

50.55(e) Report

ARIZONA



PUBLIC SERVICE COMPANY

STA. _____

P.O. BOX 21666 - PHOENIX, ARIZONA 85036

June 15, 1982
ANPP-21181-GHD/BSK

U. S. Nuclear Regulatory Commission
Region V
Creskide Oaks Office Park
1450 Maria Lane - Suite 210
Walnut Creek, California 94596-5368

Attention: Mr. T. W. Bishop, Chief
Reactor Construction Projects Branch

Subject: Interim Report, Revision 2 - DER 81-14
A 50.55(e) Potentially Reportable Deficiency
Relating to A-354 Anchor Bolt Failures
File: 82-019-026
D.4.33.2

Reference: (A) Telephone Conversation between J. Eckhardt
and B. S. Kaplan on May 29, 1981
(B) ANPP-18271, dated June 24, 1981 (Interim Report)
(C) ANPP-19693, dated December 14, 1981 (Extension)
(D) Telephone Conversation between Bob Dodds and
George Duckworth on January 5, 1982 (Extension)
(E) ANPP-19871, dated January 11, 1982 (Interim Rev. 1)

Dear Sir:

The NRC was notified of a potentially reportable deficiency in References (A) and (B), and revised Interim Report was transmitted by Reference (E). At that time, it was estimated that a Final Report would be available by June 18, 1982.

Due to the extensive investigation and evaluation required, Revision 2 of the Interim Report is attached. It is now expected that this information will be finalized by August 31, 1982, at which time a complete report will be submitted.

Very truly yours,

E. E. Van Brunt

E. E. Van Brunt, Jr.
APS Vice President
Nuclear Projects
ANPP Project Director

EEVBJr/GHD:db
Attachment
cc: See Attached Page 2

U. S. Nuclear Regulatory Commission
Attention: Mr. T. W. Bishop, Chief
June 15, 1982
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cc: Richard DeYoung, Director
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INTERIM REPORT - DER 81-14

POTENTIAL REPORTABLE DEFICIENCY

ARIZONA PUBLIC SERVICE COMPANY (APS)

PVNGS UNITS 1, 2 & 3

I. Potential Problem

The Palo Verde Project purchases anchor bolts from Marathon Steel Company, Phoenix, Arizona, who in turn uses Copper State as a subtier supplier. Copper State uses subtier suppliers as sources of anchor bolts to them.

Four (4) A-354, Grade BD, 1-1/2 inch diameter bolts, used as anchor bolts for the pipe whip restraints in the containment building, cracked and separated during normal handling. One (1) of these bolts was then lab tested for chemical and mechanical properties in accordance with ASTM A-354. The bolt passed the chemical, strength, and ductility requirements but exceeded, on the high side, the hardness requirement which is grounds for rejection. Subsequently, a representative sample consisting of five percent (80) of all remaining A-354 Grade BD, bolts in stock at the jobsite were tested for the hardness requirement. The results showed that 29% (23 out of 80) of these bolts failed with 9 high and 14 low. Of the 14 that tested low, 13 of them also failed the tensile test requirements.

II. Approach To and Status Of Proposed Resolution

As a result of the identified A-354, Grade BD, bolt failures supplied by Marathon, via their subtier suppliers, Stop Work Notice 81-SW-4 was issued stopping all concrete placements containing A-354, Grade BD bolts. The Stop Work Notice was lifted when all A-354, Grade BD, Bolts were required to be hardness tested prior to embedment in concrete and only bolts within a specified preliminary acceptance range were allowed to be used.

Marathon Steel has issued audit findings requiring that the subtier suppliers correct the identified quality assurance deficiencies. These suppliers are:

Copper State Bolt & Nut	B & G Manufacturing	Blue Ribbon
Joseph Dyson	Lone Star Screw	Custom Bolt
Cardinal Industrial	Cal Pacific	
Sullivan Bolt	Bosco Fasteners	

Bechtel has developed a program to verify the quality of all high strength bolts and nuts used at the jobsite. All high strength structural bolts are currently being investigated; however, only problems with A-354, Grade BD, bolts have been identified at this time.

With this present plan, no bolts susceptible to stress corrosion cracking will be considered in the design. Using this fact, it is felt that it is not necessary to (1) revise storage requirements of the bolts prior to installation, or (2) to perform ultrasonic examination to determine if cracks exist within the installed bolts.

In response to a question asked at a status meeting held at Walnut Creek on October 13, 1981, the B & W core bolt problem on Duke Power Oconee 1 was reviewed for similarities to the Palo Verde bolting failures. No relationship can be drawn since bolting material (stainless steel) and environments are not similar.

- A354, Grade BD, Polar Crane Bracket to Girder Hold-Down Bolts

The same concerns exist for these bolts as those that are embedded. Unit 3 bolts had not been installed at the time of discovery of the problem. Prior to installation, all bolts remaining in stock were Equotip hardness tested with only bolts within the ASTM hardness range being used. The results of these tests are shown in Table 2. The results of hardness tests of a sampling of Unit 1 and Unit 2 bolts will be used to evaluate if Units 1 and 2 are acceptable.

- Other High Strength Structural Bolts

Marathon's subsupplier of bolts, Copper State Bolt and Nut Company, sent samples of each available lot of bolts received at the jobsite to a lab for testing. Materials included were A-307, A-325 and A-490 bolts, and A-194, A-325 and A-563-C nuts. The results showed that all bolts and nuts tested were within the limits of their respective ASTM specifications.

In addition, an inspection program to verify the tension in the high strength bolts in structural steel connections has been implemented. This inspection program follows the intent of Subsection 6(d) 5 of the AISC Specification for Structural Joints using ASTM A325 or A-490 Bolts, dated April 26, 1978.

- A-540 Bolts for NSSS Supports

Most of the A-540 bolts have been installed for all 3 units. In Unit 1 thirty two (32) A-540 bolts for the Reactor Coolant Pump lateral supports were shortened (saw cut) due to excessive projection. These thirty-two samples have been sent to Bechtel's M & QS lab for complete testing. The results of these tests will be used to evaluate whether the remainder of the A-540 bolts need to be tested.

III. Projected Completion of Corrective Action and Submittal of the Final Report

Evaluation of this condition and submittal of the Final Report is Forecast to be completed by August 31, 1982.

- A survey of the design drawings has shown that there are embedded A-354, Grade BD, bolts specified for the following categories:

- 1) Pipe Whip and Jet Impingement Restraints

- 2) Column Hold-down Bolts (Column No. 9 and Column No. 10)
- 3) Bolts installed for potential pipe whip and jet impingement restraints, but not presently planned for use.
- 4) Bolts Holding Polar Crane Girders to Brackets

Over 95% of these bolts fall into Categories 1 or 3. All of Units 1 and 2, and a portion of Unit 3, bolts were already embedded prior to discovery of the deficiency. An Equotip portable hardness tester was purchased to allow hardness testing of these bolts in place. A correlation was made at the jobsite between the Equotip "L" values and Rockwell "C" hardness (used in the ASTM specification). The correlation tests showed that "L" hardness values between 570 and 620 are within the acceptable hardness range allowed by the ASTM specification for A-354, Grade BD, bolts. All bolts presently planned for use with pipe whip restraints embedded prior to discovery of the problem have been hardness tested. The results are shown in Table 1. All bolts embedded after discovery of the problem are being hardness tested prior to embedment to assure that the bolt hardness is within the acceptable ASTM range. The remainder of the embedded bolts in Categories 2 and 3 have been hardness tested. A sampling of thirty-two (32) bolts of Category 4 installed in each of Units 1 and 2 are being tested to assess their acceptability.

Additional investigation and testing were performed by Bechtel's M & QS Department on three (3) of the four (4) failed bolts.

The basic conclusions of this report are:

- 1) The bolts failed due to progressive stress corrosion cracking (and not hydrogen embrittlement) caused by improper heat treatment of the bolting material.
- 2) Recommends acceptance of A-354, Grade BD, bolts up to hardnesses of Rockwell "C" = 41 (this corresponds to Equotip "L" value of "L" 640). Stress corrosion cracking does not become a factor until tensile strength of 200,000 psi or greater are achieved. A Rockwell "C" = 41 corresponds approximately to a tensile strength of 188,000 psi.

The recommendation made by the Bechtel M & QS Department is based on a Teledyne Engineering Services report prepared for the Midland Nuclear Project. The problem at Midland appears to be similar to the Palo Verde problem. Teledyne has been retained to review the Palo Verde data and to prepare a report for Palo Verde similar to that prepared for Midland containing their investigation, evaluation, and recommendations. Additionally, a jobsite walk down has been completed and an independent review of the Teledyne work is in progress by Battelle Pacific Northwest Laboratories. Assuming that the recommendations for Palo Verde are similar to those for Midland, it is anticipated that the need to modify the design or replace these bolts will be minimized or eliminated. Bolts with a hardness value outside the ASTM specified range would be derated in accordance with the recommendations. The preload in the bolts shall be limited to a very nominal load.

TABLE 1

HARDNESS TEST RESULTS ON EMBEDDED ANCHOR BOLTS
FOR PIPE WHIP RESTRAINTS

	<u>Unit 1</u>	<u>Unit 2</u>	<u>Unit 3</u>	<u>Total</u>
Total Number Tested	518	518	416*	1452
Number within ASTM Hardness Range (570 < Equotip L < 620)	414	423	371	1208
Number Outside ASTM Hardness Range	104	95	45	244
Bolts too soft (Equotip L)				
560 - 569	27	21	14	62
550 - 559	6	4	13	23
<550	2	3	10	15
Total	35	28	37	100
Bolts too hard (Equotip L)				
621 - 630	37	51	8	96
631 - 640	26	8	-	34
>640	6	8	-	14
Total	69	67	8	144

* 74 Bolts were embedded in concrete prior to discovery of problem. 342 bolts were in forms/rebar at time of discovery. These 342 bolts were hardness tested prior to concrete placement. Any bolt that tested high was replaced with one within ASTM range (total of 24). 45 bolts tested low, 33 of these were accepted by Engineering by derating the bolts accordingly. (12 bolts were replaced.)

TABLE 2

HARDNESS TEST RESULTS FOR UNIT 3 POLAR CRANE
TO GIRDER HOLD-DOWN BOLTS

Total Number Tested (Prior to installation)	445*
Number within ASTM Hardness Range (570 <Equotip L < 620)	368
Number Outside ASTM Hardness Range	77
Number Lower than ASTM Hardness Range (Equotip L)	
560 - 569	4
550 - 559	1
<550	7
Total	12
Number Higher than ASTM Hardness Range (Equotip L)	
621 - 630	61
631 - 640	4
>640	-
Total	65

* Total Number required for Unit 3 is 288. The remaining stock was tested. Only bolts within ASTM hardness range will be used for Unit 3.