

PLUS 7 I Core Operating Analysis of PLUS 7 Lead Test Assembly

493

PLUS 7 (Lead Test Assembly) 4
 . 2003 9
 8000 MWD/MTU , CECOR
 ROCS , 가 . 4
 가 .
 ROCS RMS 4.0%
 5% . (Fq, Fxy, Fr Fz)
 (Fq, Fr, Fz : 10% Fxy : 7.5%) .
 Fz 4 ROCS
 . Fxy Fxy 0.97 가
 . 3 5

Abstract

4 LTA's of PLUS 7 are operating in Ulchin Unit 3 Cycle 5 that is Korean Standard Nuclear Power Plant. Using the measured operating data (snapshot file), the main nuclear measured data produced by CECOR code are evaluated by comparison with those predicted by ROCS code as of September 2003(~8000 MWD/MTU). At first, the core power distribution is checked to evaluate the effect of LTA on core power distribution. The maximum radial and axial RMS error between ROCS and CECOR is ~4% which is well below the PAT acceptance criteria of 5%. The difference of core peaking factors (Fq, Fxy, Fr and Fz) between ROCS and CECOR are also within the acceptance criteria (7.5% for Fxy and 10% for Fq, Fr and Fz). The measured power distribution and Fz of 4 LTA's are symmetric and agree with those of ROCS. And the ratio of LTA Fxy to core maximum Fxy is less than 0.97 that is design target. As results, it is conformed that the power distribution and peaking factor, Fz of LTA agree with those of ROCS and the trend of core operating history, core power distribution and peaking factors are very similar with other KSNP reload cores.

1.

16X16
 1999 4 (PLUS 7)
 [1]. PLUS 7 1) , 2) , 3)
 , 4) , 5) , 6) , 7)
 [1]. 2 3
 5 (Lead Test Assembly) 4
 [2]. 2003 9 8000 MWD/MTU (17000 MWD/MTU)
 1/2 . PLUS 7 가 3 5
 , 4
 , 가 .

2. PLUS 7

< 1> PLUS 7 [1]. 3 5
 가
 Axial Blanket .

	< 1>	PLUS 7	
	: 9.7mm : Zry-4 : 8.26mm TD: 95.25%(1.818kg/pin) Axial Blanket :	: 9.5 mm : Zirlo : 8.19mm TD:95.50%(1.825kg/pin) Axial Blanket:	UO ₂ 가 WH 17X17
	: : : / /	: : / : / /Contour	
	: Zry-4 :Inc. : : / /	: Inc. : Inc. : : :	
	/ :	/ :	/ /
+	: (hole) Guardian Grid	: (hole/slot) Protective Grid	

3.

< 1> 8000 MWD/MTU

100%

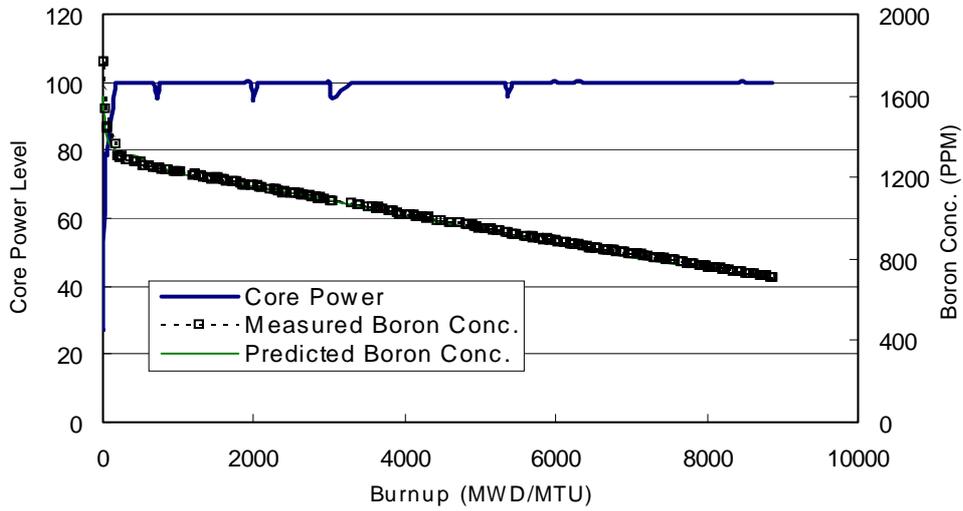
(: Borono-meter
가)

< 2> 가 ASI(Axial Shape Index)
. ASI

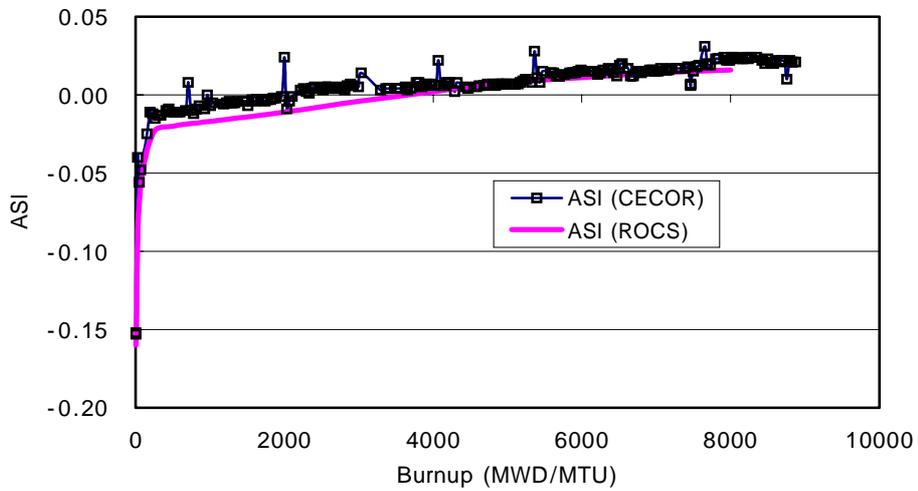
$$ASI = \frac{P_B - P_T}{P_B + P_T} \quad P_B: , P_T:$$

ASI ROCS [3]가

가 ROCS



< 1> (0 8000 MWD/MTU)



< 2> CECOR vs. ROCS ASI (0 8000 MWD/MTU)

4. 가

4.1 가

가

RMS(Root Mean Square) 가 RMS [4].

$$RMS = \sqrt{\frac{\sum_{i=1}^N (\Delta RPD)_i^2}{N}}, \quad \Delta RPD:$$

< 3> ROCS CECOR [5] RMS

RMS 8000 MWD/MTU 4.0%

(5%)[4]

RMS 가 (~1.5%)

RMS 가

가

가

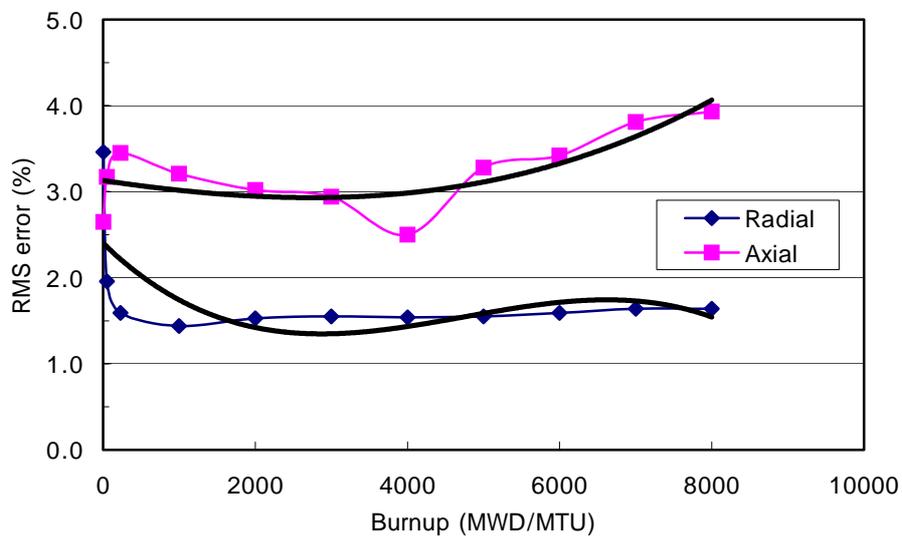
가 “ (Saddle Shape)”

RMS Fz CECOR

가

RMS

가가 가 (Gd_2O_3)



< 3>

RMS

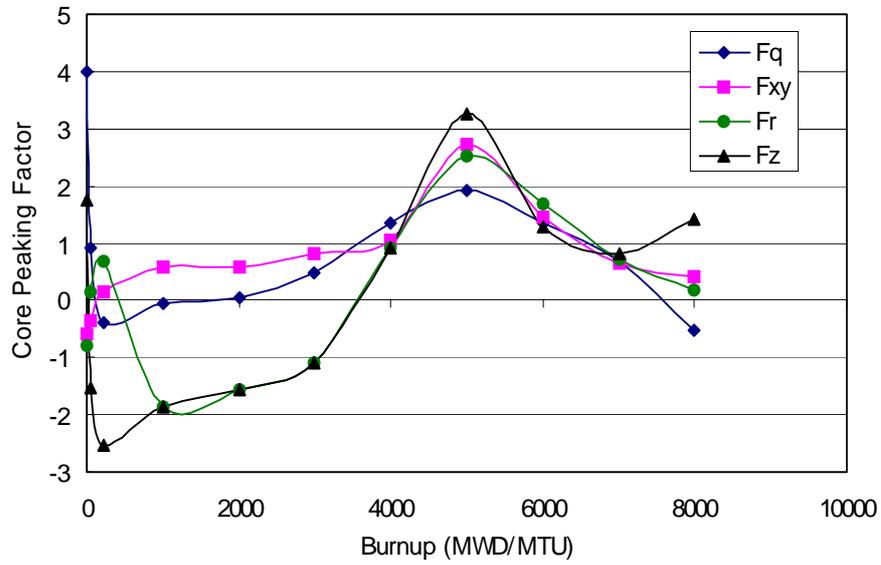
4.2 가

< 4>

ROCS CECOR

(F_q, F_{xy}, F_r, F_z)

7.5%(Fxy), 10%(Fq, Fr Fz)



< 4>

4.3

가

< 7>

가

3

5

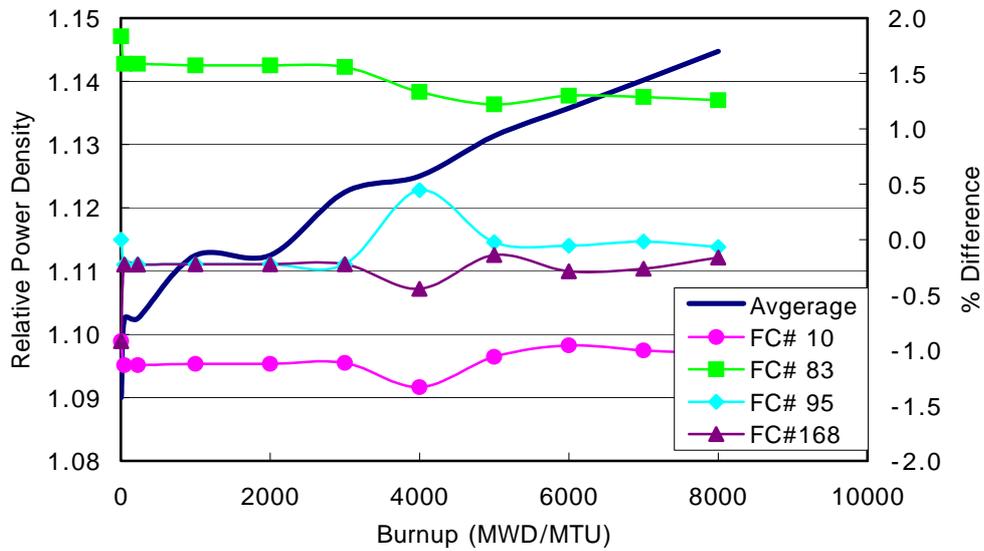
4

< 5>

가

가

±2%



< 5>

< 2>
(30%)

ROCS CECOR

1%

(:)

0.9

±10%

).

< 2>

(MWD/MTU)	CECOR	ROCS	%Difference (CECOR/ROCS-1)*100
5	1.0900	1.1042	-1.29
50	1.1025	1.1075	-0.45
500	1.1025	1.1076	-0.46
1000	1.1125	1.1132	-0.06
2000	1.1125	1.1210	-0.76
3000	1.1225	1.1281	-0.50
4000	1.1250	1.1336	-0.76
5000	1.1314	1.1376	-0.55
6000	1.1358	1.1406	-0.43
7000	1.1402	1.1430	-0.24
8000	1.1448	1.1463	-0.13

< 6>

Fz

Fz

Fz

Fz

가

(~1.1)

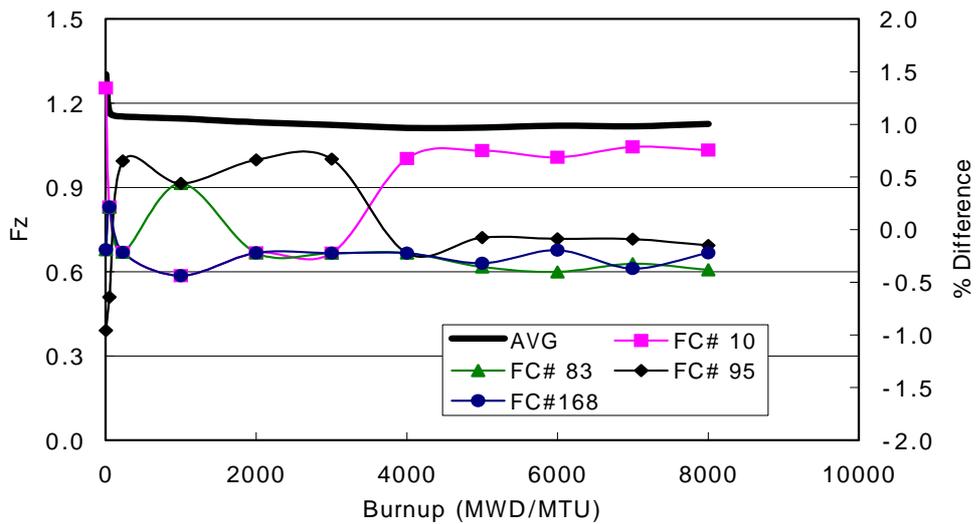
Fz

±1%

4

Fz

가



< 6>

Fz

PLUS 7

Fxy 가

. < 3>

Fxy

10% 가 Fxy 가 (8w/o, 8)
 [6] 가 Fxy 가
 0.97

< 3> Fxy vs. Fxy (CECOR)

(MWD/MTU)	Core Peak Fxy	LTA Fxy	Ratio Fxy(LTA)/Fxy(CORE)
5	1.5645	1.4092	0.90
50	1.5501	1.4083	0.91
500	1.5468	1.4060	0.91
1000	1.5478	1.4007	0.90
2000	1.5472	1.3982	0.90
3000	1.5462	1.3893	0.90
4000	1.5437	1.3857	0.90
5000	1.5420	1.3822	0.90
6000	1.5386	1.3815	0.90
7000	1.5375	1.3815	0.90
8000	1.5368	1.3812	0.90

5.

PLUS 7
4
가 3 5
8000 MWD/MTU
가 RMS ROCS 가
, (ASI)
4
Fz ROCS 가 Fxy 가
Fxy 가 PLUS 7

- [1] , " , " 2002.5.31
- [2] , " (PLUS7) 가
," 2002.3.30
- [3] Westinghouse, "User's Manual for ROCS," CE-CES-4-P Rev.15
- [4] KHNP,
- [5] Westinghouse, "User's Manual for CECOR," CE-NPSD-104 Rev.013
- [6] KHNP&KNFC "The Nuclear Design Report for Ulchin Nuclear Power Plant
Unit 3 Cycle 5," KNF-U3C5-02027.Rev.0, December 2002.