Lawrence Livermore National Laboratory

December 13, 1984
WOW: 85-06

Mr. Paul P. Narbut
U.S. Nuclear Regulatory Commission
1450 Maria Lane, Suite 210
Walnut Creek, California 94596

Subject: PALO VERDE UNIT 1, DESIGN CONTROL INSPECTION -- FIN A0753, TECHNICAL ASSISTANCE FOR INSPECTION OF REACTORS UNDER CONSTRUCTION, TASK 2, SUBTASK 3.

The attached report fulfills the requirements for paragraph 3.2.2.3 of the Statement of Work for the subject FIN. The objective was to conduct an inspection of the administrative control system for as-built plant drawings and related documents to verify that the as-built conditions observed at the site are properly reflected in these documents and the supporting design calculations.

The report identifies several discrepancies in the system from a relatively small sampling. As a consequence, the applicant, Arizona Public Service Co., has initiated an immediate response to many items to minimize any adverse impact upon the schedule for fuel loading. Lawrence Livermore National Laboratory is to assist the staff in evaluating the effectiveness of this effort as a follow on to the original work statement.

W.O. Wade

WALLACE O. WADE
MECHANICAL ENGINEERING DEPARTMENT

WOW:cog

"ATTACHMENT TO NRC INSPECTION REPORTS 50-528/84-48, 50-529/84-41, 50-530/84-31"

Licensee: Arizona Public Service Co.
P. O. Box 21666
Phoenix, Arizona 85036

Facility Name: Palo Verde Unit 1

Inspection at: Bechtel-Norwalk and Site

Inspection conducted: September 24 to October 3, 1984

Inspection Team: C. H. Morton — C. H. Morton — 12-11-84 — Date Signed

C. B. Simkins — C. B. Simkins — 12-11-84 — Date Signed

Approved: W. O. Wade — W. O. Wade — 12-12-84 — Date Signed

Distribution:

EG&G/SRO
W. Ganassin, C-2
M. Hatch, C-2
C. Morton, C-2
C. Simkins, C-2
W. Wade, C-2

LLNL
G. Cummings, L-91
C. Meier, L-90

NRC - Region V
A. Chaffee
J. Crews
G. Hernandez
D. Kirsch
L. Miller
P. Narbut
T. Young, Jr.

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1. SUMMARY

EG&G, Energy Measurements, Inc. of San Ramon, California, subcontracted by Lawrence Livermore National Laboratory under FIN A0753, performed an inspection of the administrative control system for the as-built drawings for Palo Verde, Unit 1 at Bechtel engineering offices in Norwalk, California. The inspection team consisted of two engineers from the Mechanical Engineering Department of EG&G. Forty-six pipe supports in both trains of the auxiliary feedwater system were inspected at the Palo Verde site near Phoenix, Arizona. The as-built conditions of the hardware at the site and field requested changes were compared to the design calculations to verify design control activities. There were a total of 32 issues identified. The results of the inspection at the site were sixteen discrepancies on twelve pipe supports. The review of the calculations at Bechtel resulted in six issues requiring Arizona Public Service (APS) responses and ten issues which were resolved during the inspection.

2. PERSONS CONTACTED

a) Palo Verde Nuclear Generating Station Staff - (Week of Sept. 24th)
C. N. Russo, Quality Auditing & Monitoring Manager
B. F. Love, Quality Engineer
J. C. Sherrin, Quality Engineer
L. A. Souza, Assistant Director of Corporate Q.A.
L. Reyes, Bechtel Q.C. Inspector
L. B. Spiers, Quality Engineer
L. Bolles, Bechtel Q.C. Inspector

b) Contractor Personnel - (Week of Oct. 1st)
Dick Patterson, Assistant Project Manager
Ken Stwertnik, Project Quality Engineer
Sus Kawamoto, Pipe Stress & Support, Group Leader
Helmut Miyahara, 79-14, Group Leader
David McKinney, Project Administrator
Bill Wilson, Project Manager
Bob Stein, Project Engineer

c) NRC Meeting Attendees
Norwalk -- November 8, 1984

Norwalk -- November 16, 1984 (those in attendance are noted below by asterisk).

Name	Organization	Title
Jesse L. Crews	NRC-RV	Sr. Reactor Engr. (Chief Engr.)
Wallace O. Wade	NRC Contractor	Project Mgr. EG&G
Gonzalo Hernandez	NRC-RV	Sr. Const. Resident I
Carter Rogers	APS	Nuclear Engr.. Mng.
Helmut R. Miyahara	Bechtel	Plant Design Engr.
Lee Abrahamson	Bechtel	Plant Design Engr.
Ralph Keidel	Bechtel	Mgr. M&QS
Mark Radspinner	APS	Mech. Engr.
Dennis Keith	Bechtel	Asst. Proj. Engr.
Russell Cobb	Bechtel	Asst. Plant Design EGS
Bob Welcher	Bechtel	Project QA Engr.
Russ Papworta	APS	Ops. Engr. Mgr.
Armand Langmo	Bechtel	Mgr. of Engr. - Tech.
Robert Elias	Bechtel	Plant Design Chief, Engr.
Larry Souza	APS	Asst. Corp. QA/QC Mgr.
Raubin L. Randels	Bechtel	Unit 1 Resident Engr. Supv.
*P. P. Narbut	NRC-RV	Project Engineer
*Clyde Morton	NRC Contractor	Engr. Spec./EG&G
*Charles Simkins	NRC Contractor	Engr. Spec./EG&G
*Larry Spiers	APS	QA Engr.
*W. G. Bingham	Bechtel	Project Engr. Mgr.
*Douglas Freeland	Bechtel	Plant Design EGS
*Sus Kawamoto	Bechtel	Plant Design Engr.
*R. R. Stiens	Bechtel	Project Engr.
*V. Najarian	Bechtel	Asst. Proj. Engr.
*Dave L. McKinney	Bechtel	Project Admin.

d) NRC Meeting
San Francisco -- November 30, 1984

Name	Organization	Title
L. C. Shieh	LLNL	NRC Consultant
P. P. Narbut	USNRC	Project Inspector
D. K. Morton	EG&G, Idaho	NRC Consultant
J. L. Crews	USNRC	Sr. NRC Engr. RV
Charles B. Simkins	EG&G, SRO	NRC Consultant
Tom Burr	EG&G, Idaho	NRC Consultant
R. Bosnak	NRC	NRR Div. Engr.
Carter Rogers	APS	Nuc. Engr. Mgr.
W. G. Bingham	Bechtel	Proj. Engr. Mgr.
L. E. Shipley	Bechtel	Ch. Plt. Dgn. Eng. SFO
D. J. Freeland	Bechtel	Supervisor Plant Design
G. K. Wang	Bechtel	Proj. Engr., EPD
M. Z. Khlafallah	Bechtel	Stress Group Supervisor
R. H. Elias	Bechtel	Ch. Plt. Dgn. Engr - WPI
V. Najarian	Bechtel	Asst. Proj. Engr.
M. A. Radspinner	APS	Mech. Engr.
A. I. Pressman	Bechtel	Engr. Manager
William F. Quinn	APS	Nuc. Licensing Mgr.
L. A. Souza	APS	Asst. Corp. QA/QC Mgr.
W. O. Wade	EG&G/LLNL	NRC Consultant
C. H. Morton	EG&G/LLNL	NRC Consultant
R. P. Schmitz	Bechtel	Chief Nuclear Engineer
Peter Karpa	Bechtel	Mgr. of Engr. BPM
T. C. Wiesner	Bechtel	M&QS Super. Weld. Engr.
F. C. Brieismeister	Bechtel	Mgr. M&QS SFO

e) NRC Walnut Creek -- December 7, 1984 Meeting

Name	Organization	Title
Doug Freeland	Bechtel	Engr. Group Supervisor
Vas Najarian	Bechtel	Asst. Proj. Engr.
Carter Rogers	APS	Nuc. Engr. Mgr.
Bill Bingham	Bechtel	Proj. Engr. Mgr.
P. P. Narbut	USNRC	Project Inspector
L. F. Miller	USNRC	Section Chief, Sect. II
L. C. Shieh	LLNL	NRC Consultant
J. L. Crews	NRC RV	Sr. Nuclear Engr.
Clyde Morton	EG&G/SRO	NRC Consultant
Axel Harres	APS	OPS. Engr.
Mark Radspinner	APS	Mech. Engr.
L. A. Souza	APS	Asst. Corp. QA/QC Mgr.
R. A. Manley	Bechtel	Mgr, M&QS

3. PROCEDURES/DRAWINGS/SPECIFICATIONS/CALCULATIONS REVIEWED

a) Procedures

Bechtel:

WPP 3.0 Rev. 18 - "Field Generated Drawings, Field Revision Log"

WPP 3.6 Rev. 4 - "Control of Field Generated Specification"

WPP 3.7 Rev. 8 - "Preparation & Control of Piping Technical Data Sheets"

WPP 3.8 Rev. 9 - "Field Generated Drawings/Field Change Notice"

WPP 3.9 Rev. 3 - "Control of Pipe Support Drawings"

WPP/QCI 5.0 Rev. 26 - "Nonconforming Materials, Parts & Components"

WPP/QCI 10.1 Rev. 3 - "Startup/Operations Field Material Requisition Preparation, Approval & Tracking System"

WPP/QCI 20.0 Rev. 20 - "Field Change Request"

WPP/QCI 32.0 Rev. 9 - "Modification Change Notice"

Arizona Public Service (APS):

IP-4.33 Rev. 7 - "As-Built Records"

b) Drawings

Bechtel:

See Table I of pipe support drawings

13-S-ZAS-519 Rev. 5, "Miscellaneous Weld Symbol Interpretation"

c) Specifications

Arizona Public Service (APS):

13-PM-204 Rev. 6, "Specification for Field Fabrication and Installation of Nuclear Piping Systems"

Auxiliary Feedwater System Description, Revision 2

Bechtel:

WPP/QCI 201.1 Rev. 20, "Nuclear Pipe Hangers and Supports Installation"

d) Calculations

Bechtel:

13-MC-AF-501, Auxiliary Feedwater System Pump Station Train A

13-MC-AF-501R, MSSS Turbine Drive Pump Auxiliary Feedwater System - Unit Unique Calc.

13-MC-AF-502, Auxiliary Feedwater System Pump Station Train B

13-MC-AF-502R, MSSS Motor Driven Pump - Auxiliary Feedwater System - Unit Unique. Calc.

13-MC-SG-506, Mainstream System - Downcomer Feedwater Lines

13-MC-SG-506R, Mainstream System - Downcomer Feedwater Lines, Unit Unique Calc.

13-MC-ZZ-534, Formed Plate for 2-1/2" to 6" Std. No. 01-02-52A-1

P-006, One Direction (horizontal) Formed Plate for 2-1/2" to 6"

P-007, One Direction (vertical) Formed Plate for 2-1/2" to 6"

P-025, Two Direction Strap for 2-1/2" to 6"

4. FIELD INSPECTION RESULTS

a) Summary

An inspection of 46 pipe supports on the auxiliary feedwater system was made during the week of September 24, 1984. All pipe supports located between the pump discharge in the Main Steam Support Structure (MSSS) building and the junction to the upper feedwater nozzle

of the steam generator line for both Train A and B plus the cross-over lines were inspected. The status of these pipe supports was complete and accepted by field Q.A./Q.C. The inspection consisted of verifying the as-built condition for conformance to the field pipe support drawings, FCR's and NCR's as reported by System 38. The identification of the pipe supports inspected is shown in Table I.

b) Findings

Table I lists the results of the field inspection and provides a brief description of the items found. While the inspection team was at the Palo Verde Site, there were ten pipe supports with thirteen discrepancies in the inspection document package. These findings were reported on Startup Field Reports (SFR's) 1-AF/414, 1-AF/415 and 1-AF/421 by the APS Operations personnel. There were six items of incorrect pipe support configuration - e.g. missing members, incorrect members and reverse configuration. There were seven items of undersize and underlength welds. These discrepancies are explained in detail below.

Before the inspection team left the site, there were four areas which were left to be evaluated after a review of the design calculations. See Table I for these pipe supports identified with footnote "I". After this review, three new discrepancies for three of the areas were documented on SFR's. They were SFR #1-AF/437 on 13-AF-003-H006, SFR #1-AF/434 on 13-AF-005-H001 and SFR #1-AF/432 on 13-AF-015-H003. The fourth area was the flare bevel weld condition on 13-AF-003-H004 which required no SFR but will be addressed separately as a generic issue. A complete description of all four areas is found in Sections 5(f) and 5(g).

The list of field discrepancies found is as follows:

Support 13-AF-003-H001
The intermittent fillet welds between item #B and the embedment plate #G are required to be 1-1/2" in length. Three (3) welds were up to 3/8 inch underlength. Between item #83 and item #A, a 3/16" fillet weld is undersized by 1/16" for 3/4 inch of the 3 inch weld length.

Support 13-AF-003-H007
The flare-bevel weld between item #B and the embedment plate #U is not filled flush per AWS criteria. It is 1/16 inch undersize for the full 12 inch length per Bechtel criteria (See Bechtel drawing 13-S-ZAS-519) on the near side. It is 1-1/2 inch underlength on far side.

Support 13-AF-003-H008
Item #F is required to be located on the East side of item #A. However, it is installed on the west side of #A in a reverse configuration.

Support 13-AF-015-H001
The support requires base plate #C to be installed. Item #C is missing.

Support 13-AF-015-H003
The flare-bevel weld between item #A and the embedment plate #U does not meet design length of 12 inches. It is 10-1/2 inches on far side and 10-3/4 inches on near side.

Support 13-AF-016-H001
The flare-bevel weld between item #A and the embedment plate #C should be 12 inches long. It is 4 inches underlength on the far side. The near side weld was not filled flush per AWS criteria and was 1/16 inch undersize for full length per Bechtel criteria. Near side weld was accepted "use as is" on NCR #PX-7370.

Support 13-AF-005-H002
The 1/4" fillet weld between item #A and the embedment plate "G" is 5/16 inch short of the design length of 5 inches.

Support 13-AF-035-H001
Item #B, 3x3x3/8 inch tube steel, was required to be installed in place of item #A, 4x4x3/8 inch angle. Actual installation has angle still in place.

Support 13-AF-005-H008
The drawing required items #E and #F (4 places) to be 1-3/4" plates and 1-1/2" plates were used.

Support 13-AF-006-H004
The load pin of the three-bolt clamp, item #14, used threaded stock instead of an approved bolt. The spring can, item #19, is installed at an angle and the scale is obscured by HVAC ductwork preventing inspection of the setting.

5. BECHTEL INSPECTION RESULTS

a) Summary

During the week of October 1, 1984, the Bechtel Engineering offices in Norwalk, CA, were visited. The purpose of this visit was to obtain all design calculations pertinent to the auxiliary feedwater system. A cursory review was made to assess the individual conditions noted at the site prior to an indepth review which was to be performed later. Differences between the field and design office drawings were noticed during this review. Most of the calculations requested were easily obtained but in a few cases as noted herein it was found that the design calculations were irretrievable or not performed.

During the weeks of October 8th and 15th, a more detailed review was made of the design calculations. The main objective of this review was to assure that identified field change requests (FCR's) and nonconformances reports (NCR's) were incorporated into the design calculations. The four items identified in the field (see Table I) pertaining to adequacy of engineering design were reviewed at this time. A review of a sample of material change notices (MCN's) and a review of the contents of the field drawings versus the Bechtel-Norwalk drawings was also made at this time.

During the week of October 22, the first draft of this report was prepared and forwarded to Region V. On November 8, a meeting was held at the Bechtel-Norwalk offices where the APS and Bechtel responses to the issues were discussed. On November 15 and 16, a working session was held at the Bechtel offices to review in detail the new Bechtel analyses performed in response to the identified items. On November 30 and December 7, additional meetings were held at the Bechtel San Francisco office and the NRC Walnut Creek offices respectively. There were sixteen issues discussed in these meetings and all are presented in this report with the latest Bechtel or APS response noted. Of these, six issues were identified as open items requiring more action.

b) Calculations Reviewed

The inspection team obtained from the Bechtel-Norwalk office the stress calculations performed on the portions of the auxiliary feed-water system inspected in the field. These calculations are identified in Section 3.0. It was the objective of the inspection team to verify that the as-built condition found in the field was included in the design calculations. This was done by checking the pipe support drawing configuration to that assumed in the analysis. The loads used in the analysis were compared to those listed on the drawing. The calculations were reviewed to see if changes made to the analyses were identified to an FCR, NCR, etc.

The calculation was reviewed only to the depth necessary to establish the similarity or the difference. Each difference noted between the field condition and the Bechtel-Norwalk design was identified as an "issue".

In the course of this inspection, 8 pipe supports were reviewed in the manner described above. In four other cases (13-AF-005-H001, 13-AF-009-H002, 13-AF-011-H002, 13-AF-003-H007), it was necessary to review the calculations in more depth to adequately report the issue. The adequacy of the calculational methods was questioned based on standard stress analysis practices instead of the Bechtel internal procedures established to define the pipe stress analysis methods to be applied in the calculations.

Since the inspection focused on the reconciliation of the field conditions with the original design calculation, the predominate finding was that when engineering judgements were exercised in lieu of a new or revised analysis, they were not documented as explained below.

Issue #1 - In some cases (See Issues #2, 3, 4, 5, 8 and 12 of this report), the latest computer run has yielded higher loads for a pipe support than were used in the final calculations. Since the loads on some supports were significantly higher, it is expected that these reconciliations be documented to show engineering review was performed. In the case of Issue #3, the use of engineering judgement was marginally exercised when the design loads approached to within 3% of the design allowables.

Bechtel response: APS stated that they had previously found a similar lack of engineering judgement documentation. Bechtel has commited to APS to document engineering judgements in the future for Units #2 and #3. For Unit #1, APS required Bechtel to independently recalculate 5% of the systems analyzed to provide assurance on the adequacy of the calculations already performed. During the recalculation, APS required that engineering judgements be docu-

mented. In the above cases, this was not done. In Issue #12, the inspection team found a fundamental error in the recalculation effort. APS had previously reviewed and accepted the recalculation effort. This issue on the lack of documented engineering judgements and the effect on the adequacy of the calculations performed will be answered by the actions planned for Issue #12. Twenty additional calculations will be rechecked by Bechtel and APS. This issue is closed.

Status - closed

c) Review of FCR's Reducing Design Strengths

Eighteen field change requests were reviewed (see Table I) in conjunction with the 46 pipe supports inspected. Ten FCR's were determined to have an effect upon the design analysis. These FCR's are identified in Table I with asterisks. A review of the Unit #1 unique calculation was made to see if the calculation was reconciled for the change.

There are four issues which will be explained more fully below:

(1) Issue #2 - On pipe support 13-AF-009-H002, the pipe is held against the supporting steel by a two-direction formed-plate restraint. FCR #79202-P allowed a switch from restraint item #85 to #83. A review of the calculation 13-MC-ZZ-534 sheet 24 states the maximum allowable load on the plate restraint is 1120 lb. The design loads on the drawing exceed the plate restraint allowables without any new supporting analysis in the calculation.

On pipe support 13-AF-011-H002, the same overload condition was found on the plate restraint as reported on 13-AF-009-H002. FCR #54066-P was approved without any supporting analysis for the overload.

Bechtel response: FCR's were originally approved based on engineering judgement. On 10/3/84, Bechtel reanalyzed the item #83 plate restraints by rerunning a new frame analysis program using the new loads acting simultaneously. The results showed an acceptable condition.
Status - closed

(2) Issue #3 - FCR #41859-P (13-AF-003-H005) deleted a fillet backup to a full penetration weld. The calculation was reviewed and it was determined that the fillet backup was not required. The two directional strap restraint was reviewed because the as-built stress analysis used higher loads than those reported on the hanger drawing. In calculation number P-025 on page 4, the user's guide requires; if two loads act simultaneously, (as in this case) the addition of the two percentages (design load to the allowable directional loads) must not exceed 100%. For the design loads, the total percentage was 113% and for the "as-built design loads", the total percentage was 114%. This indicates an overload which has not been justified by calculations included in the general or the Unit #1 unique analyses.

Bechtel response: The FCR was originally approved based on engineering judgement. On 10/4/84, Bechtel reanalyzed the plate restraint by using the actual faulted design allowables in the interaction formula. The results showed the new loads combined to 97% of the allowable limit.
Status - closed

(3) Issue #4 - FCR #78174-P (13-AF-023-H001) revised the hanger design to add $\pm$Z restraints to a former +Y restraint. This resulted in a new 3000 pound design load to the supporting steel for which there are no calculations to justify the change. The FCR was issued on 4/9/84 and the latest computer run NA-138 was made on 7/18/84 which continued to disregard the Z restraints. The adequacy of this pipe support could not be verified.

Bechtel response: Bechtel stated that the Z-restraints were added to fix a flow induced vibration problem on the line discovered between hot functional and hot pump testing. The 3,000 pound load was deduced by field deflection measurements. After the pipe support modification, it was then decided to replace the manual valve in the line with a blank flange thus eliminating the flow and the load. It was not clear who was responsible for the calculations if the new design load had not been eliminated. Bechtel will supercede FCR #78174-P with a new FCR to delete the 3,000 pound load.

Status - closed

(4) Issue #5 - FCR #32861-P (13-AF-005-H002), FCR #78626-P (13-AF--035-H002) and FCR #28663 (13-AF-035-H001) made field changes which affect the pipe and pipe support calculations. There are no calculations or an engineering evaluation to justify the approval of these FCR's. In these cases, a hanger location moved 1 foot, a 3x3 angle member was substituted for the 4x4 angle required and a 3x3 tube steel was to be substituted for a 4x4 angle. In this last case, it was a field finding that the change was overlooked (see section 4.b). The adequacy of the hangers could not be verified without engineering justifications.

Bechtel response: All three changes were approved based on engineering judgement. New documentation supporting these judgements was reviewed and found acceptable.

Status - closed

d) Review of NCR's

Of the 46 pipe supports inspected, six NCR's were issued during the construction period and are identified in Table 1. Four of the NCR's reviewed were found in the analysis and were recently reviewed for new loads. NCR #WC-0296 did not have calculations but the hanger design had changed which eliminated the NCR condition. NCR #PC-8169 will be discussed below.

(1) Issue #6 - In the review of the reconciliation of NCR #PC-8169 for pipe support drawing 13-AF-011-H001, Rev. 3, Bechtel engineering could not produce any supporting analysis. On the NCR form, the justification was to be filed in calculation 13-MC-ZZ-584 but it was not located there or in the Unit #1 unique analysis. It was determined that 13-MC-ZZ-584 was created to retain all NCR's for Unit #1. Two other NCR's (#PX-7370 and #PC-7983) were referenced to 13-MC-ZZ-584 but they also were not located there. They were found instead in the Unit #1 unique analysis.

Bechtel response: There was no response to why calculations were not filed as indicated on NCR's. NCR #PC-8169 was originally approved based on engineering judgement. New documentation prepared by Bechtel supporting those judgements was reviewed and found acceptable.
Status - closed

(2) Issue #7 - Contrary to Bechtel Internal Procedures Manual for Arizona Nuclear Power Project, procedure number IP-4.33, Revision 7, paragraph 3.1 which requires "the DDR to provide control logs for design drawings . . . NCR's . . . ", it was found that NCR #PX-7370 for 13-AF-006-H003 and 13-AF-006-H002 were not listed in the Document Design Requisition (DDR).

Bechtel response: It was stated that the NCR #PX-7370 was entered into System 38 as an "01" item rather than an "13" item. The DDR listing given the inspection team was not run to the correct routine. An "as-built log routine" listing would have supplied the information requested.
Status - closed

e) Review of the MCN's

Nine pipe supports were selected at random to review all modification change notices issued. There were a total of twenty-five

MCN's reviewed. The pipe supports selected are listed in Table I. Most MCN's were required to document disassembly and reassembly for pressure tests or rework. None were for permanent equipment transfers and a few were for adding weld joint identification numbers. MCN 1-122 changed a shop weld symbol to a field weld symbol. Welder access could not be evaluated away from the site to assess the effect on the weld mode. MCN 7-287 changed the configuration of the supporting steel (13-AF-015-H002) for the pipe. This MCN was issued on 4/3/81 and voided on 9/24/81 without explanation. This last MCN indicates MCN's have been used for design change documents.

A copy of Arizona Public Service (APS) Corrective Action Reports (CAR) CA-83-0091 and C83-98D dated 7/15/83 and CAR's CA-83-0092 and C83-108 dated 7/15/83 both stated that "MCN's are being generated in lieu of FCR's and NCR's" resulting in the "changing of design and correcting nonconforming conditions on a need to basis without proper approval". These CAR's have not been closed yet due continuing discussion on proper corrective action. Most recently, it was agreed by APS that all MCN's will be re-reviewed for unauthorized design changes. This issue is still unresolved and requires verification of the effectiveness of the corrective action taken by Arizona Public Service.

f) Review of the Field Construction Drawings vs. Bechtel-Norwalk Drawings and Calculations

The Bechtel-Norwalk engineering group issues drawings to the site and the Bechtel Field Engineering group reissues the same drawings under a field drawing revision status to Bechtel Field Construction. Forty-two drawing sets were reviewed for dissimilar contents. The revision status of each drawing was checked and compared to the field revision log (FRL). The review of the drawing was limited to weld symbols & hanger configuration and easily identified changes noted by different printing styles.

The results were that all drawing revision numbers were the same between the field and Bechtel-Norwalk office. The added field revision status showed more field revisions occuring than those made by the Bechtel-Norwalk office. The Bechtel-Norwalk drawings were obtained on September 6, 1984. The field drawings were obtained on September 23, 1984. The field revision log dated September 14, 1984 contained many differences of revision status and appeared 30-60 days behind status changes. The System 38 Design Document Register (DDR) listing was obtained to verify the actual status of the Bechtel-Norwalk drawings. The result of this check was acceptable. The correct field revision drawings status could not be checked away from the site.

The results of the dissimilarity review of the forty-two Bechtel field drawings versus the Bechtel-Norwalk showed that eight field drawings were significantly changed. The balance were unchanged or there were only field weld joint identification numbers added. Four field drawings had changes that increased the hanger design capability and four had changes where hanger design capability was decreased or the requirements specified were eliminated. The latter four are discussed below:

(1) Issue #8 - On 13-AF-003-H007, the field changed the position of the supporting tube steel from full contact with the embedment plate to partial contact without any controlling dimensions of minimum weld length required. (See weld between embedment plate (U insert) and item B). The extra fillet weld cap adds nothing to the weld strength. (See discussion for section 5.g.iii of this report). There is no analysis in the Unit #1 unique calculation to justify this change.

Bechtel response: This was an unauthorized "sepia" change contrary to WPP/QCI 201.1 paragraph 5.4. NCR #PC-1864 was approved for Unit #2 to avoid an interference with a run of conduit. The NCR was dispositioned as rework but no rework was performed and the condition then was allowed to remain "use as is". The sepia (field

drawing) was changed to allow the hanger to be in partial contact with the embedment plate. For Units #1 and #3, the hanger was welded in full contact with the embedment plate. There are no Unit #2 unique calculations to justify the NCR. NCR's dispositioned as "rework" normally are not sent to the Norwalk-Bechtel office for review and reconcilation.

Bechtel proposed a two phase review of the pipe support field drawings to the Bechtel-Norwalk office drawings which has been started. 272 out of 500 drawings reviewed so far have found no significant differences and no unauthorized design changes. 500 is estimated to be 3% of all drawings issued. APS will be reviewing this effort and reporting the final results.
Status - Open

(2) Issue #9 - On 13-AF-005-H009, the field changed an all around tack weld to a tack weld only symbol between item C and item E. It is not clear why the all around symbol was originally required but an FCR should have been issued.

Bechtel response: The permission to the field to change the tack weld between end plates and tube steel is given in 13-PM-204 paragraph 12.3.23.
Status - closed

(3) Issue #10 - On 13-AF-006-H001 and 13-AF-004-H001, the requirements to wrap a layer of 6-mil thick stainless steel shim stock between the clamp and the pipe was deleted and notes governing material specification were deleted without an FCR being issued.

Bechtel response: The field specification WPP/QCI 201.1 paragraph 9.2.7 permits the deletion of the stainless steel shims. This appears as an unauthorized field change but it was common knowledge with the Bechtel-Norwalk office. It was agreed that the specification 13-PM-204 would be revised to add a paragraph permitting the deletion of the stainless steel shims. A SCN #3866 was initiated for this change.
Status - closed

Issue #11 - During the field inspection, it was noted that a weld was made incorrectly with reference to the design drawings. This item was deferred from the field to be evaluated here. The pipe support 13-AF-015-H003 shows the weld in question as a 3/16" fillet weld at the intersection of items #C and #B. Using the AWS Standard for interpretation of weld symbols, the symbol, clearly, is pointing to the horizontal intersection of two angle members. The weld was made on the adjacent vertical intersection. The interviewed field inspectors stated that the weld was acceptable and that when there was doubt about the location of a weld the inspector is allowed to use his judgment. Alternate weld location charts in the fabrication spec WPP/QCI 201.1 are used in the field but this case was not identified. The purpose of standard weld symbols is to remove the need for field interpretation. The calculations were reviewed for this weld to determine where the design engineer placed the weld and it was found that the weld was not analyzed by calculation but by "inspection".

Bechtel response: The weld should have been located as explained above. Start-up Field Report SFR #1-AF/432 has been prepared and an NCR will be generated for Bechtel-Norwalk evaluation.

APS has interviewed field inspectors to determine the extent of the misinterpretation of weld symbol issue. Most inspectors and welders seek interpretation from their foremen and the field welding engineers. APS administered a test of 25 questions to the field inspectors without prior training on weld symbol interpretation and all scored at least 90%. Copies of the test were not available. APS stated the results would be made available for further review.

Status - open

Observation #1 - The following four pipe supports also had poor usage of weld symbols and were subject to inspector interpretation: 13-AF-018-H002, 13-AF-018-H003, 13-AF-005-H001 and 13-AF-011-H025.

It was noted that paragraph 5.2 of WPP/QCI 201.1 had not been invoked in any of these cases to remove the ambiguity by modifying the field drawings.

Status - No Action Required

Issue #12 - In review of Bechtel drawing 13-AF-009-H002, Rev. 3, the supporting Unit #1 Unique Calculation AF-501R was based on Revision 1 of the drawing while the installation was made to Revision 3 of the drawing. The pipe support installed in the field has a lower allowable load than the analyzed configuration.

Bechtel Response: This calculation was made by the "Staff" and not by the Bechtel Project Team. This was part of the agreement made with APS to independently recalculate 5% of the systems analyzed. Interviews with one of the Staff individuals did not produce any clarification but it was found that a previous error on the Rev. 2 evaluation of the new loads may have contributed to the final error found. Bechtel contended that regardless of the error, the hanger configuration in the field was acceptable based on engineering judgement. A new Bechtel analysis was made on 10/3/84 with the new load and was shown acceptable.

Bechtel has re-reviewed the 5% recalculations performed by the Staff and additionally has reviewed a new 5% sample of the calculations performed. This was done to assess the adequacy of both the Bechtel Staff and Project Team calculations. In total, twenty calculations were reviewed which covered 1175 pipe supports plus 2138 NCR's and FCR's which required reconciliation. There were three errors made by Staff and one by the Project Team. Of the four errors found, two were of wrong configuration, one on an NCR allowing a reduced number of bolts and one on an omitted stress analysis of a pipe lug. There was no safety significance after each error was corrected. APS is in the process of performing a detailed review of one calculation and will later overview an additional ten calculations to check Bechtels results. This issue is open until all reviews are completed.

Status - open

g) Generic design problems

(i) Pipe support, 13-AF-005-H001

Issue #13 - The field inspection revealed a gap of 3/16 inch on the "+Z" side of the pipe stop lug (item #38) and a gap of 1/16 inch on the "-Z" side. This is in excess of the 0 to 1/8 inch total gap allowed by the pipe support drawing and field installation tolerances. The pipe support as installed does not have a "-Y" restraint (the pipe is not held down). Later reviews of the computer stress analysis showed the assumed conditions did not match the actual conditions. The computer analysis assumed a three directional ±X,±Y,±Z restraint (versus ±X, +Y, ±Z in the field) and the pipe stop gaps allowed by field tolerances had not been evaluated to assure the worst case movement would not result in any equipment overloads. When Bechtel was advised of the field conditions by the inspection team, they voluntarily reran the computer program without the "Y" restraints and also without the "Z" restraints to account for the field gap conditions. Using the new computer output moments, Bechtel appeared to show by addition of the suction and discharge nozzle moments that the combined moment through the pump case produced net nozzle moments within the manufacturers allowable limits. During the review of the output of the rerun computer problem, it was noted that it did not take into account the actual field conditions or at least a worst case tolerance for the adjacent pipe support (13-AF-005-H009) which is located between this support and the pump. The computer program assumed zero clearance rather than field conditions which is not conservative and allows the adjacent pipe support to load share with the pump nozzle.

[NOTE: Field reinspection of the restraint clearances at 13-AF-005-H009 were reported on November 20, 1984, as North-0", South-1/8", East-3/16" and West-0". In this case, the field as-builts showed zero gap in the direction of the pump nozzle and matched the rerun computer program assumptions.]

The inspection team recommended that Bechtel re-evaluate their computer analyses to assure that the computer analysis matches the allowed installation condition of the pipe support. It appears, by a lack of documentation in the calculations, that the loads from the computer program output are not evaluated in a secondary appraisal to see if the pipe support design agrees with the computer model input. This secondary appraisal or reconcilliation of the output to the actual design condition is done because of the inherent difficulties in computer modeling to exactly duplicate the design. Those areas which will experience the similar problems noted above are where field tolerances allow the transfer of loads between restraints and where such load transfers could overload equipment, restraints or flanges. Also, with the lack of a -Y restraint on the 13-AF-005-H001, does the dead weight plus thermal downward loads sufficiently exceed the seismic upward loads so that the pipe always remains in contact with the +Y restraint and thus agrees with the modeling technique? The limitation of the ME-101 computer program not to accept a one directional restraint makes the documentation of this secondary appraisal important to demonstrating the pipe system design adequacy. Additionally, the field inspectors should re-examine the restraint and pipe stop clearances for conformance to the allowable tolerances. (The re-inspection of 13-AF-005-H009 reported above has a nonconformance on the East-West line not previously reported which exceeds the drawing requirement of 1/8 inch total gap.)

Bechtel response: Bechtel stated that the initial analysis is acceptable and the only problem is that the field gap was exceeded. Bechtel has stated that it is an industry-standard to use an 1/8 inch total gap on restraints and pipe stops regardless of where they are used within the pipe system. SFR #1AF-434 has been initiated in the field to document the engineering evaluation of the excessive 3/16 inch gap condition. It is Bechtels position that the rerun of the computer program justifies acceptance of the

restraint as is. The inspection team accepts this position but only because the field as-builts matched the previously questioned method of using zero gaps in the re-run.

During the November 30th meeting, Bechtel presented their interpretation of the industry standard 1/8 inch total gap. The NRC/NRR personnel presented an approach used for Diablo Canyon which limits pipe restraint clearances to 1/16 inch in the proximity of critical equipment. This method, described in NUREG 0675, is the 25th supplement to the safety evaluation report for Diablo Canyon Nuclear Power Plants. For Palo Verde, Bechtel stated that they would perform a 100% inspection of the clearances on all Unit #1 pipe supports within the proximity criteria for all Q class piping to rotating equipment. The measurements would be made in the cold condition and the pipe would be shimmed to 1/16 inch maximum clearance in the calculated hot state where it is safe to do so. The earliest inspection results reported as of December 7th showed 73 pipe supports are involved and 60 (3 hot & 57 cold) require shims. The maximum gap reported was .094 inch. Bechtel is reviewing the methods to be used to install the shims and also the effects on the piping verification program.
Status - Open

Issue #14 - As mentioned above in Issue #13, one directional pipe supports require a secondary appraisal to show the net loads on the pipe always assure contact is made with the pipe support. On 13-AF-005-H001, the seismic upward load exceeds the thermal plus deadweight by 174 pounds and lift-off can occur. In this instance, the pipe will be in a different vibratory mode than was assumed in the computer analysis. Bechtel could evaluate the lift-off condition by re-running the program without the $\pm$ Y restraints and reconciling the new loads or they could restrain the pipe by a field fix.

Bechtel response: Bechtel has checked and determined that there have not been any previous evaluations for the lift-off condition on pipe support 13-AF-005-H001. Bechtel has additionally reviewed

16 other similar one direction restraints and have found three new cases where pipe lift-off occurs. Bechtel and APS are continuing their respective evaluations. The question focuses upon whether or not the computer analyses are adequate to justify the pipe support design methods used.

Status - Open

(ii) Zero Inch Clearance (free to slide)

Issue #15 - Field inspection of pipe support 13-AF-003-H006 revealed an apparent lack of gap between the pipe and the support. The Table for Restraints, Lugs and U-Bolts (Exhibit 201.1-20, Rev. 1) and Spec. WPP/QCI 201.1 paragraph 9.5.1.1 allows a "zero inch clearance (free to slide)" condition. Field inspectors reported that they interpreted "zero inch clearance" as contact being permitted. Other supports were seen but not identified by the inspection team where the existing gap could not be determined. There is no procedure or explanation of how this requirement is to be inspected. It is questioned whether this zero gap requirement will allow the pipe to slide freely. In this specific case, the pipe strap has no clearance due to weld shrinkage. The design temperature for the line is 120°F so minimal diameteral expansion will occur but the result is that the forces normal to the sliding surface are unknown. If the pipe does not move the 1/2 inch expected then the driving force will be applied to the support steel and the adequacy of the pipe support is undetermined. It is recommended that the requirement for zero gap be re-reviewed where specified for these postulated conditions.

Bechtel response: The 1/2 inch movement indicated on the design drawing is really 1/16 inch. They agreed the specification wording is a problem in defining a "minimal" gap which is the real require ment. This specific pipe support was reinspected for gaps and SFR #1-AF/437 has been initiated to document the pipe is bound.

Bechtel has issued FCR #85981-P to specification 13-PM-204 which defines alternate inspection methods to determine that a space exists between the restraint and pipe. Bechtel reinspected 100 pipe supports using the new inspection criteria to determine how extensive the situation may be. The sample was chosen to be representative of the typical mixture of hot and cold pipe support designs. The result was 86 pipe support clearances were acceptable and 14 did not pass the criteria. Of the 14, four had contaminants in gap and ten appeared bound but a detailed QC inspection has not been completed. Eleven of the fourteen were for small bore piping.

Since the sample contained both hot and cold pipes, the results were inconclusive. Bechtel agreed to redevelop the sample and consider if a worst case study of a bound cold pipe may provide additional information.

Status - open

(iii) Flare Bevel Welds

Issue #16 - Several flare bevel welds inspected at the site were found not to be filled flush with the top surface of the tube steel.

The Bechtel field standard for measuring flare bevel welds is 13-S-ZAS-519 Revision 5 which allows filling the weld to achieve a weld width equivalent to the wall thickness of the tube steel. This does not agree with the 1981 edition AWS Standard D1.1 Section 2.3.1.4 (and Table 2.3.1.4) which requires a weld filled flush.

Bechtel could not provide a copy of the design record file or calculations to support the design basis for issuing drawing 13-S-ZAS-519 to the field. The weld analyses made by Bechtel assumes the weld effective throat of flare bevel welds is equal to 1/2 the tube wall thickness. This is shown on Figure 3.15.1 of the Bechtel "Pipe Support Design Manual". This figure depicts a flush

flare bevel weld in conflict with the field standard. AWS Table 2.3.1.4 states the effective throat of flare bevel welds is to be 5/16 of the tube radius and filled flush. Any flare bevel weld not filled flush, must therefore have a weld effective throat less than both the AWS standard and the Bechtel design standard.

The AWS D1.1 Standard excludes fillet weld caps which the Bechtel Standard allows. The Bechtel method allows credit for a fillet weld reinforcing the flare-bevel weld which specifically is disallowed by Commentary 8.6 "Combination of Welds".

It is recommended that a reconciliation be prepared by Bechtel to justify the departure from AWS standards allowed by the field standard or reinspect and repair all welds.

Bechtel response: Bechtel has issued a report on recent weld tests performed to measure the size of the groove weld when a flare bevel weld cavity is filled only to a width equal to the wall thickness of the tube steel. The report concludes that welds made in this partially filled manner will exceed the assumed design weld throat of 1/2 the tube wall thickness by a minimum of 22% for the range of tube sizes used at the site.

Bechtel stated they are committed to the earlier 1972 edition of the AWS standard which does not prohibit the use of fillet weld caps on flare bevel welds. Bechtel is preparing a written justification for why and how fillet weld caps are used and an analysis of how they are used in conjunction with a partially filled flare bevel weld to increase the groove weld design size.
Status - open

6. CONCLUSIONS/RECOMMENDATIONS

The design supporting documentation was inconsistent in reflecting the as-built condition of the pipe supports for a portion of the Auxiliary Feedwater System inspected at the site. The four documents used by the

site (FCR, MCN, NCR & field drawings) collectively had been used incorrectly preventing a determination of the design adequacy without additional calculations.

The inspection team makes these conclusions based on the 46 pipe supports inspected. This sample represents less than 1% of all similar pipe supports in Unit #1. The identification of sixteen field discrepancies and sixteen issues in the supporting design calculations represent a significant incident of errors. Most of the field problems were weld deficiencies which is directly attributed to a lack of thorough inspection. Many of the calculation issues are attributed to a lack of engineering judgement documentation. Reanalysis is not always necessary but when engineering judgements are documented, the rationale for acceptance is examined and the need for reanalysis is easier to identify. The overall lack of documentation prompts the inspection team to recommend a review of how Bechtel design verification activities are performed and on what basis does the verifier concur with the design and design changes made by the design engineer.

All the individual issues reported herein with the exception of the generic design items (Section 5g) were shown by new Bechtel analysis to technically meet the design requirements and thereby represent no individual safety significant issues. The collective and generic implications of these findings on other systems is an evaluation required in the APS responses. For the open issues of Section 5g, the safety significance of each finding has not been established and the respective generic implications also required in the APS responses.

In summary, the design documentation supporting the as-built condition was incomplete. However, there appears to be sufficient design margins in the Bechtel analysis methods for each of the problems reviewed (with the exception of Section 5g items). These design margins were sufficient to permit new overloads to be accommodated, field change requests and nonconformances (which reduced design allowables) were reconciled and calculational errors were corrected by reanalysis thus demonstrating design adequacy and eliminating any significant safety issues.

TABLE I

	Drawing Revision Status						
	Bechtel	Construction					Field Insp.
	NOR	NOR/FRL	FIELD/FRL	FCR's	NCR's	MCN's	Results
1) 13-AF-003-H001	-	4/4	2/2	-	-	-	B,2-Note E's
2) 13-AF-003-H002	1	1/1	2/2	-	-	-	OK
3) 13-AF-003-H003	2	2/1	2/1	-	-	-	OK
4) 13-AF-003-H004	3	3/2	4/3	-	-	-	I
5) 13-AF-003-H005	3	3/2	3/2	28664-P*	PC-7983	-	OK
6) 13-AF-003-H006	4	4/3	7/6	41859-P*	-	-	J, I
7) 13-AF-003-H007	2	2/1	5/4	-	-	-	B,1-Note E and 1-Note F
8) 13-AF-003-H008	2	2/1	3/2	-	-	-	C, G
9) 13-AF-004-H003	1	1/1	2/2	14803-P 36665-P	-	-	OK
10) 13-AF-018-H002	2	2/1	3/2	-	PX-7370	-	OK
11) 13-AF-018-H003	1	1/0	1/0	-	-	-	OK
12) 13-AF-023-H001	1	1/1	1/1	78174-P*	-	-	OK
13) 13-AF-023-H002	-	1/0	0/0	-	-	-	OK
14) 13-AF-009-H002	3	3/3	4/4	79202-P*	-	-	OK
15) 13-AF-009-H001	3	3/2	3/2	51416-P	-	-	OK
16) 13-AF-009-H020	-	1/1	1/1	51820-P*	-	*-2	OK
17) 13-AF-005-H004	2	2/2	2/2	81561-P	-	-	OK
18) 13-AF-015-H002	2	2/2	1/1	-	-	*-2	OK
19) 13-AF-015-H001	2	2/1	2/1	13291-P	-	-	C, H
20) 13-AF-015-H003	1	1/0	2/1	-	-	-	B, F, L, I
21) 13-AF-016-H001	2	2/2	4/4	-	-	-	D, F
22) 13-AF-005-H009	2	2/2	3/3	-	-	-	OK
23) 13-AF-005-H001	1	1/1	3/3	-	-	*-4	K, I
24) 13-AF-009-H003	-	4/4	4/4	-	-	*-3	OK
25) 13-AF-005-H002	2	2/2	2/2	32861-P*	-	-	B, F
26) 13-AF-035-H002	0	0/0	0/0	78626-P*	-	-	OK
27) 13-AF-005-H003	2	2/2	2/2	-	-	-	OK
28) 13-AF-035-H001	2	2/2	2/2	28663-P*	-	*-2	C, H
29) 13-AF-005-H005	1	1/1	2/2	-	-	-	OK

TABLE I - (cont'd)

	Drawing Revision Status						Field Insp. Results
	Bechtel NOR	Construction NOR/FRL	Construction FIELD/FRL	FCR's	NCR's	MCN's	
30) 13-AF-005-H006	2	2/2	3/3	14824-P	-	-	OK
31) 13-AF-005-H007	2	2/2	3/3	-	-	-	OK
32) 13-AF-005-H008	2	2/2	2/2	12587-P	-	-	C, H
33) 13-AF-006-H003	2	2/2	4/4	-	-	-	OK
34) 13-AF-006-H005	1	1/1	3/3	-	-	-	OK
35) 13-AF-006-H004	0	0/0	2/2	-	-	-	C,2-Note H
36) 13-AF-011-H003	2	2/2	4/4	-	WC-0296	*-3	OK
37) 13-AF-011-H002	2	2/2	3/3	54066-P*	-	*-5	OK
38) 13-AF-011-H001	3	3/3	3/3	81560-P	PC-8169	*-7	OK
39) 13-AF-011-H025	1	1/1	3/3	78625-P*	-	*-4	OK
40) 13-AF-006-H002	2	2/2	5/5	-	PX-7370	-	OK
41) 13-AF-018-H001	2	2/2	5/5	-	PC-1955	-	OK
42) 13-AF-017-H003	2	2/2	APS/4	-	-	-	OK; A
43) 13-AF-017-H002	2	2/2	APS/3	-	-	-	OK, A
44) 13-AF-017-H004	2	2/2	4/4	-	-	-	OK
45) 13-AF-006-H001	1	1/1	4/4	-	-	-	OK
46) 13-AF-004-H001	2	2/2	3/3	-	-	-	OK

NOTES:

(A) Hanger drawing obtained from APS document control instead of construction.
(B) Finding reported on SFR #1-AF/414.
(C) Finding reported on SFR #1-AF/415.
(D) Finding reported on SFR #1-AF/421.
(E) Finding is insufficient weld throat.
(F) Finding is weld under length.
(G) Finding is hanger steel support in reverse configuration.
(H) Finding is incorrect hanger steel support member installed or missing.
(I) Finding which required further review and evaluation of calculations.
(J) Finding reported on SFR #1-AF/437 for pipe bound in plate restraint.
(K) Finding reported on SFR #1-AF/434 for excessive clearances on pipe stop.
(L) Finding reported on SFR #1-AF/432 for weld placed at wrong location.
(OK) Field inspection resulted in no findings. Hanger installation is satisfactory.