DEC 4 1974

Docket Nos. 50-269 ✓
50-270 50-287
50-289 50-302
50-312 50-320
50-346

Babcock & Wilcox Co.
ATTN: James F. Malloy
Manager, Licensing
Power Generation Group
P. O. Box 1260
Lynchburg, Virginia 24505

Gentlemen:

Thank you for your two letters dated November 18, 1974 which forwarded generic evaluations on a) the design deficiency identified on the Control Rod Drive AC Breaker Cabinet Seismic Attachment, and b) the design deficiency on the Internals Handling Fixture Spherical Nut. These reports will be evaluated and should we require additional information, we will contact Mr. Williamson as requested.

Your cooperation on this matter is appreciated.

Sincerely,

Original signed by
J. G. Davis

John G. Davis, Deputy Director
for Field Operations
Directorate of Regulatory Operations

bcc: with copies of letters & reports:
PDR
LPDR } All docket numbers
NSIC referenced above
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RO: Files
DR Central Files
N.C. Moseley, Dir, RO:II
J. P. O'REilly, Dir, RO:I
J. G. Keppler, Dir, RO:III
R. H. Engelken, Dir, RO:V

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TO: Mr. Karl Goller	ORIG 1 signed	CC	OTHER	SENT AEC PDR XX SENT LOCAL PDR XX		
CLASS	UNCLASS XXX	PROP INFO	INPUT	NO CYS REC'D 1	DOCKET NO: 50-269	

DESCRIPTION: Ltr re our 7-23-74 ltr.....& re Duke Power Co's ltr of 8-22-74....trans the following:

ENCLOSURES: Program for Insertion of Zirconium Oxide Spaces in Oconee I, Batch 4.....

(1 cy encl rec'd)

ACKNOWLEDGED
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PLANT NAME: Oconee I

FOR ACTION/INFORMATION

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A. C. THIES
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Regulatory File Cy.

October 23, 1974

Mr. Karl R. Goller
Assistant Director for Operating Reactors
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Re: Oconee Unit 1
Docket No. 50-269

Dear Mr. Goller:

As additional response to your letter of July 23, 1974, please find attached the non-proprietary version of B&W's report describing the insertion of zirconium-oxide spacers in an Oconee 1, Batch 4 fuel assembly. My letter of August 22, 1974 provided you specific identification of information contained in this report considered to be proprietary, together with a full explanation of why that information should be withheld from public disclosure.

The attached non-proprietary version of B&W's report may be placed in the Public Document Room.

Very truly yours,

A. C. Thies

A. C. Thies

ACT:vr
Attachment

11100

PROGRAM FOR INSERTION OF ZIRCONIUM OXIDE SPACERS IN OCONEE 1, BATCH 4

Received w/Ltr Dated 10-23-74

I. INTRODUCTION

The following is a description of a program for loading ZrO_2 spacers between UO_2 pellets in one fuel rod of an Oconee 1, Batch 4B fuel assembly. Displacement of fuel pellets with ZrO_2 spacers will create gaps of known size which can be used to further calibrate the movable incore detectors (MIDS). Such in-reactor data will confirm the ability of the MIDS to detect densification gaps and would thus be of significant benefit in the effort to reduce densification penalties. Inclusion of known gaps in a batch 4B assembly will not adversely affect full power operation during the core residence time of the assembly (cycles 2,3, and 4). ZrO_2 spacers have been irradiated previously in a similar test at Point Beach #1 (Ref. 1).

II. ANALYSIS

A. Spacer Loading

Three ZrO_2 spacers having lengths of 0.40, 0.70, and 1.00 inches will be loaded into a fuel rod adjacent to the instrument tube (see Figure 1) in a batch 4B (3.20 wt % 235 U) assembly. The axial locations of the spacers are indicated in Table 1 and Figure 2. The axial locations were chosen to place the larger gaps in the low power regions indicated by 3D PDQ calculations consistent with the fuel densification power spike factors currently accepted by the USAEC (Reference 2).

The assembly containing the spacers will be loaded into core position D-14 (see Figure 3). This position has a relatively low power during cycle 2 and is a position in which a MIDS drive can be mounted. The spacer assembly is scheduled to be moved to core position F-13 (or a position symmetric with F-13) at the end of cycle 2 and should remain in that position during cycles 3 and 4. The assembly will be discharged at the end of cycle 4. Both core locations D-14 and F-13 contain fixed incore detectors which will provide monitoring of the spacer assembly.

B. Power Peaking

Power peaking caused by the simulated gaps only (coplanar densification gaps not included) has been determined using data from Reference 2. Table 2 shows that the power increase in rods adjacent to the simulated gaps will be much less than the power increase imposed by the current power spike model (Ref. 2) for hypothetical gaps due to fuel densification. Table 2 also shows that the power increase in adjacent rods is less than is calculated with B&W's revised power spike model, which is currently being reviewed by the USAEC.

The effect on power peaking of additional gaps coplanar with the simulated gaps has been calculated using both the current and revised power spike models. Calculations were made for the spacer assembly by including gaps represented by the ZrO_2 and for a normal assembly in

which only gaps due to postulated densification were considered. The spacer assembly calculations include the effects of both the ZrO_2 gaps and gaps due to hypothetical densification. Batch 4B fuel parameters (3.20 wt% 235 U, initial density of 95% and final density of 96.5%) were used in the calculations. Results indicate a maximum power spike increase due to the spacers of 2.1% with the current power spike model and [value of spike] based on the revised model (Table 3).

The spacer assembly will be placed in low power positions to insure that even with a [value of spike] increase in local peaking the spacer assembly power will be significantly less than the power in the hottest assembly. Calculations for fuel cycles 2 and 3 indicate that the maximum power in the assembly containing the ZrO_2 spacers will be no greater than 1.26 times the core average assembly power and no greater than 0.85 times the maximum assembly power in the core. Relative power values for the spacer assembly for cycles 2 and 3 are given in Table 4. The power in the twice-burned spacer assembly during cycle 4 is expected to be no greater than the cycle 3 power. Application of the maximum increase in the power spike factor for the spacer assembly ([value of spike] - Table 3) yields a spacer assembly power that is no greater than [value of spike] times the maximum assembly power.

C. Materials Compatibility

Zirconia spacers can be used in zircaloy clad UO_2 fuel rods with no adverse effects due to materials incompatibility. The spacers proposed for use in Oconee 1 are stabilized zirconia containing 3 wt% CaO in solid solution. The spacers are to be used to create axial gaps in the fuel column by inserting a set of annular zirconia spacers with a zirconia disk at the top (see Figure 2). The spacers will be in contact with the zircaloy cladding and the fuel pellets. The compatibility of the zirconia with the cladding has been demonstrated by a test conducted at the Lynchburg Research Center in which zirconia and zircaloy were kept in intimate contact for 2, 3, and 4 months at 700 F.

There will be no compatibility problem with the zirconia disk and the UO_2 pellet. The maximum fuel temperature expected is 2260°C (4100°F). At that temperature there will be a solid state reaction of the zirconia with the UO_2. In the reaction zone, the melting point will be lowered to 2550°C (4622°F). The presence of CaO will also lower the melting point. The melting point of the calcia-zirconia-urania system in the reaction zone has been found to be greater than 2450°C. No gross structural changes are expected except for a slight increase in volume (6% maximum) at a UO_2 concentration of 12 wt.%.

The increase in volume will be more than offset by high temperature sintering. The length change of the gap fabricated by the addition of zirconia spacers will be confined to a UO_2-ZrO_2 reaction in the spacer disk and will be limited to an observable length change of approximately 0.1 inch during the three cycles of irradiation.

Babcock & Wilcox has irradiation experience with UO_2 fuel and stabilized zirconia spacers. B&W conducted a high and low burnup irradiation program in which experimental fuel rods containing foamed zirconia spacers were run at high linear heat ratings (up to 26 kw/ft) in the Babcock and Wilcox test reactor. These fuel rods were irradiated to burnups of up to 60,000 MWD/MTM. The post irradiation examination showed no evidence of incompatibility of the zirconia with the zircaloy 4 cladding. A solid-state reaction occurred between the UO_2 fuel pellets and zirconia as expected, but no adverse effects were noted.

D. REFERENCES

1. Hellman, J. M., "Fuel Densification Experimental Results and Model for Reactor Application," WCAP-8219, October, 1973 (p. 2. 6-1).

2. Fuel Densification Report, BAW-10054, Rev. 2, May 1973.

TABLE 1

SPACER AXIAL LOCATIONS

Spacer Length, Inches	
0.40 [Tolerance on spacer length]	Between 3rd and 4th Spacer Grids - 73 [tolerance on location] from lower end of active fuel
0.70 ["]	Between 4th and 5th Spacer Grids - 95 [tolerance on location] from lower end of active fuel
1.00 ["]	Between 5th and 6th Spacer Grids - 117 [tolerance on location] from lower end of active fuel

TABLE 3

POWER PEAKING WITH COPLANAR GAPS

Spacer Length, in.	Distance From Lower End of Active Fuel, in.	Power Spike Factor: Current Power Spike Model (reference 2)			Power Spike Factor: Revised Power Spike Model		
		Normal Assembly	Spacer Assembly	% Increase	Normal Assembly	Spacer Assembly	% Increase
.40	73	1.053	1.066	1.2	[Power Spike Factor % Increase]		
.70	95	1.070	1.088	1.7			
1.00	117	1.090	1.113	2.1			

[tolerance on location]

TABLE 2

POWER PEAKING DUE TO GAPS

ZrO_2 Simulated Gaps (Effect of hypothetical coplanar gaps not included)						
Spacer Length, inches		Distance from Lower End of Fuel, inches		Power Spike Factor in Adjacent Rod*	Power Spike Factor for 95%TD Fuel Based on Current Power Spike Model**	Power Spike Factor for 95%TD Fuel Based on Revised Power Spike Model***
.40	[tolerance on spacer length]	73	[tolerance on location]	1.015	1.053	[Power Spike Factor]
.70		95		1.023	1.070	
1.00		117		1.031	1.090	

*From figure 2.4-2, reference 2

**Calculated for 3.2 wt.% 235 U, TDI = 95.0, TDF = 96.5 as per reference 2

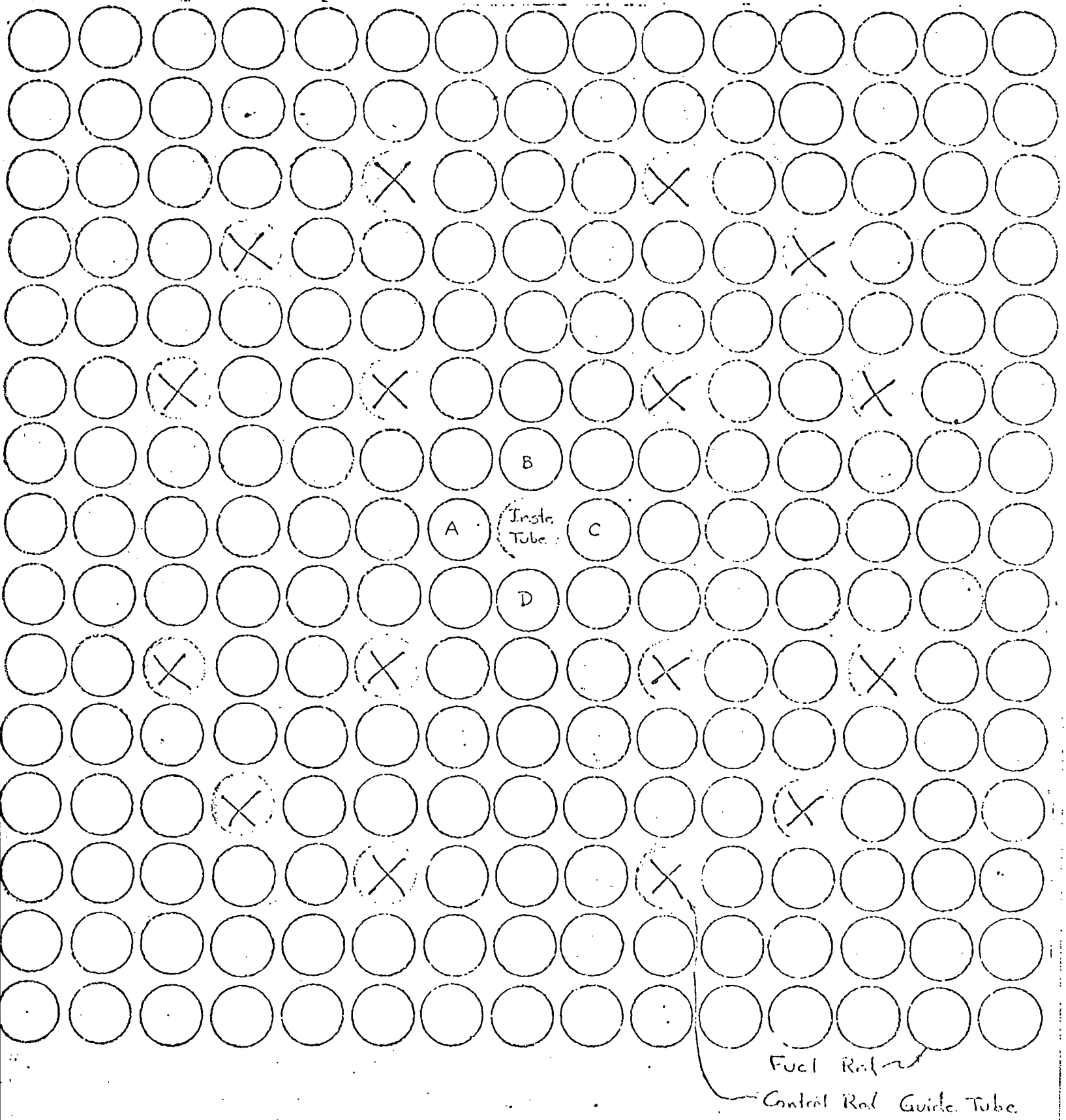
***Calculated for 3.2 wt.% 235 U, TDI = 95.0, TDF = 96.5 as per reference 3

TABLE 4

EFPD	Power in Assy. with ZrO_2 Spacer/Max Assy. Power		Power in Assy. with ZrO_2 Spacer/Avg Assy. Power	
	Cycle 2	Cycle 3	Cycle 2	Cycle 3
0	.53	.74	.83	1.15
4	.52	.74	.81	1.14
25	.51	.76	.80	1.14
50	.58	.79	.89	1.15
100	.57	.81	.86	1.14
150	.57	.82	.86	1.14
200	.57	.83	.85	1.14
265/267	.36	.83	.59	1.26
290/292	.43	.85	.65	1.23
CY2/CY3				

FIGURE 1

LOCATION IN ASSEMBLY OF ROD CONTAINING SPACERS



Rod Containing ZrO_2 Spacers should be placed immediately adjacent to instrument tube position A or B or C or D

BABCOCK & WILCOX

FIGURE 2

SPACER CONFIGURATION

All Dimensions in Inches

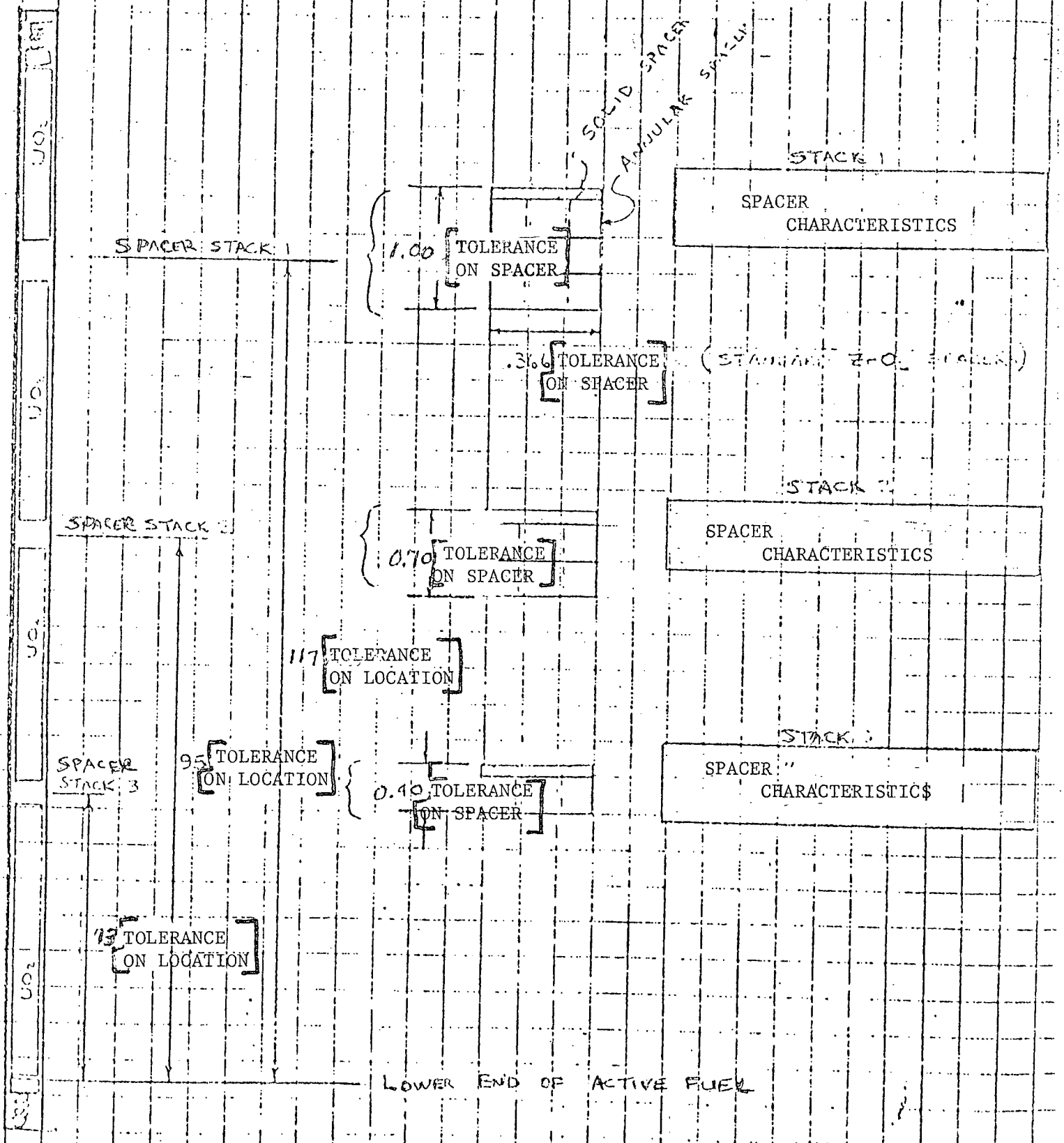
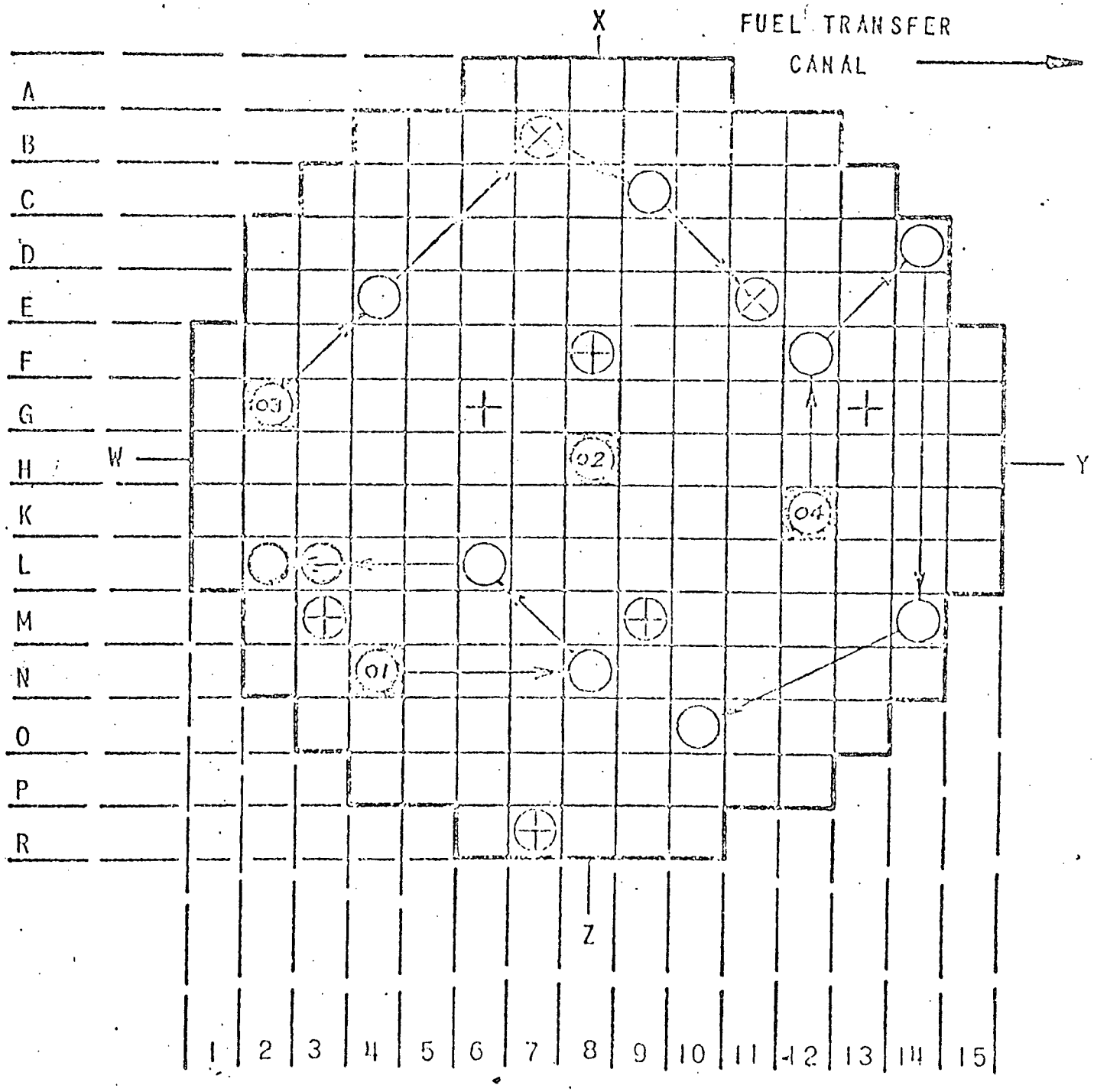


FIGURE 3 CORE LOCATIONS FOR MIDS Gd DETECTOR FLUX MAPPING

MOVABLE INCORE DETECTOR SYSTEM
DRIVE MECHANISM/FUEL ASSEMBLY
IDENTIFICATION



DRIVE MOUNTING LOCATION

INSTALLED DRIVE

DRIVE CONTROL NUMBER

LOCATION OF Rh

LOCATION OF BKG