CP&L
Carolina Power & Light Company

SERIAL: NLS-84-342

JUL 31 1984

Director of Nuclear Reactor Regulation
Attention: Mr. D. B. Vassallo, Chief
Operating Reactors Branch No. 2
Division of Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NOS. 1 AND 2
DOCKET NOS. 50-325 & 50-324/LICENSE NOS. DPR-71 & DPR-62
RELOAD ANALYSIS
RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

Dear Mr. Vassallo:

In a telephone conversation with your staff on July 17, 1984, Carolina Power & Light Company was requested to provide additional information concerning our submittal of March 15, 1984. Specifically, additional FIBWR compressed model power distribution cases were run allowing the code to calculate the core pressure drop, hot channel flow rate, and minimum critical power ratio (MCPR). These additional cases provide supplemental information concerning our question 15 response in the March 15, 1984 submittal and may be found in Attachment 1.

Should you have questions concerning this submittal, please contact Mr. John S. Dietrich at (919) 836-6154.

Yours very truly,

S. R. Zimmerman
Manager
Nuclear Licensing Section

MAT/ccc (405MAT)
Attachments

cc: Mr. D. O. Myers (NRC-BSEP)
Mr. J. P. O'Reilly (NRC-RII)
Mr. M. Grotenhuis (NRC)

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ATTACHMENT 1

QUESTION

The Topical Report presented results using one channel to represent one fuel bundle. If "collapsed" channels (one channel representing several fuel bundles) are intended for future analysis, discuss how it will be approached and the sensitivities on hot bundle parameters.

RESPONSE

The eighth core, 75 channel model illustrated in Figures 5A through 5D of the Topical Report, can be used to obtain individual assembly thermal-hydraulic conditions as well as accurate core-wide pressure drops and void fractions from detailed relative power distributions. The hot channel is identified by the highest relative peaking factor, which in turn determines the hot channel flow and void characteristics. A preferred method for core wide and hot channel analysis is to group channels according to common geometry and orifice type and to assign a representative average central, peripheral, or hot channel relative power factor to each group. This "compressed channel representation" has significant economic advantages and is shown here to preserve the accuracy of the detailed eighth core model.

A comparison between the eighth core and compressed channel models was made for each of the four 75 channel cases described in the Topical Report. Figures 15A through 15D provide the core operating parameters, relative power distribution, and fuel geometry mix for each case. These figures also identify the location of the hot channel. Please note that the location of the hot channel in Figure 5B of the topical was inadvertently misrepresented; the correct hot channel location for this case is that given in Figure 15B.

Each of the above cases was run using a compressed channel representation with fuel regions and power factors given in Table 15-1. The power factors for the compressed model were determined by first assigning the hot relative power factor from the 75-channel case to the hot channel, then taking the average of the power factors from the 76 peripherally zoned fuel assemblies, and finally calculating a single power factor for the remaining 483 central assemblies which would normalize the entire power distribution to 560. Since the hot channel in each case is located in the central region, the power distribution should normalize according to the following equation:

$$(76)\ R_{periph.} + (483)\ R_{cent.} + R_{hot} = 560.$$

where:

$R_{periph.}$ = average peripheral region relative power factor
$R_{cent.}$ = average central region relative power factor
R_{hot} = hot channel relative power factor

Each case was run with the total core flow specified, allowing the code to calculate the core pressure drop, hot channel flow rate, and minimum CPR. The test results are given in Table 15-2. In each case, the change in MCPR due to the compressed channel representation was less than the 0.005 ΔCPR uncertainty identified in Figure 7 of the Topical Report.

FIGURE 15A

75 CHANNEL RELATIVE POWER DISTRIBUTION

BRUNSWICK 2 CYCLE 4
83.13% POWER
98.99% FLOW

	27	29	31	33	35	37	39	41	43	45
26	0.9311 8x8									
24	0.8870 7x7	1.1101 8x8R								
22	1.1140 8x8R	0.9453 7x7	1.2540 8x8R							
20	1.0376 8x8	1.2030 8x8R	1.0314 7x7	1.3449 8x8R						
18	1.1087 8x8R	1.0968 8x8	1.3369 8x8R	1.1488 7x7	1.3764 8x8R					
16	0.6961 7x7	1.2009 8x8R	1.0996 7x7	* 1.4169 * 8x8R	1.1155 7x7	1.3703 8x8R				
14	0.8199 8x8R	1.0700 8x8	1.2158 8x8R	1.1237 8x8	1.3245 8x8R	1.1500 8x8	1.2371 8x8R			
12	0.9601 7x7	1.2309 8x8R	0.9975 7x7	1.2333 8x8R	1.0484 7x7	1.1413 8x8R	0.9203 8x8	1.0910 8x8R		
10	1.3755 8x8R	1.2197 8x8	1.3229 8x8R	1.1913 8x8	1.2175 8x8R	0.9367 8x8	0.9840 8x8R	0.8906 8x8	0.7824 8x8R	
08	1.2110 8x8	1.3836 8x8R	1.1810 8x8	1.2723 8x8R	1.0340 8x8	1.0703 8x8R	0.9204 8x8R	0.8522 8x8R	0.6682 8x8R	0.4135 7x7
06	1.3001 8x8R	1.1279 8x8	1.1003 8x8R	1.0003 8x8	0.9045 8x8R	0.6392 7x7	0.4646 7x7	0.4116 7x7	0.3028 7x7	
04	0.9993 8x8	1.1224 8x8R	0.9956 8x8R	0.9399 8x8R	0.7199 8x8R	0.4629 7x7				
02	0.5738 7x7	0.6178 7x7	0.5042 7x7	0.4396 7x7	0.3410 7x7					

* HOT CHANNEL

FIGURE 15B

75 CHANNEL RELATIVE POWER DISTRIBUTION

BRUNSWICK 2 CYCLE 4
49.73% POWER
38.83% FLOW

	27	29	31	33	35	37	39	41	43	45
26	1.0049 8x8									
24	0.8041 7x7	1.1784 8x8R								
22	0.9785 8x8R	1.0408 7x7	* 1.5445 * 8x8R							
20	1.1557 8x8	1.2501 8x8R	1.3006 7x7	1.4907 8x8R						
18	1.3547 8x8R	1.3252 8x8	1.4261 8x8R	1.1046 7x7	1.4747 8x8R					
16	0.8079 7x7	1.2675 8x8R	1.1102 7x7	0.9519 8x8R	0.8555 7x7	1.3472 8x8R				
14	0.9293 8x8R	1.1969 8x8	1.2279 8x8R	0.8314 8x8	0.9563 8x8R	1.2030 8x8	1.4210 8x8R			
12	1.0537 7x7	1.2359 8x8R	0.9838 7x7	1.1243 8x8R	1.0341 7x7	1.2235 8x8R	1.2844 8x8	1.3117 8x8R		
10	1.2884 8x8R	1.2042 8x8	1.3455 8x8R	1.2036 8x8	1.2321 8x8R	1.1571 8x8	1.2782 8x8R	1.0977 8x8	1.0266 8x8R	
08	0.8281 8x8	1.1854 8x8R	1.1780 8x8	1.1159 8x8R	1.0603 8x8	1.1056 8x8R	1.1181 8x8R	0.8184 8x8R	0.7138 8x8R	0.5796 7x7
06	0.7758 8x8R	1.0108 8x8	1.1557 8x8R	0.9639 8x8	0.8449 8x8R	0.6602 7x7	0.4940 7x7	0.3730 7x7	0.2940 7x7	
04	0.8698 8x8	0.9414 8x8R	1.0111 8x8R	0.9032 8x8R	0.7217 8x8R	0.4737 7x7				
02	0.4937 7x7	0.5690 7x7	0.4441 7x7	0.4029 7x7	0.3387 7x7					

* HOT CHANNEL

FIGURE 15C

75 CHANNEL RELATIVE POWER DISTRIBUTION

BRUNSWICK 1 CYCLE 3
98.98% POWER
96.82% FLOW

	27	29	31	33	35	37	39	41	43	45
26	0.7865 8x8									
24	0.8294 8x8	1.025 8x8R								
22	1.1969 8x8R	1.0219 8x8	1.3297 8x8R							
20	1.0571 8x8	1.2356 8x8R	1.1197 8x8	1.3197 8x8R						
18	1.2983 8x8R	1.1059 8x8	1.3858 8x8R	1.1769 8x8	1.1997 8x8R					
16	1.1099 8x8	1.2657 8x8R	1.1629 8x8	1.3851 8x8R	0.9777 8x8	0.9845 8x8				
14	1.2044 8x8R	1.2060 8x8R	1.1147 8x8R	0.9438 8x8	1.2678 8x8R	1.1778 8x8R	* 1.3952 8x8R *			
12	1.0007 8x8	0.9238 8x8R	0.6879 8x8	1.0566 8x8R	1.0015 8x8	1.1469 8x8R	1.0533 8x8	1.3271 8x8R		
10	1.0642 8x8R	0.6846 8x8	0.9627 8x8R	1.1431 8x8R	1.2373 8x8R	1.0978 8x8R	1.2267 8x8R	1.1609 8x8R	1.0214 8x8R	
08	0.8648 8x8	1.0221 8x8R	0.9631 8x8	1.1918 8x8R	0.9514 8x8	1.1313 8x8R	1.1405 8x8R	1.1099 8x8R	0.8612 8x8R	0.5604 8x8
06	1.1169 8x8R	1.0708 8x8R	1.1351 8x8R	1.0868 8x8R	1.0537 8x8R	0.9749 8x8R	0.5700 8x8	0.5073 8x8	0.3942 8x8	
04	0.9645 8x8R	0.9745 8x8R	0.9585 8x8R	0.9728 8x8R	0.8451 8x8R	0.6020 8x8				
02	0.5028 8x8	0.5023 8x8	0.4770 8x8	0.4615 8x8	0.3533 8x8					

* HOT CHANNEL

FIGURE 150

75 CHANNEL RELATIVE POWER DISTRIBUTION

BRUNSWICK 1 CYCLE 3
5[illegible].38% POWER
44.68% FLOW

	27	29	31	33	35	37	39	41	43	45
26	0.8402 8x8									
24	0.6382 8x8	1.0681 8x8R								
22	0.8059 8x8R	0.9496 8x8	1.1846 8x8R							
20	0.9798 8x8	1.2040 8x8R	1.0707 8x8	1.2131 8x8R						
18	1.2377 8x8R	1.0907 8x8	1.2822 8x8R	1.0798 8x8	1.1497 8x8R					
16	0.7836 8x8	1.2524 8x8R	1.0853 8x8	0.9665 8x8R	0.7330 8x8	0.9972 8x8				
14	0.9317 8x8R	1.2801 8x8R	1.2228 8x8R	0.7845 8x8	0.8983 8x8R	1.1937 8x8R	1.3649 8x8R			
12	1.1025 8x8	1.3407 8x8R	1.0894 8x8	1.2431 8x8R	1.0286 8x8	1.2324 8x8R	1.1813 8x8	1.3402 8x8R		
10	1.2279 8x8R	1.0895 8x8	* 1.4188 * * 8x8R *	1.3317 8x8R	1.3263 8x8R	1.2993 8x8R	1.3735 8x8R	1.2843 8x8R	1.0264 8x8R	
08	0.7810 8x8	1.2198 8x8R	1.1297 8x8	1.1057 8x8R	0.9066 8x8	1.1909 8x8R	1.2883 8x8R	1.1911 8x8R	0.9019 8x8R	0.5906 8x8
06	0.83[illegible]4 8x8R	[illegible].0[illegible]10 [illegible]8R	1.1440 8x8R	0.9799 8x8R	0.8703 8x8R	0.9599 8x8R	0.6117 8x8	0.5368 8x8	0.4375 8x8	
04	[illegible].97[illegible]6 [illegible]	[illegible].9724 8x8R	0.9894 8x8R	0.9386 8x8[illegible]	0.8093 8x8R	0.5837 8x8				
02	0.4743 8x8	0.4792 8x8	0.4474 8x8	0.4307 8x8	0.3439 8x8					

* HOT CHANNEL

TABLE 15-1

COMPRESSED MODEL POWER DISTRIBUTIONS

A. B2C4 HIGH FLOW CASE

ORIFICE ZONE	FUEL GEOMETRY	QUANTITY	RADIAL PEAKING FACTOR
CENTRAL	7x7	89	1.0848
PERIPHERAL	7x7	68	0.4553
CENTRAL	8x8	132	1.0848
PERIPHERAL	8x8	8	0.4553
CENTRAL	8x8R	262	1.0848
CENTRAL (HOT)	8x8R	1	1.4169

B. B2C4 LOW FLOW CASE

ORIFICE ZONE	FUEL GEOMETRY	QUANTITY	RADIAL PEAKING FACTOR
CENTRAL	7x7	89	1.0871
PERIPHERAL	7x7	68	0.4393
CENTRAL	8x8	132	1.0871
PERIPHERAL	8x8	8	0.4393
CENTRAL	8x8R	262	1.0871
CENTRAL (HOT)	8x8R	1	1.5445

C. B1C3 HIGH FLOW CASE

ORIFICE ZONE	FUEL GEOMETRY	QUANTITY	RADIAL PEAKING FACTOR
CENTRAL	8x8	152	1.0795
PERIPHERAL	8x8	76	0.4895
CENTRAL	8x8R	331	1.0795
CENTRAL (HOT)	8x8R	1	1.3952

D. B1C3 LOW FLOW CASE

ORIFICE ZONE	FUEL GEOMETRY	QUANTITY	RADIAL PEAKING FACTOR
CENTRAL	8x8	152	1.0796
PERIPHERAL	8x8	76	0.4885
CENTRAL	8x8R	331	1.0796
CENTRAL (HOT)	8x8R	1	1.4188

TABLE 15-2

COMPRESSED MODEL vs 1/8 CORE MODEL COMPARISON

A. B2C4 HIGH FLOW CASE

NUMBER OF CHANNELS	CORE ΔP (psi)	HOT CHAN. FLOW (Klb/hr)	MCPR
75	26.9770	121.0832	1.6097
6	26.9732	121.0773	1.6097

B. B2C4 LOW FLOW CASE

NUMBER OF CHANNELS	CORE ΔP (psi)	HOT CHAN. FLOW (Klb/hr)	MCPR
75	7.4664	47.3663	1.7734
6	7.4240	47.2210	1.7703

C. B1C3 HIGH FLOW CASE

NUMBER OF CHANNELS	CORE ΔP (psi)	HOT CHAN. FLOW (Klb/hr)	MCPR
75	20.7577	116.5756	1.3502
4	20.8068	116.7691	1.3507

D. B1C3 LOW FLOW CASE

NUMBER OF CHANNELS	CORE ΔP (psi)	HOT CHAN. FLOW (Klb/hr)	MCPR
75	7.4178	55.6338	2.0638
4	7.4305	55.7846	2.0667