Arizona Public Service Company
P.O. BOX 21666 • PHOENIX, ARIZONA 85036

September 23, 1983
ANPP-27866-BSK/RQT

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

Attention: Mr. D. M. Sternberg, Chief
Reactor Projects Branch 1

Subject: Final Report - DER 83-15
A 50.55(e) Reportable Condition Relating To A354 Anchor Bolt From Marathon Broke Under Installation Torque After Test Acceptance
File: 83-019-026; D.4.33.2

Reference: (A) Telephone Conversation between P. Narbut and R. Tucker on March 18, 1983
(B) ANPP-23867, dated May 24, 1983 (Interim Report)
(C) ANPP-27404, dated July 25, 1983 (Time Extension)

Dear Sir:

Attached is our final written report of the Reportable Deficiency under 10CFR50.55(e), referenced above.

Very truly yours,

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

EEVBJr/RQT:sn

Attachment

cc: See Attached Page 2

1/1 IE-27

cc: Richard DeYoung, Director
Office of Inspection and Enforcement
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

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FINAL REPORT - DER 83-15

DEFICIENCY EVALUATION 50.55(e)

ARIZONA PUBLIC SERVICE COMPANY (APS)

PVNGS UNIT 2

I. DESCRIPTION OF DEFICIENCY

During verification of installation torque of Column 9 anchor studs in Unit 2 Containment Building, a 1" diameter ASTM A354 Grade BD anchor stud supplied by Marathon Steel broke in the threaded portion (Drawing 13-C-ZCS-620 embed no. 322, bolt D). The stud has a documented EQUOTIP Hardness of L=578 and the specified installation torque is 1,071 ft-lbs.

A complete failure analysis was performed on the broken portion of the subject stud by Bechtel's Material and Quality Services (M&QS) Department. Based upon the results of this analysis, it has been determined that (see M&QS Technical Report No. 0383-03 FA, BLN No. 283-13, dated March, 1983): 1) the studs chemical content and hardness are consistent with the requirements of ASTM A354 Grade BD; 2) the stud had an acceptable quenched and tempered microstructure; 3) it experienced a torsional failure due to ductile shear overload.

The report concludes that the anchor stud was over-torqued.

An engineering review of this particular condition has limited the problem to the identified Column 9 embedded studs as follows:

a) Two other studs which secure column nine experienced excessive elongation during torquing prior to achieving the specified value.

b) The other identical installations (Column 10 of Unit 2 and Columns 9 and 10 of Unit 3) have been verified to be torqued to the specified values with no problems.

c) The torque wrench used for this particular installation has been checked and found to be within calibration requirements.

Additional evaluations of the torque specifications were performed by Bechtel Engineering. The root cause of this condition has been attributed to the specified torque value. Section III explains and dispositions this circumstance.

II. ANALYSIS OF SAFETY IMPLICATIONS

This condition is evaluated as reportable. Column 9 serves as a pipe whip restraint in the event of a Main Steam System Break. Should the subject condition remain uncorrected, Column 9 could potentially be unable to perform its safety-related function. Since this condition could adversely affect safety of operations and represents a significant deficiency in construction which requires extensive remedial action, it is reportable under the requirements of 10CFR50.55(e).

III. CORRECTIVE ACTION

A. Bechtel Engineering has provided an alternate column base anchoring detail which will utilize side straps and core-drilled through-bolts in lieu of the embedded anchor studs. NCR CC-3993 will be dispositioned to repair the defect by installing this alternate anchoring detail.

B. To preclude recurrence of inadvertent bolt failures, the methodology of determining torque values has been reviewed and evaluated. The torque values specified on drawing 13-C-00A-001 and in specification 13-MM-510 are based upon recommendations found in literature published by bolt manufacturers using an empirical formula:

$$T = C\ D\ P$$

where T = Installation Torque (ft-lbs)
C = Torque Coefficient = 0.20
D = Bolt Diameter (ft)
P = Bolt Tension (lbs)

Drawing 13-C-00A-001 is based upon $P = 70\%\ P_u$ where P_u is the minimum tensile strength of the bolt.

Subsequent to the failure of the ASTM A354 Grade BD stud, a testing program was conducted at the jobsite to check the tension/torque relationship. A total of 48 specimens were used, comprised of A325, A490, A354 BD, and A193 B7 bolts in 3/4", 7/8", 1", and 1-1/4" diameters. The results are as follows: The values of C, as calculated by the equation, ranged from 0.11 (one specimen) to 0.17 (one specimen) with a mean and median value of 0.14. The mode value was 0.15. Since the torque coefficient is actually lower than assumed, the torque in the drawing table results in a tension higher than expected: e.g. (if the actual bolt strength only meets the minimum specified tensile strength and the actual torque coefficient is 0.14, then the actual tension, P, would be

$$\frac{0.20}{0.14}\ (70\%P_u) = 1.00\ P_u$$

and it becom s possible for the bolt to experience combined tensile and torsional shear overload during tightening).

Change notices are being issued to revise Drawing 13-C-00A-001 and specification 13-MM-510. A torsion coefficient of 0.16 will assure proper tightening and to minimize the likelihood of recurrence by overtorquing failure. These changes do not impact the construction procedures.

ATTACHMENT DER 83-15

Bechtel Group, Inc.

Interoffice Memorandum

To R. A. Keidel

Subject Failure Analysis of an
ASTM A-354 Bolt
Palo Verde Project
Job No. 10407-002

Copies to R. A. Manley/B. D. Hackney (6)
N. H. Evans
C. Dunn
DCC 131177/Proj. File
J. E. Drennan/BLN-283-13-SF
BLN-283-13-WC

File No. GRS-033-09

Date March 17, 1983

From G. R. Schmidt

Of R&E/Materials & Quality
Services Department

At WC/E1/A4 Ext 930-2408

Transmitted with this IOM are six copies of a report covering our examination of a fractured bolt.

GR Schmidt

G. R. Schmidt

GRS/JCG/nlj

Attachment

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