department. To improve technical direction of design efforts, insure consistent engineering practices and increase the scope of work which may be performed at the plant site, the Mechanical & Nuclear Engineering Department will reassume responsibility for all Design Class I piping and pipe support activities effective April 26, 1982.

All design will be performed as dictated by the Engineering Department Manual and implementing procedures. The on-site Engineering Group will be supplemented by placing the majority of General Construction personnel currently assigned to piping support design work under the direct supervision of Mechanical and Nuclear Engineering. Work will be assigned, directed and controlled by Mr. M. E. Leppke, reporting to Mr. M. R. Tresler, Diablo Canyon Piping Coordinator.

General Construction will continue to provide administrative control for personnel on their payroll and they will continue to provide facility and supply support for the group. These responsibilities will continue under the supervision of Mr. R. D. Etzler.

ORIGINAL SIGNED BY — R. S. BAIN

ORIGINAL SIGNED BY — J. V. ROCCA

MELeppke/sar
cc: DOBrand
DABrand
GSBates
GHMoore
GHAster
CEWolte

ONSITE PROJECT ENGINEERING GROUP

APPROVED: Gary H. Moore 9/17/82
PROJECT ENGINEER UNIT 1 DATE

Gregory V. Cranston 9/17/82
PROJECT ENGINEER UNIT 2 DATE

1.0 PURPOSE

This procedure establishes the organization of the Onsite Project Engineering Group at the Diablo Canyon jobsite and describes its duties, responsiblities, and authority.

2.0 SCOPE

This procedure applies to all Unit 1 and Unit 2 engineering work performed at the jobsite by the Onsite Project Engineering Group.

3.0 RESPONSIBILITIES

3.1 The Onsite Project Engineering Group (OPEG) is an extension of the home office project engineering organization. OPEG's basic functions are to expedite resolution of engineering design problems for Construction and Startup, and to expeditiously issue limited design changes to the field organization where home office guidelines and directives permit.

3.2 The OPEG is composed of an Onsite Project Engineer (OPE), an Onsite Assistant Project Engineer (OAPE), lead discipline engineers assigned on an as-needed basis by the Project Engineer, and various engineers needed to accomplish the assigned scope of work.

3.3 The Onsite Project Engineer is the Project Engineer's representative in the field. He is the Onsite Project Engineering Group team leader who provides overall coordination, guidance, and administrative supervision to the group.

3.4 The Onsite Assistant Project Engineer is responsible for overall coordination, guidance, and administrative supervision of the OPEG in the absence of the OPE. His primary responsibility is to control the engineering work of the OPEG for Unit 1. However, he can be used as needed for Unit 2 work and has SFHO Project Engineer signature authority as designated by the OPE.

3.5 The lead discipline engineers are jobsite representatives for the Home Office Engineering Group Supervisors (EGSS). Although administrative direction is provided to them by the Onsite Project Engineer, technical direction and, to a certain extent, scope of work are provided by the home office EGSS.

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Unless directed otherwise by the Home Office EGSS, the lead discipline engineers are responsible for determining whether a proposed design change can be initiated, reviewed and approved by the group, or if it should be forwarded to the home office engineering group for resolution.

In general, all proposed design changes should be coordinated with the SFHO EGSS to evaluate possible effects of field changes on SFHO work. Changes to systems, structures, and components important to safety (i.e., those associated with the reactor coolant pressure boundary, systems required for safe shutdown, or systems required to mitigate the consequences of postulated accidents) should be discussed with SFHO EGSS to evaluate whether or not any required design modifications would be more expeditiously accomplished in the home office due to effects on design criteria, positions on Regulatory Guides, licensing commitments, and off-project chief engineer design review commitments. Those changes involving FSAR revisions, procurement actions, significant vendor interface or which affect Design Verification shall be accomplished by Project Engineering.

3.6 Specific responsibilities of the Onsite Project Engineering Group include, but are not limited to, the following:

3.6.1 Assist in the evaluation of piping and pipe support modifications. This includes walkdown to verify as-built piping and pipe support configurations and to verify the installation feasibility of any proposed modifications.

3.6.2 Issue pipe support designs for small pipe and approve pipe support modifications for large or small pipe as required.

3.6.3 Review and approve Design Change Requests (DCR's) and Design Change Notices (DCN's) for design changes falling within the guidelines of Section 3.5. All DCN's shall be issued with sketches attached, in accordance with Engineering Manual Procedure 3.6 or 3.6 ON. Sketches shall be incorporated into drawings and issued by SFHO.

3.6.4 Resolve problems related to design modifications identified on Plant Modification Followers (PMF's) and DCR's/DCN's when determined to be within the guidelines of Section 3.5

3.6.5 Resolve Diablo Problems (DP's) issued by Construction/Startup and issue DCN's as appropriate when determined to be within the guidelines of Section 3.5.

3.6.6 For those design changes determined to be outside the guidelines of Section 3.5, review the associated DP's ,DCN's, DCR's, Action Request Transmittals (ART's) and PMF's for completeness in terms of problem definition prior to forwarding to SFHO Project Engineering for resolution.

3.6.7 Provide representation to the Systems Interaction Program (SIP) walkdown team to assist in the definition of potential problems as designated by the Home Office EGS; and assist in providing design fixes to problems identified by DCR, ART, or PMF when determined to be within the guidelines of Section 3.5.

3.6.8 Provide general liaison between PG&E/Bechtel Engineering/Startup personnel in the field and SFHO personnel on matters that pertain to engineering.

3.6.9 Represent Project Engineering at Plant Staff Review Committee meetings, as required.

3.6.10 Provide input to SFHO for weekly and monthly Engineering Progress Reports.

4.0 PROCEDURES

4.1 General

4.1.1 Copies of any DCN's issued by the Onsite Project Engineering Group shall be forwarded to SFHO for review. In addition, any clarification of design requirements or technical direction of a significant nature to Construction or Startup shall be appropriately documented and distributed.

4.1.2 SFHO Engineering shall review each DCN for concurrence, but Construction or Startup does not require SFHO concurrence prior to proceeding with the OPEG approved design or design modifications. However, Unit 1 modifications shall not be implemented until all necessary requirements of the operating license for design changes are met. In the event that the SFHO does not concur with the direction provided therein, Project Engineering shall notify the OPE immediately and resolve any problems. Any design documents issued will be revised, reissued or cancelled as appropriate.

4.2 Jobsite Initisted Design Changes

4.2.1 Design of piping and piping supports, and design modifications produced by the OPEG shall be in accordance with the applicable sections of the following documents as augmented below:

- Project Procedures Manual, Diablo Canyon Project

- Engineering Manual, Engineering Department Pacific Gas & Electric

- M&NE Piping Group Controlled Procedures, Instruction & Criteria

- Project Engineer's Instructions Manual

4.2.2 DCR's, DCN's, DP's, and ART's requiring Engineering action shall be screened to the criteria of Section 3.5 to determine which ones could be more expeditiously completed by the group in the field.

4.2.3 Numbers for DCN's/DCR's initiated by the group shall be obtained by calling the PG&E Project Coordination Section.

4.2.4 Upon design completion, the applicable document will be signed off as follows:

- Lead Discipline Engineer for Discipline Group Supervisor.

- Onsite Project Engineer or Onsite Assistant Project Engineer for Project Engineer.

4.2.5 After signing, copies of the documents including documentation of discussion with SFHO shall be forwarded to Project Enginering for action as applicable.

4.2.6 Original copies of Unit 1 DCR's/DCN's issued by the OPEG that fall outside the PSRC guidelines for supports and as-builts shall be forwarded to the Plant Manager for acceptance and work assignment.

Original copies of Unit 2 DCR's/DCN's issued by the OPEG shall be sent to GC for implementation.

4.2.7 The OPEG shall keep SFHO PCS apprised at all times of the coordination and implementation status of any DCR's/DCN's initiated or issued by them for tracking purposes.

4.3 Signature Authority

4.3.1 The Onsite Project Engineer and the Onsite Assistant Project Engineer have the authorization to sign for the Project Engineer in all matters related to Engineering as delegated by this Instruction. Copies of all items signed by the OPE or OAPE shall be forwarded to the Project Engineer.

Exhibit No. 3

INTEROFFICE MEMORANDUM

Diablo Canyon Project

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

To S. Bhat

From R.G. Oman

Of Onsite Project Engineering

At Jobsite Extension 3507

Date April 1, 1983

File No. 927

Subject Non-Manual Manpower Estimate

As per your request, OPEG is forwarding the estimate of non-manual to go manpower as of April 1, 1983.

RG Oman

R.G. Oman
Onsite Project Engineer

JJ/RGO/ln

Reply Requested: No

cc: G.H. Moore w/a
G.V. Cranston w/a
J.D. Jumper w/a
M.E. Leppke w/a
J. Shryock w/a

MMS -0072.

DIABLO CANYON JOBSITE
UNIT 1 & 2

SHEET 1 OF 1

FIELD NONMANUAL MANPOWER SCHEDULE

ORGANIZATION: OPEG

DATE ISSUED: 01 April 1983

BY: [illegible signature]

DEPARTMENT	FUNCTIONAL WORK TITLE	CURRENT NUMBER EMPLOYED	1983 JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1984 JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Supervision	Project Engineer					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
	Asst. Project Eng.					1	1	1	1	1	1	1	1	1	1	1	1									
Administrative	Supervision					2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1				
	Clerks					7	7	7	7	7	7	6	6	6	4	4	4	1	2	1	1	1				
Disciplines	Mechanical Eng.					6	6	6	6	6	5	5	4	4	3	3	2	2	2	2	1	1				
	Electrical Eng.					5	5	5	5	5	4	4	3	3	2	2	2	2	1	1	1	1				
	Instrumentation Eng					2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1				
	Civil Eng.					6	6	6	6	6	5	5	4	4	3	3	2	2	1	1	1	1				
	Piping Eng.					6	6	6	6	6	6	5	5	4	4	4	4	4	3	3	2	2				
Stress	Small Bore Stressers					40	40	40	34	34	6	6	6	6	10											
Supports	Small Bore Support Eng.					84	72	72	60	60	12	12	12	12	12	6										
Pipe Rerun Team	Support/Stress Eng					20	20	20	10	10	16	6	6	10	10	5	5									
Walkdown Team	Supervisor					1	1	1	1	1	1	1	1	1	1	1										
	Designers					58	58	28	10	20	13	9	9	6	6	6										
Scheduling/Computer Services	Scheduling					3	3	3	3	2	1	1	1	1	1	1	1	1	1	1	1	1				
	Computer Services					7	7	7	7	7	3	3	3	2	2	1	1									
Drafting/Document Control	Supervision					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
	Clerks					5	5	5	5	5	5	4	4	4	3	2	2	1	1	1	1	1				
	Drafters					26	26	26	26	26	26	14	14	10	10	10	10	8	6	4	4	2				
	Totals					281	269	269	203	202	107	88	83	78	73	54	37	26	21	18	16	14				

TOTAL MANMONTHS BY DEPARTMENT

DEPARTMENT	FUNCTIONAL WORK TITLE	Supervision	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
Supervision	Project Engineer	17							
	Asst. Project Eng.	12							
Administrative	Supervision	29							
	Clerks					79			
Disciplines	Mechanical Eng.		64						
	Electrical Eng.		51						
	Instrumentation Eng		36						
	Civil Eng.		62						
	Piping Eng.		76						
Stress	Small Bore Stressers		318						
			[illegible]						
Supports	Small Bore Support Eng.		418						
Pipe Rerun Team	Support/Stress Eng		138						
Walkdown Team	Supervisor	11					2[illegible]	263	
	Designers								
Scheduling/Computer Services	Scheduling			26					
	Computer Services				50				
Drafting/Document Control	Supervision	17				54			
	Clerks						248		
	Drafters								
TOTAL THIS SHEET MANMONTHS		86	1058	26	50	133	248	263	1845
TOTAL BROUGHT FORWARD MANMONTHS									
TOTAL MANMONTHS									
TOTAL MANHOURS = 186 MANHOURS/MANMONTH									

NOTES:
1) USE 186 MANHOURS PER MONTH WHEN CONVERTING MANMONTHS TO MANHOURS – MANHOURS ESTIMATED WITH APPROX. 20% O.T.
2) A LINE ENTRY SHOULD BE INCLUDED FOR EACH DEPT, IE: SUPERVISION, ENG'R, Q.C., COST & SCHEDULING, SUBCONTRACT ADMINISTRATION, FIRST AID/SAFETY, PROCUREMENT, ETC: OTHER.

Exhibit No. 4

INTEROFFICE MEMORANDUM

Diablo Canyon Project

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

To S. Bhat

From R. G. Oman

Of Onsite Project Engineering

At Jobsite Extension 3507

Date July 25, 1983

File No. 927

Subject Non-Manual Manpower Estimate

In response to the recent request of July 12, 1983, attached is the forecast estimate of total OPEG non-manual manpower as of July 1, 1983.

RGOman

R. G. Oman
Onsite Project Engineer

RGO:kms

Reply Requested: No

cc: G. H. Moore w/a
G. V. Cranston w/a
J. W. Shryock w/a
P. Snooks w/a
J. Leahy w/a

MMS - 0158

DIABLO CANYON JOBSITE
UNIT 1 & 2

FIELD NONMANUAL MANPOWER SCHEDULE

ORGANIZATION: OPEG

UNIT 1 FUEL LOAD (Oct. 1983) — UNIT 1 COMM. OP. & UNIT 2 FUEL LOAD (Apr. 1984) — UNIT 2 COMM. OP. (Oct. 1984)

DEPARTMENT	FUNCTION / JOB TITLE	CURRENT NUMBER OF EMPLOYEES	CURRENT AVERAGE HRS/WK	1983 MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	1984 JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	TOTAL
MANAGEMENT	ONSITE PROJECT ENGINEER	1	60			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
	ASST. ONSITE PROJECT ENGINEER	1	50			1	1	1	1	1	1	1	1	1										
ENGINEERING	MECHANICAL - BECHTEL	6	50			6	6	6	6	6	6	6	6	6	3	3	2	2	1	1				
	ELECTRICAL - BECHTEL	5	45			5	5	5	4	4	4	3	3	3	2	2	2	1	1	1				
	INSTRUMENTATION - BECHTEL	2	45			3	3	3	3	3	3	2	2	2	1	1	1	1	1	1				
	CIVIL - BECHTEL	12	50			12	12	12	12	12	12	12	12	12	9	7	5	3	1	1				
	AGENCY	3	50			3	3	3	3	3	3	3	3	3										
	CIVIL WALKDOWN - BECHTEL	26	50			26	26	24	24	20	19	3	2	2										
	AGENCY	3	50			3	3																	
	PIPING LAYOUT - BECHTEL/PGE	5	50			5	5	5	5	4	4	4	4	4	4	3	3	2	2	1				
	AGENCY	2	50			2	2																	
	PIPING WALKDOWN - BECHTEL	9	50			9	7	6	5	4	3	2	2	1	1									
	PIPE STRESS - BECHTEL/PGE	29	50			27	28	27	27	27	27	20	10	5	2	2								
	AGENCY	7	50			7	7	7	7	7	7													
	PIPE SUPPORT - BECHTEL/PGE	77	60			77	79	77	79	77	76	56	56	56	36	16	8	4	2	2				
	AGENCY	16	60			16	16	16	10	10														
DOCUMENT CONTROL/DRAFTING	SUPERVISION - PGE	2	50			2	2	2	2	2	2	1	1	1	1	1								
	FILE CLERKS - AGENCY	5	45			5	5	5	5	4	4	3	3	2										
	PMS. [illegible] - AGENCY	4	45			4	4	4	4	4	4	2	2											
	DRAFTEES - AGENCY	17	40			17	17	17	17	17	17	10	10	10	2									
COMPUTER SERVICES	SUPERVISION - PGE	1	40			1	1	1	1	1														
	AGENCY	4	40			4	4	4	4	4	3	2	1	1										
SCHEDULING		1	40			2	2	2	2	2	2	1	1	1										
QUALITY ENGINEERING		1	40			1	1	1	1	1	1													
ADMINISTRATION	SUPERVISION - BECHTEL/PGE	2	45			2	2	2	2	2	2	2	2	2	1	1	1	1	1	1				
	CLERKS - AGENCY	10	40			10	10	9	9	9	9	7	5	4	3	3	2	2	1	1				
	TOTAL NON-AGENCY	182				184	181	177	175	169	163	114	103	97	61	37	23	15	10	9				
	TOTAL AGENCY	71				71	71	65	59	58	47	27	24	20	5	3	2	2	1					
	TOTAL MANPOWER REQUIREMENTS	253				255	252	242	234	227	210	141	127	117	66	40	25	17	11	10				

TOTAL THIS SHEET MANMONTHS	
TOTAL BROUGHT FORWARD MANMONTHS	
TOTAL MANMONTHS	
TOTAL MANHOURS & PC MANHOURS/MANMONTH	

NOTES: 1) A LINE ENTRY SHOULD BE MADE FOR AGENCY PERSONNEL BY DEPARTMENT.

2) A LINE ENTRY SHOULD BE INCLUDED FOR EACH DEPT, IE: SUPERVISION, ENG'R, Q.C., COST & SCHEDULING, SUBCONTRACT ADMINISTRATION, FIRST AID/SAFETY, PROCUREMENT, ETC. OTHER. THE BREAKDOWN FOR YOUR ORGANIZATION SHOULD REFLECT YOUR DEPARTMENTAL MATRIX.

Exhibit No. 5

Procedure 10.2
Attachment A
Page 1 of 1

Submitted 2/12/83

PACIFIC GAS AND ELECTRIC COMPANY
ENGINEERING DEPARTMENT

DISCREPANCY REPORT

Control Number
00-000-0 | 2

PROJECT OR PLANT(S): DIABLO CANYON UNIT No. 1 & 2

ORGANIZATION AFFECTED: PIPE SUPPORT DESIGN ENGINEERING

INDIVIDUAL RESPONSIBLE FOR RESOLUTION: [illegible]

SUBJECT (ITEM/ACTIVITY): CENTER TO CENTER DISTANCE OF ANCHOR BOLTS

REFERENCES: HILTI CATALOG, AND PHILLIPS CATALOG N-9 & ESD 223

DISCREPANCY: MANUFACTURES SPECIFY THE MINIMUM CENTER to CENTER DISTANCE TO BE EQUAL TO 10 D WHERE D = the HOLE DIAMETER. DESIGN has used the BOLT SIZE ON SHELLS, NOT THE HOLE req'd FOR THE SHELL FOR D. | 2

PROPOSED ACTION: recheck ANCHOR BOLT CALC. FOR SHELLS. REDUCING ALLOWABLES PER N-9 AND rechecking INTERACTION EQUATIONS for THESE CASES where 10 D (shell hole size) exceeds that used on DWG.

SCHEDULED COMPLETION:

Initiated by: Charles C. Stokes Date: 8/9/83

Approved by: Date:

ACTIONS TAKEN:

CLOSED
Approved by: Date:

Concur* Date:
Chief, Engineering Quality Control

* Only required if initiated by EQC.

2-3/9/81

PACIFIC GAS AND ELECTRIC COMPANY
ENGINEERING DEPARTMENT

DISCREPANCY REPORT

Control Number
00-000-0

PROJECT OR PLANT(S): DIABLO CANYON UNIT NO. 1 & 2

ORGANIZATION AFFECTED: PIPE SUPPORT DESIGN ENGINEERING

INDIVIDUAL RESPONSIBLE FOR RESOLUTION: G.V. CRANSTON, Proj. L Eng

SUBJECT (ITEM/ACTIVITY): WELD. EN, INSTALLATION & INSPECTION

REFERENCES: AWS, AISC, M-9, Pullman WELD Procedures

DISCREPANCY: See ATTACHED SHEETS (7)

PROPOSED ACTION: MAKE NECESSARY CHANGES IN DESIGN GUIDES ~~to~~ AND ESD 223 ~~to~~ AND Pullman WELD Procedures to Bring them up to AWS requirements for Pre-qualified partial & full Penetration WELDS

SCHEDULED COMPLETION:

Initiated by: Charles C. Stokes Date: 4/12/82

Approved by: Date:

ACTIONS TAKEN:

CLOSED
Approved by: Date:

Concur* Date:
Chief, Engineering Quality Control

* Only required if initiated by EQC.

Diablo Problems concerning weld design, drawing documentation ~~and~~, installation and Q.C. inspection.
C.C. Stokes 7/5/83

1. Flare Bevel and Flare-V- groove welds

Design ... Bechtel .. San Fran: .. per Dan Curtis by phone -- AWS. Table 2.3.1.4 Applied to radius of tube steel: obtained from Table in a paper entitled "A Designer's Guide to Welded Joints" written by Mark Michaels of maximum outside corner radii! Table [illegible]

Note: the word MAXIMUM radii. This is not good engineering practice. The conservative approach dictates that the minimum radii be used to ensure the safety of the weld joint.
It should also be noted that Mark Michaels paper on the Design of welded joints has to my knowledge never been approved by the engineering department and issued as a control document to Engineering for use on Diablo Canyon.

Bechtel Site: per a handbook supplied by the Tube Manufactures Institute, all tubing manufactured in the U.S. is made or rolled with a radius of 2t to 3t for all sizes. Having assumed 2t to be the minimum all calculations were made to AWS. Table 2.3.1.4 using 2t = R

Per site investigations, ~~we~~ Jeff Van Klompenburg, Ken Aumer & myself know ~~the~~ some tubing on site (Diablo Canyon) has a minimum radius of 1 ½ t. Therefore all welds per this design group are ~~[illegible]~~ not conservative.

Design per Westinghouse an or other organizations are also in question.

Cont.

CC Stokes 7/5/83
&Full

2. Partial Penetration Groove Welds.

Design Bechtel San Fran. Per Dwg Supplied to field very few if any are used (Correct) symbols (weld indicate complete joint welds. This is true for all welds for joints requiring preparation no angle has been indicated and it is not obvious that the designer is aware of the minimum joint requirements per AWS. 2.3.12 and Fig. 2.10.1. However on joints created by natural intersection of 2 members it is obvious that the joint in many cases is a partial per AWS & not a full penetration joint due to angle created by intersecting members.

Bechtel Site: one group has tried to comply with AWS. requirements in designating both S & E per 2.1.3 + 2.10.3.1 Table 2.10.3 and Fig 2.10.1 and the included dihedral angle either on prep or by natural creation of members intersecting. However, Pullman QC have continually refuse to check weld per call out and have required the (E) effective part of callout to be removed.

Design by Westinghouse see comments for Bechtel San Fran.

cont

CCStikes 7/5/83

3. SKEWED JOINT FILLET WELDS

DESIGN BECHTEL SAN FRAN. PER DWGINGS SUPPLIED TO FIELD AND continued use of fillet allaround symbol INSTEAD OF a specific call out adjusting the FILLET SIZE for THE DIHEDRAL ANGLE ADJUSTMENT IT'S OBVIOUS THAT THE DIHEDRAL ANGLE HAS NOT BEEN CONSIDERED IN THE JOINT DESIGN OR IF IT WAS, IT WAS DONE incorrectly.

BECHTEL SITE ONE group has tried to be consistent in ADJUSTING THE INNER AND outer DIHEDRAL WELDS SO THAT the EFFECTIVE THROAT AROUND THE MEMBER IS THE SAME. THIS Allows the joint to be ANALYZED AS though it IS AN EQUAL LEG fillet allaround w/only a leg adjustment to obtain this when WELDED.

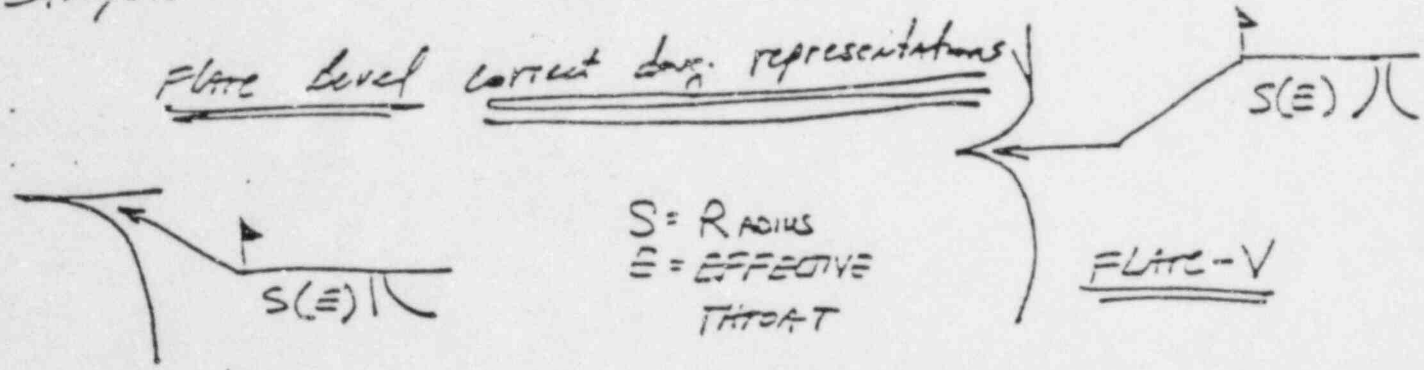
DESIGN WESTINGHOUSE SEE BECHTEL SAN FRAN. comments.

Cont'

CC Stokes 7/5/83

1) Flare Bevel AND Flare - V groove WELDS

Drawing Representation BECHTEL San. Fran.
No. Partial WELDS are shown since S (E)
Have been omitted. AWS. 2.1.3. + 2.10.3.1 +
2.10.3 state that (S) groove depth + (E) effective
throat shall be specified on [illegible] working
DWGS. THE Hanger DWG.S SENT to THE FIELD are
Both SHOP + working DWGS. ALSO M-9 STATES THAT
only Pre-qualified joints should be used on Diablo
Canyon



BECHTEL SITE ONE Group has Complied with
Callouts above. However Pullman QC per ESO 223
Have req'd the removal of S(E) from all field
[illegible] they [illegible] been supplied [illegible] procedure.
Flare Bevel + Flare-V Symbols Left, [illegible] indicate full
penetration welds even though, Q.C. states this is not
the case.

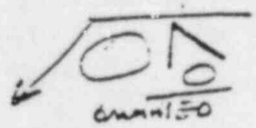
DRAWING REPRESENTATION WESTINGHOUSE see BECHTEL
San Fran. comments.

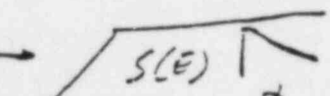
cont

CC Stokes 7/6/83

2) Partial Penetration Groove Welds

Drawing representation Bechtel San Fran.
No partial welds are shown since in most cases S(E) callouts have been committed along with prep. angle
Primary weld used is bevel

indicated  per this this is a full Penetration weld

— callout should show →  → with consideration given to AWS → Section 2.3.1.3 in specifying S(E) + α

Bechtel Site : one group on site has tried to comply with 2.3.1.3. However they have meet continued resistance from Q.C. Pullman in that the weld specs used on site were written for Piping are being used for the installation of Structural Support Steel [illegible] the prep angle for partial welds are different. Per AWS for Pipe the Prep angle is 37½° see Fig 10.13.1.1A AWS; this is different from the Prep angle specified in Fig 2.9.1 + 2.10.1, which usually indicates a minimum angle of 45°

Westinghouse see Bechtel San Fran. Comments

Exhibit No. 6

INTEROFFICE MEMORANDUM

Diablo Canyon Project

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

To Mike Tresler

From Leo Mangoba

Of Onsite Project Engineering

At Jobsite Extension 3067

Date September 29, 1983

File No. 910

Subject Discrepancy Reports

Three discrepancy reports were proposed by one of the OPEG engineers assigned to PSDTC team.

I have reviewed their contents and conclude they are more like questions than discrepancies associated with the review program or other activities performed by the project.

The following are the subjects of these write-ups:

1. Anchor Bolt Spacings: The write-up referenced manufacturer's recommendation. The original copy of this write-up has already been given to you for review by the Civil/Structural group. This write-up appears to duplicate earlier reviews by them.

2. Welds: The write-up generally duplicates the effort of John Miller, who was aided by Tze Quan and Paul Brooks in resolving the identified issues.

3. "Unbraced Length of Angles: OPEG has performed detailed evaluations of the supports listed in the attachment to the write-up and has not found any to be discrepant. In addition, this issue was a subject of the small bore review program and generally referred in the NRC SER.

These write-ups are being sent to you for your information, and unless otherwise directed, OPEG will take no further action.

Thank you,

Leo Mangoba

SMP-1445

LM:kms
Response Required: No
Attachment: Yes

cc: MLeppke w/o
SChitnis w/o
LShipley w/o
ROman w/o

PACIFIC GAS AND ELECTRIC COMPANY
ENGINEERING DEPARTMENT

DISCREPANCY REPORT

Control Number
(8)(3) - (0)(4)(3)-(5)

PROJECT OR PLANT(S): Diablo Canyon Unit No. 1 & 2

ORGANIZATION AFFECTED: Pipe Support Design Engineering

INDIVIDUAL RESPONSIBLE FOR RESOLUTION: G.V.Cranston Project Engineer

SUBJECT (ITEM/ACTIVITY): Center to center distance of Anchor Bolts

REFERENCES: Hilti Catalog, and Phillips Catalog M-9 & ESD 223

DISCREPANCY: Manufactures specify the minimum center to center distance to be equal to 10D where D= the hole diameter. Design has used the bolt size on shells, not the hole req'd for the shell for D. This was caused due to missing informatic as to hole size req'd for shells from catalog.

PROPOSED ACTION: Rechech anchor bolt calc. for shells, Reducing allowables per M-9 and rechecking interaction equations for these cases where 10D (shell hole size) exceeds that used on Dwg.

SCHEDULED COMPLETION: 10-7-83

Initiated by: Charles C. Stokes Date: 10/5/83 ORIGINAL SIGN 8/9/83

Approved by: [signature] Date: 10/7/83

ACTIONS TAKEN: SEE ATTACHED LETTER FROM CIVIL ENGINEERING DOC # 033037.

CLOSED
Approved by: [signature] Date: 10/7/83

Concur* [signature] Date: 10/7/83
Chief, Engineering Quality Control

Submitted
8/12/83

PACIFIC GAS AND ELECTRIC COMPANY
ENGINEERING DEPARTMENT

DISCREPANCY REPORT

Control Number
00-000-0

PROJECT OR PLANT(S): DIABLO CANYON UNIT 1 & 2

ORGANIZATION AFFECTED: PIPE SUPPORT DESIGN ENGINEERING

INDIVIDUAL RESPONSIBLE FOR RESOLUTION: G.V. CRANSTON Project Eng.

SUBJECT (ITEM/ACTIVITY): UNBRACED LENGTH OF ANGLES

REFERENCES: AISC 7ed. SECT 1.5.1.4.6b

DISCREPANCY: MANY ANGLE MEMBERS USED TO BUILD PIPE SUPPORTS EXCEED THE MAXIMUM LENGTH FOR WHICH THE ALLOWABLE BENDING STRESS may be ~~taken~~ AS .6 (Fy)

PROPOSED ACTION: THESE MEMBERS SHOULD BE MODIFIED by boxing OR BRACING AT critical compression points to comply with AISC OR the ALLOWABLE BENDING STRESS REDUCED AND INTERACTION EQUATIONS reverified.

SCHEDULED COMPLETION:

Initiated by: Charles C. [signature] Date: 8/9/83

Approved by: Date:

ACTIONS TAKEN:

CLOSED
Approved by: Date:

Concur* Date:
Chief, Engineering Quality Control

* Only required if initiated by EQC.

033037

INTEROFFICE MEMORANDUM

Diablo Canyon Project

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

To M.R. Tresler

From J.K. McCall

Of Civil Engineering

At 45/23/B34 Extension 8-1414

Date September 28, 1983

File No. 52.3.6

Subject DR on Expansion Anchor Spacing, Shell Type Anchor

1. The attached DR initiated by Charles Stokes on August 9, 1983 questioned the use of spacing in accordance with DCM-M9 for shell anchors of 10 times the normal size of the bolt while manufacturers specify 10 times hole size as the minimum spacing.

2. Discussion of the effect of this difference follows:

   a. The anchor length for shell anchors (Phillips and Hilti) is in all cases less than 5d (d-nominal diameter). Appendix B of ACI 349 specifies that the areas to be considered for reduction due to overlapping are 45° sloping cones starting at the enter of the base of the anchor. Based on this criteria there would be no reduction required for a spacing of 10d (nominal).

   b. In 1962 Doberne and Elgenson, Counsulting Engineers of North Hollywood, performed a series of tests on Phillips Red Head concrete anchors to determine the effects of spacing on pullout capacities. The reported results showed no decrease for 10d on ½" diameter anchors and 9.14d for 7/8" diameter anchors. Reduction of spacing by a factor of 2 only reduced the capacity by 20 percent. This reduction is small compared to the factor of safety used.

3. Recommendation

   Accept as is the spacing requirements of DCM-9.

J. K. McCALL

JKMcC/EHEpstein:dnl
Reply Requested: No
Attachment

cc: GVCranston
GHMoore
WRWhite

[DNL003]

PACIFIC GAS AND ELECTRIC COMPANY
ENGINEERING DEPARTMENT

DISCREPANCY REPORT

Control Number
(8)(3) - (0)(4)(1)-(5)

PROJECT OR PLANT(S): Diablo Canyon Unit No. 1 & 2

ORGANIZATION AFFECTED: Pipe Support Design Engineering

INDIVIDUAL RESPONSIBLE FOR RESOLUTION: G.V.Cranston Project Eng.

SUBJECT (ITEM/ACTIVITY): Weld Design, Installation & Inspection

REFERENCES: AWS, AISC, M-9, Pullman Weld Proceedures

DISCREPANCY: See attached sheets (5)

PROPOSED ACTION: Make necessary changes in Design Guides and ESD 223 and Pullman Weld Proceedures to bring them up to AWS requirements for pre-qualified partial & full penetration welds.

SCHEDULED COMPLETION:

Initiated by: Charles C. Stokes Date: 10/5/83

Approved by: [signature] Date: 10/7/83

ACTIONS TAKEN: The Diablo Canyon Project has no commitment to observe welding requirements of AWS. The issues identified by this discrepancy report duplicate an investigation conducted by General Construction (continue on Page 5 Of

CLOSED
Approved by: RG [signature] Date: 10-7-83

Concur* GLS Date: 10/7/83
Chief, Engineering Quality Control

DIABLO PROBLEMS CONCERNING WELD DESIGN, DRAWING DOCUMENTATION, INSTALLATION AND QC INSPECTION.

C.C. STOKES, 10/4/83—Rewritten from 7/5/83 paper.

1. FLARE BEVEL AND FLARE-V GROOVE WELDS DESIGN

Bechtel San Francisco Office-Per Dan Curtis by phone AWS table 2.3.1.4 applied to radius of tube steel obtained from table in a paper entitled "A Designers Guide to Welded Joints" written by: Mark Michaels of maximum outside corner radii 'table 3.3'.

Note: The word maximum radii. This is not good engineering practice. The conservative approach dictates that the minimum radii be used to ensure the safety of the weld joint. It should also be noted that Mark Michaels paper on the design of welded joints has, to my knowledge never been approved by the Engineering Department and issued as a control document to engineering for use on Diablo Canyon.

Bechtel Site-Per a handbook supplied by the tube manufactures institute, all tubing manufactured in the U.S.A. is made or rolled with a radius of 2t to 3t for all sizes. Having assumed 2t to be the mimimum, all calculations were made to AWS. table 2.3.1.4 using 2t = R.

Per site investigations, Jeff Van Klompenburg, Ken Palmer and myself discovered some tubing on site (Diablo Canyon) has a minimum radius of 1½ t. Therefore, all welds of this type per this design group are not conservative.

Westinghouse-Through review of drawings issued, their designs are also in question.

2. PARTIAL AND FULL PENETRATION GROOVE WELDS DESIGN

Bechtel San Francisco-Per drawings supplied to field, very few if any are designed correctly. Symbols indicate complete joint welds. This is true for all joints requiring preparation. No angle for preparation has been indicated and it is not obvious that the designer is aware of the minimum joint requirements per AWS 2.3.12 and Fig. 2.10.1. However, on joints created by natural intersection of 2 members, it is obvious that the joint in many cases is a partial per AWS and not a full penetration weld due to angle created by intersecting members being to small for a full penetration weld to be made.

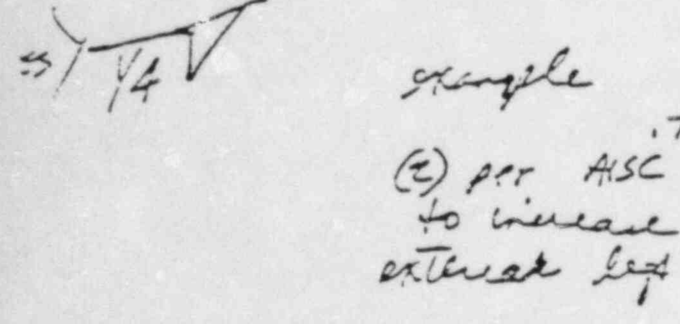
cont

C CStKer 7/5/83

3. SKEWED JOINT FILLET WELDS

Drawing representation Bechtel San Fran.
Per Dwg. are shown as fillet allaround for all angles. I'm sure no reduction was made for effective throat according to dihedral angle. [illegible]
I'm sure the calc [illegible] made [illegible] dihedral angle

Bechtel site one group has considered dihedral angle. To facilitate design, joint was sized assuming 90° fillet or a constant ~~effective~~ throat size. After sizing either 90 fillet leg or obtaining ~~effective~~ throat requirements for 90° joint then using dihedral angle the 2 non-90° sides were adjusted so that installed ~~effective~~ throat would be equivalent in SIZE thereby ~~satisfying~~ calculation.



(1) ASSUME 90° OBTAIN EFFECTIVE throat
(2) adjust exterior and interior leg [illegible]
Calculated considering dihedral angle adjustment.

example (1) obtain 1/4" fillet allaround or .707 (.25) EFFECTIVE throat
(2) per AISC + AWS reduce internal leg due to increase in effective throat and increase external leg to due to decrease in effective throat

Cont

C C Stiles 7/6/83:

2) 3) INSTALLATION AND QC inspection

All installation has been per Pullman's weld procedures. Per a copy obtained from Pullman QC and review, I found that the procedures are written state that they are for the installation [illegible] and pipe [illegible]. No [illegible] is made of their use in installation of pipe supports. All angles and joint details are written for pipe, no notes or other modifications are indicated for the use of these procedures for installing pipe support steel.

QC is supplied only with Pullman Procedures to inspect pipe supports has no means to verify the correct installation of the qualified joints per AWS or AISC. furthermore per ESD 223 they have been instructed to check some joints and not others. A joint formed by flare-bevel weld on all sides such as 2 tubes crossing does not require checking and per ESD 223 when the size of a flare-bevel is shown the method of measurement does not [illegible] determine the eff throat.

Per attachment I of ESD 223, no limitations are indicated for structural steel or tube dihedral angle. AWS gives mini. for structural steel as 30° and 15° for tube steel.

Per attachment J of ESD 223, of what use is S? Per AWS unless S = R, E can not be determined thru use of Table 2.3.1A. Also upon review of this attachment and Mark Michaels table of maximum radii of tube steel. It can be shown that attachment [illegible] exceed Mark Michaels table of Max. radii. It

Bechtel Site-One group has tried to comply with AWS. requirements in designating both S and E per 2.1.3 and 2.10.3.1 table 2.10.3 and Fig. 2.10.1 and the included dihedral angle either on preparation or by natural creation of members intersecting. However, Pullman QC have continually refused to check weld per call out because ESD does not provide them with a procedure for performing verification. They have required the (E) effective throat call out to be removed.

Westinghouse-See comments for Bechtel, San Francisco.

3. SKEWED JOINT FILLET WELDS DESIGN

Bechtel San Francisco-Per drawings supplied to field and continued use of fillet all around call out instead of a specific call out adjusting the leg size for the dihedral angle adjustment. It's obvious that the dihedral angle has not been considered in the joint design or if it was, it was done incorrectly.

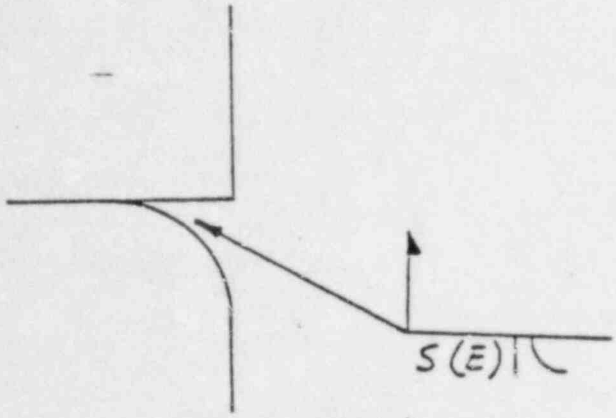
Bechtel Site-One group has tried to be consistent in adjusting the inner and outer fillet leg size based on dihedral angle so that the effective throat on all sides is the same. This allows the joint to be analyzed as though it is an equal leg fillet all around with only a leg adjustment to obtain this when welded. This is shown on drawing, so construction only has to make what is shown and not interpret what is shown using a table which is not usually at hand.

Westinhouse-See Bechtel San Francisco.

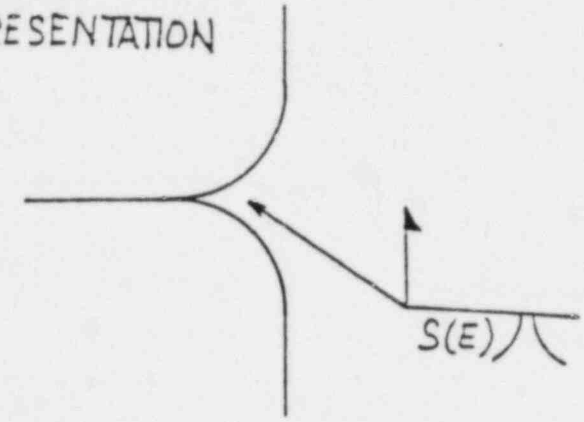
1. FLARE BEVEL AND FLARE-V GROOVE WELDS DRAWING REPRESENTATION

Bechtel San Francisco-No partial welds have been shown since S(E) have been omitted. AWS 2.1.3 and 2.10.3.1 and 2.10.3 state that (S) groove weld depth and (E) effective throat shall be specified on shop or working drawings. The hanger drawings sent to the field are both shop and working drawings. Also, M-9 states that only pre-qualified joints should be used on Diablo Canyon. Many in management contend that this job is not covered by AWS code. However, M-9 states that it is governed by AISC 7th, Ed.. In AISC section on welded joints, page 4-131, paragraph 4, AISC states that small deviations are possible per AW[illegible] and other joint forms and welding procedures may be employed provided th[illegible] are tested and qualified in accordance with AWS D1.1-72. Therefore, Diablo is gov[illegible]rned by AWS D1.1-72.

CORRECT DWG. REPRESENTATION



FLARE · BEVEL



FLARE -V

S=Radius of tube
E=Effective Throat per table 2.3.1.4 AWS

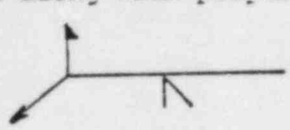
Bechtel Site-One group has complied with call outs above. However, Pullman QC per ESD 223 have required the removal of S (E) from all drawings. This was because the ESD does not provide a procedure for them to use to verify the welds above. The symbols left, after removal of S (E) indicate full penetration welds even though, QC states this is not the case.

Westinghouse-See Bechtel San Francisco.

2. PARTIAL AND FULL PENETRATION GROOVE WELDS DRAWING REPRESENTATION

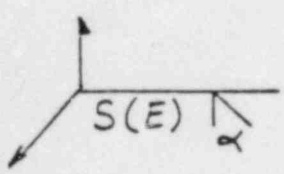
Bechtel San Francisco-No partial welds are shown since S(E) call outs have been omitted along with preparation angle. Primary weld used is bevel.

Now indicated



Per AWS this is a full penetration weld.

Should show



With consideration given to AWS section 2.3.1.3 in specifing S(E) and

Bechtel Site-One group on site has tried to comply with the above call out per AWS 2.3.1.3. However, they have meet continued resistance from QC in that the weld specs used for installation were written for piping per AWS chapter 10, Fig. 10.13.1.1A is 37½° differs from the prep angles for structural steel specified in Fig. 2.9.1 and 2.10.1, which usually indicate a minimum angle of 45°.

Westinghouse-See Bechtel San Francisco Comments.

3. SKEWED JOINT FILLET WELDS DRAWING REPRESENTATION

Bechtel San Francisco-Per Drawings are shown as fillet all around for all angles. Per AWS fillets are limited to a minimum dihedral angle of 60° and a maximum external dihedral angle of 135°. All fillet made beyond these angles are considered partial penetration welds since AWS requires a reduction of effective throat of 1/8" when angle is less than 60° and greater than 45° and ¼" reduction when less than 45° but greater than 30°. 30° is the minimum dihedral angle for structural steel except tube steel which has a minimum angle of 15°. Per ESD 223 the leg is adjusted for dihedral angle but no increase has been added to account for throat reduction required by design resulting in adequate effective throats per AISC and AWS.

Bechtel Site-One group has considered dihedral angle. To facilitate design, joint was sized assuming a constant effective throat size. After sizing effective throat requirements then using dihedral angle the 2 non 90° sides were adjusted so that the installed effective throats would be correct per design. Fillets are not called out when dihedral angles are less than 60°. Partial penetration welds are shown.

1)2)3) INSTALLATION AND QC INSPECTION

All installation has been made per Pullman's weld procedures. Per a copy obtained from Pullman QC of these procedures. These procedures as written state that they are for the installation of pipe and pipe attachments. No mention is made of their use in installation of pipe supports. All prep angles and joint details are written for pipe, no notes or modifications are indicated for their use in installing pipe support steel. QC has been supplied with these procedures and ESD 223 to inspect pipe support welds. They have been supplied no information as to the correct installation of pre-qualified joints per AISC or AWS. Furthermore, per ESD 223, they have been instructed to check some weld joints and not others.

A joint formed by flare-bevel or flare-v welds on all sides such as 2 tubes crossing does not require checking and per ESD 223 when the size of a flare-bevel or flare-v is shown, the method of weld measurement per ESD 223 does not supply the effective throat or any dimension which can be used to determine the effective throat.

Per attachment I of ESD 223, no limitation are indicated for structural or tube steel dihedral angles. AWS gives the minimum dihedral angle 30° for structural and 15° for tube steel. Also no throat increase is included to compensate for required throat reductions based on dihedral angle per AWS 2.3.1.3.

Per attachment J of ESD 223, of what use is the measurement of S ? Per AWS unless S=R. R=Radius of tube, E can not be determined through use of table 2.3.1.4. Also upon review of this attachment and table of maximum radii of tube steel in paper by Mark Michaels, it can be shown that table J was and is based upon the maximum radius and not the minimum resulting in a non-conservative design.

ACTION TAKEN: and Engineer. The resolution of this issue was monitored by Project QA. See chron No's 023208, 024230, 031964 and 033851 plus attached QA " Work plan and log" sheets in which no discrepancy was noted.

{12}

BECHTEL WORK PLAN AND LOG

1 JOB NUMBER	2 PERIOD FROM TO	3 ASSIGNED DAE
15320	6-27 TO 7-8-83	J.W. CARSON

4. ITEM NO.	5 ACTIVITY	6. REFERENCE(S)	8 DATE CMPT
#1	MONITORING ACTIVITY - DESIGN DEFICIENCY TREND ANALYSIS	QADM, SEC. C. NO. 20 REV. 0	CONTINUE
#2	MONITORING ACTIVITY - PREPARE/VERIFY RESPONSES TO MANAGEMENT AUDIT OF-317.	QADM, SEC. B. NO. 7, REV. 5	CONTINUE
#3	MONITORING ACTIVITY - FOLLOW UP ON MEMO CRON 23208 DATED 6-10-83	QADM, SEC. C. NO. 1, REV. 1.	CONTINUE

NOTE: REFER TO ABOVE ITEM NUMBER WHEN MAKING ADDITIONAL COMMENTS BELOW

7. COMMENTS ON ITEMS ABOVE:

#1. NO TRENDS IDENTIFIED THIS REPORTING PERIOD.

#2. THIS MONTHS STATUS REPORT TO BE PREPARED BY P. HORNBECK.

#3 UNIT #2 IS COMPLETE WITH NO DISCREPENCIES. UNIT #1 MATERIAL TURNED OVER TO M. GUZMAN.

DCN'S REVIEWED FOR UNIT #2 - 412-8R-6716, REV. 0, 412-13SL-6718, REV. 0, 412-25SL-6881, REV. 0, 412-37SL-8112, REV. 0, 412-53SL-8254, REV. 0, 412-63SL-12121, REV. 0, 412-70SL-8673, REV. 0, 412-77SL-12124, REV. 0, 412-142SL-10135, REV. 0, 412-146R-8853, REV. 0, 413-26R-10257, REV. 0, 413-29SL-8045, REV. 0, & 414-2ESL-6663, REV. 1.

9 SIGNATURE: [signature] DATE 7-8-83

10 REVIEWED BY DATE

BECHTEL

WORK PLAN AND LOG

1 JOB NUMBER	2 PERIOD FROM	TO	3 ASSIGNED QAE
15320	8/15/83	8/26/83	Manuel G. Guzman

4 ITEM NO.	5. ACTIVITY	6. REFERENCE(S)	8. DATE CMPT
1	monitoring activity per memo (Chron 23268H dated 6/10/83) on pipe support weld requirement for AISC	QADM SECT C NO 1 REV 1	8/26/83
2.	U-Bolt calculation verification	QADM SECT C NO 1 REV 1	8/26/83
3.	Engineering Audit 3.2-4 - Design Calculation Unit 2	NQAM VI-1	continuing

NOTE: REFER TO ABOVE ITEM NUMBER WHEN MAKING ADDITIONAL COMMENTS BELOW

7. COMMENTS ON ITEMS ABOVE:

1 — Unit No 1 is complete with no discrepancies. Pipe supports REVIEWED for Unit 1 were the ff: 56N-131R REV 4, 235-136R REV 1, 12-180SL REV. 0, 98-150A REV 3, 10-117SL REV 3, 2-21R REV 2, 10-28SL REV 4, 13-46SL REV 2, 99-6R REV 0.

2 — Verified that calculation S-2 File No 52.23.1 titled All rod. & U-Bolt Pipe whip restraint was approved as revision 0 on 6/13/83.

3 — To be continued in the next time period.

SIGNATURE	DATE	10 REVIEWED BY	DATE
Manuel G. Guzman	8/31/83	M. J. Encedon	9-1-83

PACIFIC GAS AND ELECTRIC COMPANY
ENGINEERING DEPARTMENT

DISCREPANCY REPORT

Control Number
8 3 - 9 4 2 - 5

PROJECT OR PLANT(S): Diablo Canyon Unit 1 & 2

ORGANIZATION AFFECTED: Pipe Support Design Engineering

INDIVIDUAL RESPONSIBLE FOR RESOLUTION: G.V.Cranston Project Engineer

SUBJECT (ITEM/ACTIVITY): Unbraced Length of Angles

REFERENCES: AISC 7th edition Section 1.5.1.4.6b See attached underlined copy of AISC.

DISCREPANCY: Many angle members used to build pipe supports exceed the maximum length for which the allowable bending stress may be taken as .6(Fy)

PROPOSED ACTION: These members should be modified by boxing or bracing at critical compression points to comply with AISC or the allowable bending stress reduced and Interaction Equations reverified.

SCHEDULED COMPLETION:

Initiated by: Charles C. Stokes Date: 10/5/83 original signed 8/9/83

Approved by: M C Lyde Date: 10/7/83

ACTIONS TAKEN: A list of 18 supports identified by C.Stokes as discrepant were evaluated for bending stress and all found to be acceptable based upon SFPSM 3.10.1 Rev 0. This procedure makes use of mathematical (see page 2)

CLOSED
Approved by: R.C. Iman Date: 10-7-83

Concur* C.L.S Date: 10/7/83
Chief, Engineering Quality Control

expressions providing more exact estimates of buckling strength see commoentary on paragraph H 1.5.1.4.6 in A ISC manual. See attached excerpts of A I.S.C code and letter P. Schurer.

...sed in the gas metal-arc process shall con-
...d Steel Electrodes for Gas Metal-Arc Welding,
...he provisions of Sect. 1.17.3; E60T or E70T
...d-arc process shall conform to the Specifica-
...for Flux-Cored-Arc Welding, AWS A5.20,
... of Sect. 1.17.3.
...n shall constitute sufficient evidence of con-

...E STRESSES*

...s. 1.6, 1.7, 1.10, 1.11 and in Part 2, all com-
...be so proportioned that the stress, in kips
...ed the following values, except as they are

...at pin holes:

$F_t = 0.60F_y$

...e minimum tensile strength of the steel.
...es in eyebars, pin-connected plates or built-

$F_t = 0.45F_y$

...ts see Table 1.5.2.1.

$F_v = 0.40F_y$

...d and fabricated shapes may be taken as
... and the thickness of the web. See Sect.
...n webs. For discussion of high shear stress
...nections of members whose webs lie in a
... Sect. 1.5.1.2.)

...tion of axially loaded compression members
...enderness ratio of any unbraced segment as
... C_c:

$$\frac{\left[1 - \frac{(Kl/r)^2}{2C_c^2}\right]F_y}{\frac{5}{3} + \frac{3(Kl/r)}{8C_c} - \frac{(Kl/r)^3}{8C_c^3}} \qquad (1.5\text{-}1)$$

$$= \sqrt{\frac{2\pi^2 E}{F_y}}$$

...merical values for various grades of steel corre-

1.5.1.3.2 On the gross section of axially loaded compression members when Kl/r exceeds C_c:

$$F_a = \frac{12\pi^2 E}{23(Kl/r)^2} \qquad (1.5\text{-}2)$$

1.5.1.3.3 On the gross section of axially loaded bracing and secondary members, when l/r exceeds 120*:

$$F_{as} = \frac{F_a \text{ (by Formula (1.5-1) or (1.5-2))}}{1.6 - \frac{l}{200r}} \qquad (1.5\text{-}3)$$

1.5.1.3.4 On the gross area of plate girder stiffeners:

$$F_a = 0.60F_y$$

1.5.1.3.5 On the web of rolled shapes at the toe of the fillet (crippling, see Sect. 1.10.10):

$$F_a = 0.75F_y$$

** 1.5.1.4 Bending

← 1.5.1.4.1 Tension and compression on extreme fibers of compact hot-rolled or built-up members (except hybrid girders and members of A514 steel) symmetrical about, and loaded in, the plane of their minor axis and meeting the requirements of this section:

$$F_b = 0.66F_y$$

In order to qualify under this section a member must meet the following requirements:

a. The flanges shall be continuously connected to the web or webs.
b. The width-thickness ratio of unstiffened projecting elements of the compression flange, as defined in Sect. 1.9.1.1, shall not exceed $52.2/\sqrt{F_y}$.
c. The width-thickness ratio of stiffened elements of the compression flange, as defined in Sect. 1.9.2.1, shall not exceed $190/\sqrt{F_y}$.
d. The depth-thickness ratio of the web or webs shall not exceed the value

→ Supplement No. 1

$$d/t = 412\left(1 - 2.33\frac{f_a}{F_y}\right)/\sqrt{F_y} \qquad (1.5\text{-}4)$$

except that it need not be less than $257/\sqrt{F_y}$.
e. The compression flange shall be supported laterally at intervals not to exceed $76.0b_f/\sqrt{F_y}$ nor $\frac{20{,}000}{(d/A_f)F_y}$.

Except for hybrid girders and members of A514 steel, beams and girders (including members designed on the basis of composite action) which meet the requirements of sub-paragraphs a, b, c, d and e above and are continuous over supports or are rigidly framed to columns by means of rivets,

* For this case K is taken as unity.

proportioned for $^{9}/_{10}$ of the negative
which are maximum at points of
ers, the maximum positive moment
negative moments. This reduction
loading on cantilevers. If the nega-
dly framed to the beam or girder, the
oning the column for the combined
hat the stress, f_a, due to any con-
not exceed $0.15F_a$.

girders and members of A514 steel)
1.5.1.4.1, except that $b_f/2t_f$ exceeds
may be designed on the basis of an

$$014 \left(\frac{b_f}{2t_f}\right) \sqrt{F_y}\Big] \qquad (1.5\text{-}5)$$

ion on extreme fibers of doubly-
meeting the requirements of Sect.
bent about their minor axes (except
d square bars; and solid rectangular

$75F_y$

on on extreme fibers of box-type
ange or web width-thickness ratio
1.5.1.4.1 but does conform to the
mpression flange is braced laterally
s the transverse distance out-to-out

$0F_y$

s of flexural members not covered in
1.4.4:

$60F_y$

me fibers of flexural members in-
axis of symmetry in, and loaded in,
on extreme fibers of channels* bent
computed by Formulas (1.5-6a) or
ess a higher value can be justified
but not more than $0.60F_y$.

10^3C

r_T 10^3C_b F_y (1.5-6a)

...als.

1.4.6, last two paragraphs.

When $\quad l/r_T \geq \sqrt{\dfrac{510 \times 10^3 C_b}{F_y}}$

$$F_b = \frac{170 \times 10^3 C_b}{(l/r_T)^2} \qquad (1.5\text{-}6b)$$

Or, when the compression flange is solid and approximately rectangular in cross-section and its area is not less than that of the tension flange

$$F_b = \frac{12 \times 10^3 C_b}{ld/A_f} \qquad (1.5\text{-}7)$$

In the foregoing,

l = distance between cross-sections braced against twist or lateral displacement of the compression flange

r_T = radius of gyration of a section comprising the compression flange plus one-third of the compression web area, taken about an axis in the plane of the web

A_f = area of the compression flange

C_b = $1.75 + 1.05 (M_1/M_2) + 0.3 (M_1/M_2)^2$, but not more than 2.3*, where M_1 is the smaller and M_2 the larger bending moment at the ends of the unbraced length, taken about the strong axis of the member, and where M_1/M_2, the ratio of end moments, is positive when M_1 and M_2 have the same sign (reverse curvature bending) and negative when they are of opposite signs (single curvature bending). When the bending moment at any point within an unbraced length is larger than that at both ends of this length, the value of C_b shall be taken as unity. C_b shall also be taken as unity in computing the value of F_{bx} and F_{by} to be used in Formula (1.6-1a). See Sect. 1.10 for further limitation in plate girder flange stress.

For hybrid plate girders, F_y for Formulas (1.5-6a) and (1.5-6b) is the yield stress of the compression flange. Formula (1.5-7) shall not apply to hybrid girders.

1.5.1.4.6b Compression on extreme fibers of flexural members included under Sect. 1.5.1.4.5, but not included in Sect. 1.5.1.4.6a:

Suppl N°1

$$F_b = 0.60F_y$$

provided that sections bent about their major axis are braced laterally in the region of compression stress at intervals not exceeding $76.0b_f/\sqrt{F_y}$.

∠2 L ≤ 25.33"   ∠3 L ≤ 38"   ∠4 L ≤ 50.67"

1.5.1.5 Bearing (on contact area)

1.5.1.5.1 Milled surfaces, including bearing stiffeners and pins in reamed, drilled, or bored holes:

$$F_p = 0.90F_y{}^{**}$$

* C_b can be conservatively taken as unity. For smaller values see Appendix A, Fig. A1, p. 5-104.

** When parts in contact have different yield stresses, F_y shall be the smaller value.

Supplement No 1

1.5.1.4 Bending

1.5.1.4.1 Delete subparagraph d in its entirety and substitute the following:

"d. The depth-thickness ratio of the web or webs shall not exceed the value given by Formulas (1.5-4a) or (1.5-4b) as applicable.

$$\frac{d}{t} = \frac{412}{\sqrt{F_y}}\left(1 - 2.33\frac{f_a}{F_y}\right) \text{ when } \frac{f_a}{F_y} \leqslant 0.16 \quad (1.5\text{-}4a)$$

$$\frac{d}{t} = \frac{257}{\sqrt{F_y}} \quad \text{when } \frac{f_a}{F_y} > 0.16 \quad (1.5\text{-}4b)\text{"}$$

1.5.1.4.2 Immediately following the words "of Sect. 1.5.1.4.1" add a comma and immediately following the words "except that $b_f/2t_f$" delete the comma.

Change formula number "(1.5-5)" to "(1.5-5a)".

1.5.1.4.3 Add a second paragraph as follows:

"Doubly-symmetrical I- and H-shape members bent about their minor axis (except hybrid girders and members of A514 steel) meeting the requirements of Sect. 1.5.1.4.1, subparagraph a, except where $b_f/2t_f$ exceeds $52.2/\sqrt{F_y}$ but is less than $95.0/\sqrt{F_y}$, may be designed on the basis of an allowable bending stress

$$F_b = F_y\left[0.933 - 0.0025\left(\frac{b_f}{2t_f}\right)\sqrt{F_y}\right] \quad (1.5\text{-}5b)\text{"}$$

1.5.1.4.6a Immediately following the words "under Sect. 1.5.1.4.5," add: "and meeting the requirements of Sect. 1.9.1.2,".

1.5.1.4.6b Immediately following the words "under Sect. 1.5.1.4.5," add: "and meeting the requirements of Sect. 1.9.1.2,".

SECTION 1.10 PLATE GIRDERS AND ROLLED BEAMS

1.10.5 Stiffeners

1.10.5.3 In the third paragraph, immediately following the words "holes shall be such that", delete: "the smaller panel dimension, a or h, shall not exceed $348t/\sqrt{f_v}$" and substitute the words "f_v does not exceed the value given by Formula (1.10-1)".

SECTION 1.11 COMPOSITE C

1.11.2 Design Assumptions

1.11.2.2 At the beginning of "For construction without tempo modulus of the transformed comp (referred to the bottom flange of th stitute the following:

"For construction without tem stress may be computed from the t formed section modulus S_{tr}, except shall not exceed that of Formula (1 appropriate value of Sect. 1.5.1."

SECTION 1.15 CONNECTIONS

1.15.5 Restrained Members

In the first line of the second strained".

SECTION 1.23 FABRICATION

1.23.1 Straightening Material

Delete this subhead and the ent the words "Rolled material", and sub reading as follows:

"1.23.1 Cambering, Curving, an

The local application of heat or troduce or correct camber, curvatur of heated areas, as measured by appr for A514 steel nor 1200°F for other ste

1.23.6 Welded Construction

In Table 1.23.6, for thickness "T the heading "Welding Process", chan

$F_v = $ [illegible] $- 1.6 f_t \leq 20.0$

$F_v = $ [illegible] $- 1.6 f_t \leq 27.0$

...stress area $F_t = $ [illegible] $- 1.6 f_t \leq 20.0$

...reaming-

$F_t = 50.$[illegible] $- 1.6 f_t \leq 40.0$

...ype joints $F_t = 70.0 - 1.6 f_t \leq 54.0$

...y the same forces, shall not exceed the

...oints, the shear stress allowed in Sect.

$F_v \leq 15.0(1 - f_t A_b / T_b)$

$F_v \leq 20.0(1 - f_t A_b / T_b)$

...due to a direct load applied to all of the ...ecified pretension load of the bolt.

... CONNECTIONS SUBJECT TO ...LATION OF STRESS (FATIGUE)

...tion, is defined as the damage that may ...umber of fluctuations of stress. Stress ...f these fluctuations. In the case of a ...e computed as the numerical sum of ...ressive stresses or the sum of maximum ...tion at a given point, resulting from

... conventional buildings need to be de- ...anges in such structures occur only a ... only minor stress fluctuations. The ...earthquake loads is too infrequent to ...n. However, crane runways and sup- ...l equipment are often subject to fatigue.

...s subject to fatigue loading as defined ... to satisfy the stress range limitations

... SLENDERNESS RATIOS

... for the structure as a whole and for

...ratio of an axially loaded compression ...1.5.1.3.3, the length shall be taken as its ...sponding radius of gyration.

1.8.2 Sidesway Prevented

In frames where lateral stability is provided by adequate attachment to diagonal bracing, shear walls, an adjacent structure having adequate lateral stability, or to floor slabs or roof decks secured horizontally by walls or bracing systems parallel to the plane of the frame, and in trusses, the effective length factor, K, for the compression members shall be taken as unity, unless analysis shows that a smaller value may be used.

1.8.3 Sidesway Not Prevented

In frames where lateral stability is dependent upon the bending stiffness of rigidly connected beams and columns, the effective length Kl of compression members, shall be determined by a rational method and shall not be less than the actual unbraced length.

1.8.4 Maximum Ratios

The slenderness ratio, Kl/r, of compression members shall not exceed 200.

The slenderness ratio, Kl/r, of tension members, other than rods, preferably should not exceed:

For main members 240

For bracing and other secondary members 300

SECTION 1.9 WIDTH-THICKNESS RATIOS

1.9.1 Unstiffened Elements Under Compression

1.9.1.1 Unstiffened (projecting) compression elements are those having one free edge parallel to the direction of compression stress. The width of unstiffened plates shall be taken from the free edge to the first row of fasteners or welds; the width of legs of angles, channel and zee flanges, and stems of tees shall be taken as the full nominal dimension; the width of flanges of I-shape members and tees shall be taken as one-half the full nominal width. The thickness of a sloping flange shall be measured halfway between a free edge and the corresponding face of the web.

* 1.9.1.2 Unstiffened elements subject to axial compression or compression due to bending shall be considered as fully effective when the ratio of width to thickness is not greater than the following:

b/t

Single-angle struts; double-angle struts with separators . . . . $76.0/\sqrt{F_y}$

Struts comprising double angles in contact; angles or plates projecting from girders, columns or other compression members; compression flanges of beams; stiffeners on plate girders . . . . $95.0/\sqrt{F_y}$

Stems of tees . . . . $127/\sqrt{F_y}$

When the actual width-to-thickness ratio exceeds these values, the design stress shall be governed by the provisions of Appendix C.

L's T's Z's etc.

1.5.1.4.4. Box-type members are torsionally very stiff.* The critical flexural stress due to lateral-torsional buckling for the compression flange of a box-type beam loaded in the plane of its minor axis so as to bend about its major axis can be obtained using Formula (1.5-[illegible]) with an equivalent slenderness ratio by the expression

$$\left(\frac{l}{r}\right)_{equiv} = \sqrt{\frac{5.1lS_x}{\sqrt{JI_y}}}$$

where l is the distance between points of lateral support and S_x, I_y and J are respectively the major axis section modulus, minor axis moment of inertia and the torsional constant of the beam cross-section. It can be shown that when $d < 10b$ and $l/b < 2{,}500/F_y$, the allowable compression flange stress indicated by the above equation will approximate $0.60F_y$. Beyond this limit deflection rather than stress is likely to be the design criterion.

1.5.1.4.5 and 1.5.1.4.6 The allowable bending stress for all other flexural members is given as $0.60F_y$, provided the compression flange is braced laterally at relatively close intervals ($l/b_f \leq 76.0/\sqrt{F_y}$).

Members bent about their major axis and having an axis of symmetry in the plane of loading may be adequately braced laterally at greater intervals if the maximum bending stress is reduced sufficiently to prevent premature buckling of the compression flange. Mathematical expressions affording an exact estimate of the buckling strength of such members, which [illegible] their torsional rigidity about their longitudinal axis (St. Venant torsion) as well as the bending stiffness of their compression flange between points of lateral support (warping torsion), are too complex for [illegible]. Furthermore, their accuracy is dependent upon the [illegible] regarding restraint at points of lateral support and [illegible] which, at best, can be no more than engineering judgments.

[illegible] Formulas (1.5-6a) or (1.5-6b) and (1.5-7) provides [illegible] in more convenient form.

[illegible] Formula (4) of the 1963 edition of the Specification, Formulas (1.5-6a) and (1.5-6b) are based on the assumption that only the bending stiffness of the compression flange will prevent the lateral displacement of that element between bracing points. The new Formulas (1.5-6a) and (1.5-6b) differ from the earlier Formula (4) in two ways:

1. Whereas the earlier provisions required no stress reduction when l/r was less than 40 (regardless of yield stress value) and then a reduction to the value obtained from the parabolic expression, the new formulas, by increasing F_b at $l = 0$ from $0.60F_y$ to $2F_y/3$, provides a continuous stress relationship with the unbraced length when F_b is reduced from the maximum permissible value of $0.60F_y$.
2. Whereas the earlier single Formula (4) applied even in the range of elastic buckling stress (on the assumption that Formula (5) would [illegible]), the replacement of Formula (4) is liberalized in [illegible] the addition of an Euler-type expression, since this [illegible] correct.

* [illegible] Guide to Design Criteria for Metal Compression [illegible] 4.2.

Formula (1.5-7) is a convenien[illegible] ence of both lateral bending resist[illegible] Due to the difference between fla[illegible] girder, it is desirable to base the lat[illegible] torsion of the flange. Hence, use of [illegible] members. Its agreement with m[illegible] strength of intermittently braced f[illegible] neous sections having substantial re[illegible] in the case of doubly-symmetrical s[illegible]

For some sections having a co[illegible] than the tension flange area, Formu[illegible] its use is limited to sections whos[illegible] great as the tension flange. In pl[illegible] higher d/A_f ratio than rolled W sha[illegible] the conservative side. For such [illegible] Formula (1.5-6a) and, at times by [illegible] mate of buckling strength. While [illegible] strength somewhat because they ig[illegible] the profile, this rigidity for such sec[illegible] of overconservatism, therefore, is li[illegible]

It should be noted that Formu[illegible] expressions it replaces, is written fo[illegible] tion is not provided for this formu[illegible] when actual conditions of load appl[illegible] are considered, any unconservative [illegible]

Singly-symmetrical, built-up, [illegible] girders, often have an increased co[illegible] bending due to lateral loading actio[illegible] Such members usually can be propo[illegible] stress when that stress is produced [illegible] loading. Where the failure mode c[illegible] having a larger compression than ten[illegible] the permissible bending stress can [illegible] or (1.5-7).

Through the introduction of th[illegible] stress is permissible when there is mo[illegible] except where, in the case of combin[illegible] adjustment is provided by the facto[illegible]

Formulas (1.5-6a) and (1.5-6b[illegible] Venant and warping torsion by su[illegible] equivalent radius of gyration. [illegible] priate expression giving the critical e[illegible] flange of a beam† with that of an ax[illegible]

* Column Research Council Guide [illegible] Members, Second Edition, Eq. 4.5.

** Ibid., Eq. 4.10

† Ibid., Eqs. (4.9), (4.20), (4.21) [illegible]

‡ Ibid., Eq. 2.3

Formula (1.5-7) is a convenient approximation which assumes the presence of both lateral bending resistance and St. Venant torsional resistance. Due to the difference between flange and web yield strength of a hybrid girder, it is desirable to base the lateral buckling resistance solely on warping torsion of the flange. Hence, use of Formula (1.5-7) is not permitted for such members. Its agreement with more exact expressions for the buckling strength of intermittently braced flexural members* is closest for homogeneous sections having substantial resistance to St. Venant torsion, identifiable in the case of doubly-symmetrical sections by a relatively low d/A_f ratio.

For some sections having a compression flange area distinctly smaller than the tension flange area, Formula (1.5-7) may be unconservative; hence, its use is limited to sections whose compression flange area is at least as great as the tension flange. In plate girders, which usually have a much higher d/A_f ratio than rolled W shapes, Formula (1.5-7) may err grossly on the conservative side. For such members the larger stress permitted by Formula (1.5-6a) and, at times by Formula (1.5-6b), affords the better estimate of buckling strength. While these latter formulas underestimate this strength somewhat because they ignore the St. Venant torsional rigidity of the profile, this rigidity for such sections is relatively small and the margin of overconservatism, therefore, is likewise small.

It should be noted that Formula (1.5-7), like the more precise, complex expressions it replaces, is written for the case of elastic buckling. A transition is not provided for this formula in the inelastic stress range because, when actual conditions of load application and variation in bending moment are considered, any unconservative error without it must be small.

Singly-symmetrical, built-up, I-shape members, such as some crane girders, often have an increased compression flange area in order to resist bending due to lateral loading action in conjunction with the vertical loads. Such members usually can be proportioned for the full permissible bending stress when that stress is produced by the combined vertical and horizontal loading. Where the failure mode of a singly-symmetrical I-shape member having a larger compression than tension flange would be by lateral buckling, the permissible bending stress can be obtained by using Formula (1.5-6a) or (1.5-7).

Through the introduction of the modifier** C_b, some liberalization in stress is permissible when there is moment gradient over the unbraced length except where, in the case of combined bending and axial compression, this adjustment is provided by the factor C_m in Formula (1.6-1a).

Formulas (1.5-6a) and (1.5-6b) may be refined to include both St. Venant and warping torsion by substituting a derived value for r_T. This equivalent radius of gyration, $r_{T equiv}$, can be obtained by equating the appropriate expression giving the critical elastic bending stress for the compression flange of a beam† with that of an axially loaded column.‡

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* Column Research Council Guide to Design Criteria for Metal Compression Members, *Second Edition, Eq. 4.5.*

** Ibid., *Eq. 4.13.*

† Ibid., *Eqs. (4.9c), (4.30), (4.31) or (4.32).*

‡ Ibid., *Eq. (2.2).*

For the case of a doubly-symmetrical I-shape beam,

$$r_{T\,equiv} = \frac{I_y}{2S_x}\sqrt{d^2 - \frac{0.156L^2J}{I_y}}$$

where I_y is the minor axis moment of inertia of the member, S_x is its major axis section modulus, and

$$J = \frac{2bt_f^3}{3} + \frac{dt_w^3}{3}$$

1.5.1.5 Bearing

1.5.1.5.1 As used throughout the Specification the terms "milled surface," "milled" or "milling" are intended to include surfaces which have been accurately sawed or finished to a true plane by any suitable means. The recommended bearing stress on pins is not the same as for rivets. The lower value, nine-tenths of the yield stress of the part containing the pin hole, provides a safeguard against instability of the plate beyond the hole,* which is considerably larger than a rivet hole.

1.5.2 Rivets, Bolts, and Threaded Parts

1.5.2.1 Tension

As in earlier editions, permissible stresses for rivets are given in terms applicable to the nominal cross-sectional area of the rivet before driving. For greater convenience in the proportioning of high strength bolted connections, permissible stresses for the bolts are given in terms applicable to their nominal body area, i.e., the area of the unthreaded shank. However, for A307 bolts (which are available in sizes up to 4 in. in diameter) and threaded parts other than high strength bolts, the allowable tensile stress is applicable to a stress area equal to 0.7854 (D − 0.9743/n)². This area, intermediate between gross area and area at the root of the thread, when multiplied by the mechanical properties of the unthreaded material, has been found to more closely predict the tensile strength of larger diameter threaded parts, such as might be used for anchor bolts or upset rods.

In recognition of the protection against notch effect in the threading, assured by the required initial tightening of high strength bolts, the Research Council on Riveted and Bolted Structural Joints has recommended a relatively higher working stress in tension for high strength bolts.

Any additional fastener tension resulting from prying action due to distortion of the connection details should be added to the stress calculated directly from the applied tension in proportioning fasteners for an applied tensile force, using the specified working stresses. Depending upon the relative stiffness of the fasteners and the connection material, this prying action may be negligible or it may be a substantial part of the total tension in the fasteners.**

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* Johnston, B. G. ... Connected Plate Links. 1939 ASCE Transactions.

** Munse, W. H. ... Research on Bolted Connections. 1956 ASCE Transactions, ... 1222

1.5.2.1 Shear

Connections which transmit load ...
are categorized as "friction-type" or ...
upon sufficiently high clamping force ...
The latter depend upon contact of t...
holes to transfer the load from one co...

The amount of clamping force de...
cooling and by A307 bolts is unpredict...
vent complete slippage at the permis...
connections and connections made wit...
bearing-type. The high clamping forc...
strength bolts is sufficient to prevent ...
equal number of these bolts are substi...
would be required to transmit a given ...
rivets and A490 bolts for A502 Grade ...

The efficiency of threaded fasten...
connections is reduced when the thr...
between the connected parts. In the c...
able shear stress values are given: one ...
shear plane and one where it is not. ...
this feature in the case of A307 bolts, ...
tend into the shear plane and the all...
gross area, is reduced accordingly.

1.5.2.2 Bearing

Bearing values are provided, not a...
it needs no such protection, but as an ...
computed in accordance with Sect. 1.1...
assembled with rivets or with bolts, re...
the presence or absence of threads in ...
joints* have shown that the tensile str...
paired when the bearing pressure of ...
fastener is as much as $2\frac{1}{4}$ times the te...
of the part. In this investigation the ...
according to the usual convention, as t...
eter and thickness of the connected p...
tween single-shear bearing and enclos...
the recommended working stress is t...
shear bearing, and approximately eq...
stress recommended for determining re...

1.5.3 Welds

As in the past, the allowable work...
penetration welds are the same as the ...
vided the mechanical properties of the ...
or exceed those of the weakest struct...

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* Jones, Jonathan. Effect of bearing ... 1958 ASCE Transactions.

ATTACHMENT 1

INTEROFFICE MEMORANDUM

Diablo Canyon Project

PACIFIC GAS AND ELECTRIC COMPANY
BECHTEL POWER CORPORATION

To M. Leppke

From T. Schurer

Of Insite Project Engineering Group

Date September 27, 1983

File No 925

Subject Slenderness Ratio Review

Per your request, the following hangers were reviewed for compliance with AISC, 7th Ed. 1.5.1.4.6b. Supporting documents used in this review are SFPSM-3.10.1, computer program "Strudl," and Kleinlogal:

Hanger #	Remarks
51-8R	Analysis per Kleinlogal. IAC: .069 ∴ Acceptable
46-20	Analysis per Strudl. Worst IAC: 0.63 ∴ Acceptable
2182-41	Identical to Hgr. #2182-45 with lower loading.
10/77SL	Analysis per Strudl. Worst IAC: 0.57 ∴ Acceptable
2182-4	Identical to Hgr. #2182-45 with lower loading.
	Worst IAC: 0.81 ∴ Acceptable
2182-69	From MP-175, Max. total stress is 4510 P.S.I., Max.all.Fa=7980, Max.all.Fb=7200 ∴ Acceptable
2182-3	Analysis per Strudl. All members passed code check ∴ Acceptable
2182-97	From MP-289, Max. total stress is 8666 P.S.I., Max.all.Fa=9350, Max.all.Fb=8820 ∴ Acceptable
2182-96	Max unbraced length < Lu. ∴ Acceptable

S98-0337

Hanger #	Remarks
2153-13	Analysis per Strudl. All members passed code check ∴ Acceptable
65-13	Unbraced length < Lu ∴ Acceptable
46-3	Analysis per Strudl. All members passed code check ∴ Acceptable
2151-84	Acceptable in comparison with Hgr. 2151-58.
2151-186	Analysis per Strudl. All members passed code check ∴ Acceptable.
[illegible]	[illegible] [illegible] ∴ Acceptable.
2151-58	Analysis per Strudl. Max IAC: 0.84 ∴ Acceptable

The only hanger not reviewed was 56N-13R which was qualified by the home office and should, therefore, be acceptable against the above criteria.

In conclusion then, all above 18 hangers are in compliance with AISC, 7th Ed. 1.5.1.4.6b. The work copy for the above qualification is hereby transmitted to file.

Thank you,

P. Schurer

P.Schurer/jb

Reply Requested: No

cc: R.G.Cman w/o
[redacted]
File w/a