ORGANIZATION: COMBUSTION ENGINEERING, INCORPORATED
POWER SYSTEMS GROUP
WINDSOR, CONNECTICUT

REPORT NO.: 99900401/82-04	INSPECTION DATES: 10/25-29/82	INSPECTION ON-SITE HOURS: 26

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Power Systems Group
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PRINCIPAL PRODUCT: Nuclear Steam Supply Systems

NUCLEAR INDUSTRY ACTIVITY: The Power Systems Group of Combustion Engineering (CE) has contracts for 22 of the domestic reactor units to date, of which 14 are in the design and construction phase. In addition, they have modification/repair/service contracts for 22 reactor units.

ASSIGNED INSPECTOR: W. M. McNeill — 12/8/82
W. M. McNeill, Reactive & Component Program Section (R&CPS) — Date

OTHER INSPECTORS:

APPROVED BY: I. Barnes — 12/8/82
I. Barnes, Chief, R&CPS — Date

INSPECTION BASES AND SCOPE:

A. BASES: Topical Report CENPD-210-A, Revision 3 and 10 CFR Part 21.

B. SCOPE: This inspection was made as a result of the identification at the Arkansas Nuclear One, Unit 2 (ANO-2) facility of insufficient clearance between fuel rods and the upper flow plate in Batch C fuel assemblies. Specific areas reviewed during inspection of this subject included: design process control (ANO-2 shoulder gap and fuel assembly AKC-204); 10 CFR Part 21; statistical screening criteria; zircaloy growth models; and design calculations and their verification.

PLANT SITE APPLICABILITY: Docket No. 50-368.

DESIGNATED ORIGINAL
Certified By Rueanne Clark

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A. VIOLATIONS:

None

B. NONCONFORMANCES:

Contrary to Section 17.5 of the Topical Report and Quality Assurance of Design Procedure (QADP) No. 5.7, Sections 1.4.1.3, 2.4.1, and 2.4.2, the shoulder gap modification of Batch C assemblies for ANO-2 was accomplished without the implementation of the design change procedure as evidenced by:

1. An FAR was not issued to document the problem and its solution.

2. No documentation was available which would indicate that a review had been performed in regard to: (a) determination of the cause and corrective action, (b) applicability to other projects, and (c) determination if changes are required to the design process to prevent similar deficiencies.

C. UNRESOLVED ITEMS:

None

D. OTHER FINDINGS OR COMMENTS:

1. Design Process:

   a. ANO-2 Shoulder Gap - The mechanical design of the shoulder gap was inspected with respect to the initial core (Batches A, B, and C), reloads D and E, and the Batch C modification. The shoulder gap modification was made to prevent fuel rod contact with the upper flow plate and subsequent bowing. It consisted of the addition of a shim between the bottom of the upper flow plate and the top of the fuel rods. The design review, design calculation log, and lists of qualified design reviewers were inspected. The physics input data, the design criteria, and bases were examined. The computer programs and their verification were also inspected. The design drawings (design output) were examined, and the statistical screening calculations plus models used to identify the Batch C fuel assemblies to be modified were inspected. Shoulder gap measurements at the end of Cycle 2 were also reviewed.

b. Fuel Assembly AKC-204 - It was also noted that one fuel assembly, AKC-204, was identified in the manufacturing order as not having its center guide tube to be sleeved. This is contrary to previous information supplied to the NRC which stated that all center guide tubes would be sleeved. The modification of AKC-204 was stated to have encountered a condition which precluded the center guide tube's sleeving.

2. 10 CFR Part 21:

CE personnel stated that the shoulder gap closure problem was not considered to be of a magnitude which would require evaluation with respect to 10 CFR Part 21 requirements. Accordingly, there was no documentation of this problem as having being reviewed in accordance with CE 10 CFR Part 21 Procedure API-17 requirements. In regard to the shoulder gap, CE had reportedly identified a concern in this area to ANO on July 13, 1982. A design calculation (6370-610-94) was begun on July 17, 1982, and completed with its design review on September 17, 1982. This calculation predicted an end of Cycle 3 gap of 0.050 inches and, consequently, concluded there was no shoulder gap closure problem. On July 27, 1982, Manufacturing Order 9030355, Supplement 9 was issued to fabricate the shims in accordance with an engineering sketch. On August 30, 1982, the first special inspection instructions were issued on the ANO-2 Batch C fuel for measurement and evaluation of gap closure. On October 5, 1982, CE informed the NRC in a memorandum of the condition. Based on the above, it was not possible to establish when the shoulder gap question was indeed identified as a problem by CE engineering and management. CE management and engineering monthly reports were not made available to allow establishment of the applicable time frame in regard to identification of the problem.

3. Statistical Screening Criteria:

The statistical screening criteria used to establish which Batch C fuel assemblies were required to be modified has no quantified confidence level. The screening was performed assuming the worst case of shoulder gap closure rate that had been observed at the end of Cycle 2 in two pre-characterized (i.e., premeasured) Batch C assemblies. The prediction of end of Cycle 3 shoulder gaps was then made using end of Cycle 2 shoulder gap measurements of observable rods and utilizing the growth rate identified above with a projected fluence for Cycle 3. It was then simulated (Monte Carlo) what the nonobserved rods' shoulder gap distribution would be with the same identified growth rate, highest range of projected fluences, and a projected worst gap based on a 99.5% distribution of the observed gaps. If less than 5% of the above rod simulations resulted in a gap of less than zero, an assembly was accepted. Hence, accepted assemblies have a 95% probability that no rod will contact.

However, because of the "worst case" assumptions and the Monte Carlo simulation, no confidence factor is apparent; e.g., 95% confidence that there is a 95% probability that no rod will contact.

4. Zircaloy Growth Models:

The data collected by CE after Cycle 1 and reported under an Electric Power Research Institute (EPRI) project published in July 1982 (Report No. CE NPSD-174) used models which predicted greater fuel rod growth and less guide tube growth than the models used in the original or even the current design. The shoulder gap modification was necessitated because of under prediction of the shoulder gap closure that results from differential growths of the fuel rods and the guide tubes within the fuel assembly. The current constants used by CE in the equations for predicting zircaloy growth under irradiation are referenced in Topical Report CENPD 198-P. These constants are smaller than the constants used with these equations in the EPRI report. The data points for ANO-2 Cycle 1 fuel rod growth fall within 95% confidence limit bands around a line of best fit of the design equation. However, the larger constants as in the EPRI report showed better agreement with the line of best fit. In regard to guide tubes, it was noted that data points lay below the 95% confidence limits of the design model. This has been reported (EPRI report) as being related to fuel assembly hold down spring pressure.

5. Design Calculations and their Verification:

It was observed that some of the design calculations were not controlled, in that:

a. The statistical screening criteria and the mechanical design of the modified fuel had not been given the required design verification as of the inspection date, although the modification had been completed.

b. The mechanical design calculation for the modified fuel was not entered into the design log books. Entering the calculation in the logs identifies it as part of the design process for that project.

c. The historical calculation which established the larger shoulder gap for the Batch D fuel and assumed higher burn-up, could not be found. Because of the larger shoulder gap used for Batch D fuel assemblies, no modification is required.

PERSONS CONTACTED

Company Combustion Eng. Dates 10/25-29/82

Docket/Report No. 99900401 Inspector McNeill

	NAME(Please Print)	TITLE(Please Print)	ORGANIZATION(Please Print)
*	CLIFF HOFFMAN	DIR. QA	C.E.
*	RALPH LALLY	QA MGR.	MIDDLE SOUTH SERVICES
*	GEO HUBA	NUCLEAR ENG QA	CE
*	PETE FORD	QA ENG SUPER.	"
	GENE HARVEY	QA ENG	"
	STEV HATFIELD	FUEL DESIGN MECHICAL SUPER.	"
	RICK BRODERS	FUEL DESIGN ENG	"
	HENRY ANDREWS	MGR FUEL TECH	"
	JOHN HERRS	MGR RELIABILITY SYSTEMS	"
	BRIAN WOODMAN	RELIAB. ENG	"
	LARRY CORSETTI	RAD TESTING SUPER	"
*	JOE ROGERS	LICEN.	"

* Attended Exit Meeting

Inspector McNeill

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DOCUMENTS EXAMINED

1	2	TITLE/SUBJECT	3	4
WADP 5.0	3	DESIGN PROCESS	July 1 '80	1
5.4	3	DESIGN VERIFICATION	APRIL 30 '81	3
6.2	3	TECHNICAL CHANGE REQUEST (TCR)	MAY 1 '80	2
CAP 16.1	3	CORRECTIVE ACTION REPORT	3/31/81	B
15.2	3	DCR REVIEW	3/31/81	B
4.1	3	PROCUREMENT DOCUMENT CONTROL	3/31/81	B
6370-610-39	9	STATISTICAL DETERMINATION OF THE END OF LIFE AXIAL GAP BETWEEN FUEL ROD AND FLOW PLATE	10/11/77	-
6370-610-B1	9	SAME AS ABOVE FOR BATCH D	1/29/80	-
6370-610-92	9	" " E	5/17/82	-
2500-610-27	9	VERIFICATION of SIGREEP	9/27/79	-
18-424	10	AXIAL CREEP AND GROWTH of COLD WORKED AND ANNEALED S.T.	10/27/79	-
9431135	5	Mfg Order ABC	1-8-79	108
9830498	5	D	3-27-81	17
9830355	5	E	8-10-82	10
CA-074	9	QUALIFICATION (VERIFICATION) of SIGMA I	2-9-77	-
18-P	10	ZIRCALOY GROWTH	DEC 75	—

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchas Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)
9. ANALYSIS
10. REPORT

Columns:
1. Sequential Item Number
2. Type of Document
3. Date of Document
4. Revision (If applicable)

Inspector McNeill

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DOCUMENTS EXAMINED

1	2	TITLE/SUBJECT	3	4
A-PH-602	10	Physics Input to Batch E	5/14/82	—
A-PH-327	10	PHYSICS DATA FOR ANO-2 BATCH D	7/26/79	—
TR-FMDT-003	10	T.R. IN-REACTORS DIMENSIONAL CHANGES IN ZIRC4	5/12/75	—
PHR-77-103	10	PHYSICS RELATED DESIGN BASES	5/27/77	—
E-STD-161-114	1	UPPED END FIT	—	06
E-STD-161-103	1	FUEL ASS'Y DETAILS	—	05 & 07
ECE 81-030	10	FUEL DESIGN LIST OF QUALIFIED REVIEWERS (BACK TO 1977)	JUNE 1 '82	—
CE NPSD-174	10	EXAM OF ANO-2 CHARACTERIZED FUEL AFTER CYCLE 1	July '82	
RP586-1	10	FAB & CHARACTERIZATION OF ANO-2 16x	Oct '82	
—	—	LOG OF CAL' FUEL MECH. DESIGN	—	—
—	—	SHOULDER GAP DATA SHEETS dated 9-15-82 to 9-30-82	—	—
—	—	DCR & TCR's for batches A, B, & C	—	—
—	—	Computer Input/Output of Shoulder Gap-	—	—
		FUEL SITE SURVEILANCE REPORTS		
9130037	3	SUPPLEMENT 6-8	9/17/82	—
6370 16-10-1	2	Design Criteria BATCH A, B, C	2-4-77	2
DC-STD 610-2	2	Design Criteria BATCH D & E	1/11/79	—

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchas Order
6. Internal Memo
7. Letter
8. Other (Specify-If necessary)
9. Analysis
10. Reports

Columns:
1. Sequential Item Number
2. Type of Document
3. Date of Document
4. Revision (If applicable)

Inspector McNeill

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DOCUMENTS EXAMINED

1	2	TITLE/SUBJECT	3	4
6370-610-28	9	ANO/DOE Clad Collapse and Dimensional Change Ver	7/10/81	—
6370-610-98	9	ANO II Cycle 3 Fuel Loading Justification	9/17/82	
CENPD-198	10	Supplement to CENPD-198-P	Dec 77	1
"	10	"	Nov 78	2
CENPSD-146	10	Examination of Calvert Cliffs 1 Test Fuel Assembly after cycle 4	OCT 81	-
-	9	Draft Analysis of 1/2" Shim	—	—
API-17	3	REPORTING OF SAFETY HAZARDS	1/23/79	2
A-CCE-03	6	ANO-2 EOC 2 Cold out of Core Shoulder Gap Requirements	8/30/82	—

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