Arizona Public Service Company

September 14, 1984
ANPP-30521-TDS/TRB

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

Attention: Mr. T. W. Bishop, Director
Division of Resident
Reactor Projects and Engineering Programs

Subject: Final Report - DER 83-57
A 50.55(e) Reportable Condition Relating To Cracks In The Control Element Assembly Shroud.
File: 84-019-026; D.4.33.2

Reference: A) Telephone Conversation between P. Johnson and R. Tucker on July 29, 1983
B) ANPP-27598, dated August 19, 1983 (Interim Report)
C) ANPP-28093, dated October 26, 1983 (Time Extension)
D) ANPP-28654, dated January 20, 1984 (Interim Report)
E) ANPP-29715, dated June 11, 1984 (Time Extension)
F) Telephone conversation between P. Narbut and T. Bradish on August 14, 1984
G) ANPP-30187, dated August 13, 1984 (Time Extension)

Dear Sir:

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

Very truly yours,

EEVanBrunt/TDS/K

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

EEVB/TRB/nj
Attachment

cc: See Page Two

1/1 IE-27

CE Doc. No. CEN-267(V)-P
- Revision 1-P -
Proprietary Copies

cc:

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File: DER 83-57	#38

* Non-Proprietary Copy Attached

FINAL REPORT - DER 83-57
DEFICIENCY EVALUATION 50.55(e)
ARIZONA PUBLIC SERVICE COMPANY (APS)
PVNGS UNITS 1, 2, 3

I. Condition Description

Inspection of the Palo Verde Unit 1 reactor internals subsequent to Pre-Core HFT in July 1983 revealed damage to the CEA shroud. The CEA shroud is part of the upper Guide Structure (UGS) assembly furnished by Combustion Engineering (C-E). The CEA shroud consists of an array of vertical round tubes arranged in a square grid pattern. The tubes are joined by welding vertical plates called webs between adjacent tubes. Tubes and webs are fabricated from type 304 stainless steel.

Guides for the 4-finger CEA extension shafts are attached to the top of the tubes and guides for the 12-finger CEA extension shafts are attached to the webs. These guides align the CEA extension shafts for entry into the closure head nozzles during closure head installation and into the internals lift rig during attachment.

The damage, revealed by visual and dye penetrant examination and documented by NCRs SM2470 and SM3155, consisted of the following:

1. A total of 13 cracks in eleven 4-finger CEA shroud tubes. In most instances, these cracks start in the welds at the attachment of the 4-finger CEA guides to the shroud tubes.

2. Two cracks involving the welds at the attachment of the 12-finger CEA extension shaft guides to the webs.

3. Three cracks involving the welds between 4-finger CEA shroud tubes and webs; two at the top of the shroud and one at the bottom.

4. One crack in the base metal of a web.

5. Three wear marks on the shroud at the 45° location.

6. One ductile break, one half-inch long, located in a web at the bottom.

Evaluation

The CEA shroud is a feature first used in the C-E System 80 reactor. The design is not used on other C-E NSSSs. In addition to Palo Verde Unit 1, similar CEA shrouds are part of the upper guide structure (UGS) delivered to Palo Verde Units 2 and 3, and other System 80 plants under construction.

The CEA shroud is not a core support structure under the definition of the ASME code, Section NG, and does not in itself perform a safety function. The assembly of tubes and webs serves to provide separation of the CEAs. Flow is restricted within the CEA shroud region, therefore, the shroud assembly is not subjected to significant operating loads.

The extension shaft guides located at the top of the shroud are provided to align CEA extension shafts for entry into the closure head nozzles during closure head installation. They have no function during reactor operation. Although not observed, a hypothetical, complete failure in CEA shroud tubes or webs particularly to the extent that extension shaft guides loosen or become detached would have potential adverse safety implications in that the insertion of CEAs could be impeded or prevented by interference with the loose components. The damage which was observed on the Palo Verde Unit 1 CEA shroud would not have prevented a reactor trip had it been present in an operating reactor.

An intensive investigative program was initiated by C-E to evaluate the nature and extent of the cracks which were observed in the CEA shroud and to determine the necessary modifications to correct the problems. The program included vibration tests, hydraulic and mechanical tests, analytical modeling and metallurgical examinations both at C-E and at independent testing labs. A combination of experimental and analytical results indicate the root cause to be vibration which caused the fatigue cracks in localized regions with high stress concentration. A modified design minimizes this stress concentration and limits the maximum possible amplitude of the likely damaging mode of vibration.

In addition to the fatigue cracking, the other principal failure mechanism was determined to be trans-granular stress corrosion cracking (TGSCC) due to concentrations of potassium hydroxide (KOH). This source of contaminant was traced to entrapped slag from the welding electrode coating from the shielded metal arc welding (SMAW) process used at the tube-to-web joints.

An evaluation to determine if other RCS components might have been affected by the KOH considered material in close proximity and overall RCS KOH concentration, i.e., KOH concentrations greater than 100 ppm at reactor-operating conditions will cause TGSCC. There was no evidence of TGSCC in either damaged or undamaged thread areas on adjacent parts. Furthermore, a conservative estimate determined a 1.4 ppm rise in KOH would occur in the RCS if all the flux in the tube-to-web joints were dissolved.

II. Analysis of Safety Implications

Based on the above, this condition is evaluated as reportable under the requirements of 10CFR50.55(e) since, if this condition were to remain uncorrected, it would represent a significant safety condition.

This project has also evaluated this condition as reportable under 10CFR21.21(b)(3). This report addresses the reporting requirements of the regulation with the exception of subpart (vi), regarding the number and location of such components supplied to other facilities. A copy of this report will be transmitted to C-E.

III. Corrective Action

The corrective actions taken were in two specific areas, i.e., CEA guide modifications and CEA shroud lateral support modifications, with a subsequent demonstration test to validate the adequacy of the modifications.

CEA Guide Modifications

The modification consists of removing the top three inches of the CEA shroud and all the 4-finger and 12-finger CEA guides. Since the guides have no function during normal operation, their function is provided by a separate tool, utilized only during refueling operations, which is not a permanent part of the vessel or the internals. This eliminates locations for crack initiation due to high stress concentration at the top of the tubes, the potential for interference with CEA insertion and the potential for resonance failure caused by vibration of the CEA guides.

Cutting three inches from the top of the CEA shroud eliminates the affects of the original welding of the guides. This length is reduced everywhere except at the eight tie rod locations and two locations for Reactor Vessel Level Monitoring System (RVLMS) probes. These shroud tubes remain full length to eliminate the need for changes to the tie rod assembly and to the Heated Junction Thermocouple RVLMS.

After cutoff, a minimum of three inches of the welds at the top between webs and shroud tubes were ground out and replaced with full penetration welds. An additional fillet weld was applied over this to minimize the stress concentration at the junctions. The bottom welds at the tie rod locations were also reworked in like manner. SMA welding, which led to the TGSCC failure mechanism, was not used for any rework.

CEA Shroud Lateral Support Modifications

The CEA shroud is held down to the Upper Guide Structure Support Plate by eight tie rods. Stiffness of the shroud assembly provides the restraint against lateral forces in the original design. Analyses indicated that global modes of vibration of the shroud could cause lateral deflection of the outer tubes and webs and would contribute to higher stresses. To limit such lateral deflections, four snubbers were added to the CEA shroud.

The snubber consists of three pieces. A snubber block assembly is shop welded into the three outermost shroud tubes on each of four sides of the shroud. A flange block assembly is field installed on the UGS barrel flange by pins and bolts. A hard shim is field fitted to the snubber block to provide a controlled clearance with the sides of the slot in the flange block. The completed snubber assembly allows radial and axial differential motion between the CEA shroud and the UGS barrel but restricts lateral or tangential motion to the amount of clearance at the shim.

The CEA guide modifications and the installation of the snubber block assembly onto the CEA shroud were performed by C-E at their Newington facility.

The field installation of the flange block assembly onto the UGS barrel was performed via DCPs (Reference 1).

These DCPs and the modifications by C-E as detailed in Reference 2 provide corrective action disposition of NCRs SM2470 and SM3155.

Demonstration Test

A demonstration test incorporating extensive instrumentation was performed on Unit 1 during July and August, 1984 to confirm the adequacy of the modified shroud and UGS under operating conditions and to determine actual loadings and structural responses. A detailed post-test inspection confirmed conclusions from the previous component tests and analyses that the modified CEA shroud is adequate for its design service.

A detailed description of the investigative and testing program, the results, and the physical modifications performed are included in Reference 2.

IV. References

1. DCPs 1SM-RC-112, 2SM-RC-112, 3CM-RC-112

2. C-E's Proprietary Final Report CEN-267 (V)-P, Rev. 1-P, dated August, 1984, Performance Evaluation of the Palo Verde Control Element Assembly Shroud.

'84 SEP 12 P2:15

WE2

C-E Power Systems
Combustion Engineering, Inc.
1000 Prospect Hill Road
Windsor, Connecticut 06095

Tel. 203/688-1911
Telex 99297

DOCUMENT CENTER

84-001-419.1

POWER SYSTEMS

Enclosure in locked cabinet. See Karen Jones or S & C Security personnel for access

September 10, 1984
V-CE- 30912

Mr. E. E. Van Brunt
Arizona Nuclear Power Project
P. O. Box 21666 - Sta. 3003
Phoenix, Arizona 85036

Subject: 10 CFR 50.55(e) Report on the Palo Verde CEA Shroud

Dear Mr. Van Brunt:

Enclosed for your submittal to the Nuclear Regulatory Commission is the 10 CFR 50.55(e) report on the Palo Verde CEA Shroud along with the proprietary affidavit. Copies 1 through 25 of the proprietary report are intended for submittal to the NRC. Copies 26 through 43 are provided for APS use. In addition, thirty-five copies of the non-proprietary version are also enclosed. This report is a final report and is considered complete.

If you have any questions feel free to call.

Very truly yours,

C. Ferguson
Project Manager

CF/TJC:jld
Enclosures
cc: D. B. Amerine w/copy 45
W. G. Bingham w/copy 44
T. R. Bradish
G. A. Butterworth
J. R. Bynum
J. W. Dilk
R. H. Holm
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*To Assign	WEI	
Resp. Mgr./ Supv	ACG	
	GCA	
	SCJ	
	BSK	
	DBF	
ANPF Management Distribution	ACR	✓
	WEI	
	BFG	
	ELL	
	FDS	✓
	TRB	✓ enc.
	WFQ	✓
	*EEVB, Jr.	✓ enc.
	ROUTE	
	F-U	

File
84-001-419.1 enc.

AFFIDAVIT PURSUANT

TO 10 CFR 2.790

Combustion Engineering, Inc.)
State of Connecticut)
County of Hartford) SS.:

I, A. E. Scherer, depose and say that I am the Director, Nuclear Licensing, of Combustion Engineering, Inc., duly authorized to make this affidavit, and have reviewed or caused to have reviewed the information which is identified as proprietary and referenced in the paragraph immediately below. I am submitting this affidavit in conformance with the provisions of 10 CFR 2.790 of the Commission's regulations and in conjunction with the construction permit of Arizona Public Service Company, for withholding this information.

The information for which proprietary treatment is sought is contained in the following document:

CEN-267(V)-P Revision 1-P Final Report on the Performance Evaluation of the Palo Verde Control Element Assembly Shroud, August 1984.

This document has been appropriately designated as proprietary.

I have personal knowledge of the criteria and procedures utilized by Combustion Engineering in designating information as a trade secret, privileged or as confidential commercial or financial information.

Pursuant to the provisions of paragraph (b) (4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure, included in the above referenced document, should be withheld.

1. The information sought to be withheld from public disclosure are experimental data from the Palo Verde 1 Comprehensive Vibration Assessment Program (CVAP), demonstration test, and other associated laboratory tests, detailed design data and analytical results for the Control Element Assembly (CEA) shroud, which is owned and has been held in confidence by Combustion Engineering.

2. The information consists of test data or other similar data concerning a process, method or component, the application of which results in a substantial competitive advantage to Combustion Engineering.

3. The information is of a type customarily held in confidence by Combustion Engineering and not customarily disclosed to the public. Combustion Engineering has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The details of the aforementioned system were provided to the Nuclear Regulatory Commission via letter DP-537 from F.M. Stern to Frank Schroeder dated December 2, 1974. This system was applied in determining that the subject document herein are proprietary.

4. The information is being transmitted to the Commission in confidence under the provisions of 10 CFR 2.790 with the understanding that it is to be received in confidence by the Commission.

5. The information, to the best of my knowledge and belief, is not available in public sources, and any disclosure to third parties has been made pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence.

6. Public disclosure of the information is likely to cause substantial harm to the competitive position of Combustion Engineering because:

a. A similar product is manufactured and sold by major pressurized water reactor competitors of Combustion Engineering.

b. Development of this information by C-E required thousands of man-hours of effort and hundreds of thousands of dollars. To the best of my knowledge and belief a competitor would have to undergo similar expense in generating equivalent information.

c. In order to acquire such information, a competitor would also require considerable time and inconvenience related to the detailed design, testing, and analysis for the Control Element Assembly shroud.

d. The information required significant effort and expense to obtain the licensing approvals necessary for application of the information. Avoidance of this expense would decrease a competitor's cost in applying the information and marketing the product to which the information is applicable.

e. The information consists of experimental data and the associated laboratory tests, detailed design data, and analytical results for vibration testing of the Control Element Assembly shroud at Palo Verde 1, the application of which provides a competitive economic advantage. The availability of such information to competitors would enable them to modify their product to better compete with Combustion Engineering, take marketing or other actions to improve their product's position or impair the position of Combustion Engineering's product, and avoid developing similar data and analyses in support of their processes, methods or apparatus.

f. In pricing Combustion Engineering's products and services, significant research, development, engineering, analytical, manufacturing, licensing, quality assurance and other costs and expenses must be included. The ability of Combustion Engineering's competitors to utilize such information

without similar expenditure of resources may enable them to sell at prices reflecting significantly lower costs.

g. Use of the information by competitors in the international marketplace would increase their ability to market nuclear steam supply systems by reducing the costs associated with their technology development. In addition, disclosure would have an adverse economic impact on Combustion Engineering's potential for obtaining or maintaining foreign licensees.

Further the deponent sayeth not.

A. E. Scherer
Director
Nuclear Licensing

Sworn to before me
this 4th day of September,
1984

Sally A. Almstead
Notary Public
My Commission
expires 3/31/86