CP&L

Carolina Power & Light Company

MAR 2 8 1986

SERIAL: NLS-86-097
85TSB35

Director of Nuclear Reactor Regulation
Attention: Mr. Dan Muller, Director
BWR Project Directorate #2
Division of BWR Licensing
United States Nuclear Regulatory Commission
Washington, DC 20555

BRUNSWICK STEAM ELECTRIC PLANT, UNIT NO. 2
DOCKET NO. 50-324/LICENSE NO. DPR-62
SUPPLEMENT TO REQUEST FOR LICENSE AMENDMENT
FUEL CYCLE NO. 7 - RELOAD LICENSING

Dear Mr. Muller:

On March 18, 1986, representatives from Carolina Power & Light Company (CP&L) met with members of your staff to resolve questions raised during review of the pending Brunswick-2 reload license amendment submitted on December 20, 1986. In specific, the methods used to calculate conservative minimum critical power ratio (MCPR) operating limits and the recommendations of General Electric's SIL 380, Revision 1 were discussed. The purpose of this submittal is to formally docket information provided in this meeting.

Enclosure 1 consists of an internal memorandum which details the methods used to establish conservative MCPR limits which bound the Cycle 7 core design. These limits will be verified, as bounding, based on a CP&L review of the General Electric supplemental reload licensing submittal for Reload 6, a copy of which will be sent to your staff for informational purposes upon receipt by CP&L.

The decay ratio for Cycle 7 of Brunswick-2 has been calculated by General Electric using standard, approved methodology and determined to be 0.78 for the extrapolated APRM rod line. CP&L has reviewed General Electric SIL 380, Revision 1 and Generic Letter 86-02 and determined that based on the calculated decay ratio being less than 0.80, a commitment to the recommendations of SIL 380 for Cycle 7 operation of Brunswick-2 is not necessary.

Please refer any questions regarding this matter to Mr. Sherwood R. Zimmerman at (919) 836-6242.

Yours very truly,

A. B. Cutter - Vice President
Nuclear Engineering & Licensing

ABC/MAT/pgp (3588MAT)
Enclosure

*cc: Mr. W. H. Ruland (NRC-BNP)
Dr. J. Nelson Grace (NRC-RII)
Mr. E. Sylvester (NRC)
Mr. Dayne H. Brown

A001 1/1 Add: NRR/DSRO/RSIB
RGN2/DRSS/EPRPB
RM/DDAMI/MIB

* Enclosure with all cc's.

411 Fayetteville Street • P. O. Box 1551 • Raleigh, N. C. 27602

ENCLOSURE 1

TO SERIAL: NLS-86-097

(3588MAT/ccc)

[redacted]

Raleigh, North Carolina

December 17, 1985

FILE: NF-402.0703 SERIAL: NF-85-602

MEMORANDUM TO: Mr. E. B. Wilson

FROM: K. E. Karcher

SUBJECT: Proposed Operating MCPR Limits for Brunswick 2 Cycle 7

INTRODUCTION

The goal of this evaluation is to establish Minimum Critical Power Ratio (MCPR) Operating Limits which, with high assurance, bound any reasonable expected variation in Cycle 7 core designs. The establishment of these limits will allow Cycle 7 to startup under the provisions of 10CFR50.59 which provides for increased flexibility in the timing of core design decisions. An additional goal is to establish the MCPR Operating Limits with sufficient conservatism to bound potential abnormal modes of operation without adversely impacting operations. Abnormal modes of operation include, but are not limited to, recirculation pump out of service, main steam line out of service, hard bottom burn, end of cycle (EOC) extension with reduced feedwater temperature and/or increased core flow, etc. This approach assumes that some small potential for EOC derate due to insufficient MCPR margin is preferable to a mandatory derate and/or technical specification change required when entering into an abnormal mode of operation.

If in fact the proposed EOC 7 limits prove to be overly conservative such that a significant EOC derate is projected, then it is still possible to resubmit Cycle 7 technical specifications to incorporate more appropriate EOC 7 operating MCPR limits. This resubmittal can be made subsequent to startup in a time frame consistent with approval and implementation prior to EOC - 2,000 MWD/ST.

PROPOSED MCPR LIMITS FOR BRUNSWICK 2 CYCLE 7

Based on an evaluation of past Brunswick 1 and Brunswick 2 licensing analyses and the Cycle 7 core design work completed to date, a set of MCPR

limits for Brunswick 2, Cycle 7 operation are proposed in Table 1. The basis for the selection of these limits is explained below:

1. Non-Pressurization Transients (BOC to EOC)

Tables 2 and 3 are a compilation of results presented in References 1-4 and are summaries of the licensing analyses performed for Brunswick 1, Cycles 4 and 5 and Brunswick 2, Cycles 5 and 6. Table 2 presents the reload transient ΔCPR's for the limiting fuel type which, except as noted, is BP/P8X8R. Table 3 presents the difference in ΔCPR for the BP/P8X8R and 8X8R fuel for the pressurization transients listed in Table 2. Examination of Table 2 indicates that the most limiting non-pressurization event is either the Rod Withdrawal Error (RWE) or the Loss of Feed Water Heating (LFWH) event. The maximum uncorrected ΔCPR observed for these transients is 0.22 and 0.17, respectively. Since the maximum observed ΔCPR for the RWE bounds the maximum observed ΔCPR for the LFWH, bounding the RWE will bound both of these events. To bound the RWE, it is proposed to employ General Electric's (GE's) generic RWE analysis. This analysis is valid for all fuel types, exposure ranges, and modes of operations. For a Rod Block Monitor (RBM) setpoint of 107 percent, which is customary at Brunswick, the generic analysis (Reference 10) provides a ΔCPR of 0.22 for the RWE.

2. Pressurization Transients (BOC to EOC - 2,000 MWD/ST)

2a. Option A MCPR Limits

Table 2 indicates that the most limiting Option A pressurization transient for the BOC to EOC - 2,000 MWD/ST exposure range is the Load Rejection without Bypass (LRw/oB). The maximum observed uncorrected ΔCPR for the LRw/oB is 0.16 with a cycle-to-cycle variation of only 0.01 ΔCPR. It is proposed to conservatively bound this maximum uncorrected ΔCPR by imposing a 0.04 ΔCPR adder. This adder is comprised of three components: 1) a 0.01 ΔCPR to account for the GETAB round-off process; 2) a 0.01 ΔCPR to account for mid-cycle exposure shape and scram reactivity differences between Brunswick 2, Cycle 6 and Brunswick 2, Cycle 7; and 3) a 0.02 ΔCPR adder to provide a high assurance, without an adverse impact on operations, that the proposed MCPR limits bound any reasonable variation in Cycle 7 designs and potential abnormal modes of operation.

Application of this adder gives an uncorrected ΔCPR of 0.20 and a corrected for Option A MCPR operating limit of (1.07 + 0.20) x 1.044 = 1.33 for BP/P8X8R fuels. Table 3 indicates that the difference between BP/P8X8R and 8X8R fuel type uncorrected ΔCPR's for the LRw/oB in the BOC to EOC-2,000 MWD/ST exposure range is 0.02. Therefore, the Option A MCPR operating limit for 8X8R fuels in this exposure range is (1.07 + (0.20-0.02)) x 1.044 = 1.31.

2b. Option B MCPR Limit

Table 2 indicates that the most limiting Option B pressurization transient for the BOC to EOC - 2,000 MWD/ST exposure range is the Feed Water Controller Failure (FWCF). The maximum observed uncorrected ΔCPR for the FWCF is 0.11 and 0.07 for Brunswick Units 1 and 2 respectively,

with a cycle-to-cycle variation of 0.02 ΔCPR. The 0.04 difference in ΔCPR between the two Brunswick units is due to the differences in the bypass flow capacity of the units. Unit 2 has approximately 90 percent bypass flow capacity while Unit 1 has only approximately 25 percent bypass flow capacity.

It is proposed to conservatively bound the maximum observed Unit 2 uncorrected ΔCPR for the FWCF by imposing the 0.04 ΔCPR adder described in Section 2a. Application of this adder gives an uncorrected ΔCPR of 0.11 for the Unit 2 FWCF transient. The formula to correct this ΔCPR to the Option B operating limit MCPR is:

$$OLMCPR_B = SLMCPR\ (1.0/1.0-x)$$

where x = (C/(C + SLMCPR)) + AF
c = the calculated uncorrected ΔCPR
AF = an additive factor of -0.009 for a mid-cycle BWR/4 without RPT FWCF transient
SLMCPR = the safety limit MCPR of 1.07

which gives an Option B operating limit of 1.17 for BP/P8X8R fuel. Table 3 indicates that there is no difference between BP/P8X8R and 8X8R fuel type uncorrected ΔCPR's for the FWCF in the BOC to EOC-2,000 MWD/ST exposure range. Therefore, the Option B MCPR operating limit for 8X8R fuel in this exposure range is identical to that of BP/P8X8R fuel, i.e., 1.17.

3. Pressurization Transients (EOC - 2,000 MWD/ST to EOC)

3a. Option A MCPR Limits

Table 2 indicates that the most limiting Option A pressurization transient for the EOC - 2,000 MWD/ST to EOC exposure range is the LRw/oB. The maximum observed uncorrected ΔCPR for the this event is 0.28 with a cycle-to-cycle variation of 0.01 to 0.02 ΔCPR. The observed 0.02 ΔCPR variation occurred for Brunswick 1 Cycles 4 and 5 and is due largely to the short Cycle 5 full power exposure capability resulting from the long Cycle 4 coastdown. The short Cycle 5 endurance results in an EOC 5 Haling axial power distribution which is significantly more bottom peaked than the EOC 4 Haling power distribution as shown in Figure 1. This significant power shape difference results in a significant scram reactivity difference, directly impacting the calculated transient ΔCPR. Consequently, the LRw/oB for Brunswick 1, Cycle 5 is significantly (0.02 ΔCPR) lower than that for Brunswick 1, Cycle 4.

For Brunswick 2, Cycles 5 and 6, the EOC Haling power distributions, shown in Figure 2, are in better agreement and the ΔCPR's for the LRw/oB differ by only 0.01.

The PANACEA EOC 7 Haling power distribution is not available for comparison to the EOC 6 Haling power distribution. However, the PRESTO Haling power distributions are available and are shown in Figure 3. Although PRESTO and PANACEA EOC Haling power distributions for a

particular unit and cycle are not identical, as illustrated by Figure 4 for Brunswick 2, Cycle 6, experience has shown that trends exhibited by one code will be confirmed by the other. Comparison of Figures 2 and 3 leads one to expect that the Unit 2 PANACEA EOC 7 Haling power distribution will be very similar to the Unit 2 PANACEA EOC 5 Haling power distribution. Therefore, the EOC 7 LRw/oB transient ΔCPR is expected to be similar to the EOC 5 value from an EOC axial power distribution standpoint.

In addition to the EOC axial power distribution and its impact on the EOC scram reactivity insertion, other parameters that impact the transient ΔCPR calculations are the core average void fraction and the void coefficient of reactivity. These parameters are summarized in Table 4, which indicates that the core average void fraction and void coefficient vary only slightly from cycle to cycle. It is not expected that any changes in these parameters from Brunswick 2, Cycle 6 to Brunswick 2, Cycle 7 will result in a significant change in the ΔCPR calculation.

Based on the above discussion, the expected uncorrected ΔCPR for the Brunswick 2 EOC 7 LRw/oB is that observed for Brunswick 2 at EOC 5, that is 0.28. To cover other potential uncertainties in the ΔCPR calculation such as the GETAB round-off and code convergence, etc., a 0.01 adder to this value is proposed. Furthermore, in an effort to bound any reasonable abnormal mode of operation, an additional 0.02 ΔCPR adder is proposed. Application of these adders gives an uncorrected ΔCPR of 0.31 and a corrected for Option A MCPR operating limit of (1.07 + 0.31) x 1.044 = 1.44 for BP/P8X8R fuels. Table 3 indicates that the difference between BP/P8X8R and 8X8R fuel type uncorrected ΔCPR's for the LRw/oB in the EOC-2,000 MWD/ST to EOC exposure range is 0.03. Therefore, the Option A MCPR operating limit for 8X8R fuels in this exposure range is (1.07 + (0.31-0.03)) x 1.044 = 1.41.

3b. Option B MCPR Limit

Table 2 indicates that the most limiting Option B transient for the EOC - 2,000 MWD/ST to EOC exposure range for Brunswick 2 is the LRw/oB. The FWCF is not limiting for Brunswick 2 at EOC, as is the case for Brunswick 1, because of Unit 2's large bypass capacity as discussed above in Section 2b.

Application of the Option B correction formula of Section 2b to the proposed uncorrected EOC 7 ΔCPR for the LRw/oB of Section 3a with an EOC BWR/4 non-RPT additive factor of -0.039 gives an Option B operating MCPR limit of 1.32 for BP/P8X8R fuel and 1.29 for 8X8R fuel.

SUMMARY

Table 1 summarizes the proposed operating MCPR limits for Brunswick 2, Cycle 7. The set of conservative limits proposed are expected to bound the final reload licensing analysis results with high confidence and allow Cycle 7 to startup under the provisions of 10CFR50.59 without adversely impacting plant operations. Furthermore, the proposed limits have made allowance for reasonable abnormal modes of operation. If the proposed EOC 7 limits prove to

be overly conservative such that a significant EOC derate is projected, then it will be possible to resubmit Cycle 7 technical specifications to incorporate more appropriate EOC 7 operating MCPR limits. This resubmittal can be made subsequent to startup in a time frame consistent with approval and implementation prior to EOC-2,000 MWD/ST.

Table 5 summarizes the effective "adders" to the Brunswick 2, Cycle 6 MCPR operating limits required to arrive at the proposed Cycle 7 MCPR limits of Table 1. This table indicates that the "adders" range from 0.04 to 0.06 ΔCPR. As Table 2 indicates that the maximum observed cycle to cycle variation in MCPR operating limits is only 0.02 ΔCPR, these adders are judged to be more than adequate to conservatively bound the Cycle 7 licensing results and any reasonable abnormal mode of operation.

Kenneth E. Karcher

MJD/adl

Attachments

2081ICA

References

1. Supplemental Reload Licensing Submittal for Brunswick Steam Electric Plant Unit 1, Reload 3 (without Recirculation Pump Trip), General Electric Co. Document Y1003J01A53, May 1983.

2. Supplemental Reload Licensing Submittal for Brunswick Steam Electric Plant Unit 1, Reload 4 (without Recirculation Pump Trip), Revision 1, General Electric Co. Document 23A4663, April 1985.

3. Supplemental Reload Licensing Submittal for Brunswick Steam Electric Plant Unit 2, Reload 4, Revision 2, General Electric Co. Document Y1003J01A37, June 1982.

3a. Letter, G. R. Hull to J. D. Martin, "Revised Brunswick 2, Cycle 5 Transient and MCPR Data", February 10, 1983, CP&L NFS File Number 402.0504.

3b. Letter, G. R. Hull to J. D. Martin, "Revised Brunswick 2, Cycle 5, Rod Withdrawal Error MCPR Data", March 22, 1983, CP&L NFS File Number 402.0504.

4. Supplemental Reload Licensing Submittal for Brunswick Steam Electric Plant Unit 2, Reload 5, General Electric Co. Document 23A1765, May 1984.

5. Brunswick 1, Reload 3, Nuclear Design Report, General Electric Co. Document NEDE-22207, October 1982.

6. Brunswick 1, Reload 4, Nuclear Design Report, General Electric Co. Document NEDE-30888, July 1985.

7. Brunswick 2, Reload 4, Nuclear Design Report, General Elect.ic Co. Document NEDE-22072, March 1982.

8. Brunswick 2, Reload 5, Nuclear Design Report, General Electric Co. Document NEDE-30747P, October 1984.

9. M. J. DeVoe, "Brunswick Unit 2, Cycle 6, Cycle Management Target Control Rod Patterns, Rodded Depletion Hot Excess Reactivity, a d Reactivity Anomaly Curve Development", NFS DA 84-0007, September 1984.

10. General Electric Standard Application for Reactor Fuel (Supplement for United States), General Electric Co., Document NEDE-24011-P-A-7-US, August 1985.

Table 1

Proposed Operating Limits

Brunswick 2 Cycle 7

	Fuel Type					
	BP/P8X8R			8X8R		
	Unc.#	$MCPR_A$	$MCPR_B$	Unc.	$MCPR_A$	$MCPR_B$
Non-Pressurization (BOC-EOC)	0.22	1.29		0.22	1.29	
Pressurization (BOC to EOC-2,000 MWD/ST)						
LRw/oB	0.20	1.33	NL*	0.18	1.31	NL
FWCF	0.11	NL	1.17	0.11	NL	1.17
(EOC-2,000 MWD/ST to EOC)						
LRw/oB	0.31	1.44	1.32	0.28	1.41	1.29
FWCF	NL	NL	NL	NL	NL	NL

* NL = Not Limiting

\# Unc = the uncorrected (for ODYN option A and B) delta CPR as calculated by GETAB.

Table 2

Summary of Licensing Analyses

(For Limiting Fuel Type*)

	BOC To EOC - 2000 MWD/ST				EOC - 2000 MWD/ST to EOC			
	Event	Unc.#	Opt. A	Opt. B	Event	Unc.	Opt. A	Opt. B
B1C4	LRw/oB	0.16	1.28	1.09	LRw/oB	0.28	1.41	1.29
	FWCF	0.11	1.23	1.17	FWCF	0.23	1.36	1.29
	RWE	0.18	1.25	1.25				
	LFWH	0.14	1.21	1.21				
	FLE	0.15	1.22	1.22				
B1C5	LRw/oB	0.15	1.27	<1.08	LRw/oB	0.26	1.39	1.27
	FWCF	0.09	1.21	1.15	FWCF	0.21	1.34	1.27
	RWE	0.15	1.22	1.22				
	LFWH	0.17	1.24	1.24				
	FLE	0.13	1.20	1.20				
B2C5	LRw/oB	0.16	1.28	1.09	LRw/oB	0.28	1.41	1.29
	FWCF	0.07	1.19	1.13	FWCF	0.07	1.19	1.13
	RWE	0.22	1.29	1.29				
	LFWH	0.13	1.20	1.20				
	FLE	0.15	1.22	1.22				
B2C6	LRw/oB	0.16	1.28	1.09	LRw/oB	0.27	1.40	1.28
	FWCF	0.05	1.17	1.11	FWCF	0.05	1.17	1.11
	RWE	0.17	1.24	1.24				
	LFWH	0.16	1.23	1.23				
	FLE	0.13	1.20	1.20				

* With the exception of the B2C5 RWE, the limiting fuel type is BP/P8X8R. For the B2C5 RWE the limiting fuel type is 8 x 8.

Unc = the uncorrected (for ODYN option A and B) delta CPR as calculated by GETAB.

Table 3

Summary of Licensing Analyses

Differences Between BP/P8X8R and 8X8R ΔCPR's for Pressurization Events

	BOC to EOC-2000 MWD/ST				EOC-2000 MWD/ST to EOC			
	Event	Unc.#	Opt A	Opt B	Event	Unc.	Opt A	Opt B
B1C4	LRw/oB	0.01	0.01	0.01	LRw/oB	0.03	0.03	0.03
	FWCF	0.01	0.01	0.01	FWCF	0.02	0.02	0.02
B1C5	LRw/oB	0.02	0.02	0.00	LRw/oB	0.03	0.03	0.03
	FWCF	0.00	0.00	0.00	FWCF	0.02	0.02	0.02
B2C5	LRw/oB	0.02	0.02	0.01	LRw/oB	0.03	0.03	0.03
	FWCF	0.00	0.00	0.00	FWCF	0.01	0.01	0.01
B2C6	LRw/oB	0.02	0.02	0.01	LRw/oB	0.03	0.03	0.03
	FWCF	0.00	0.00	0.00	FWCF	0.00	0.00	0.00

Unc = the uncorrected (for ODYN option A and B) delta CPR as calculated by GETAB.

Table 4

Void Reactivity**

	Core Average Void Fraction	3D Void Coefficient
B1C4	39.25	-.00125
B1C5	40.54 (40.54)	-.00125
B2C5	38.82	-.00126
B2C6	40.06 (40.63)	-.00127
B2C7*	? (40.10)	?

* Values in ( ) are PRESTO Results

** GE values obtained from References 5 through 8.

Table 5

Summary of "Adders" to B2C6 OLMCPR's

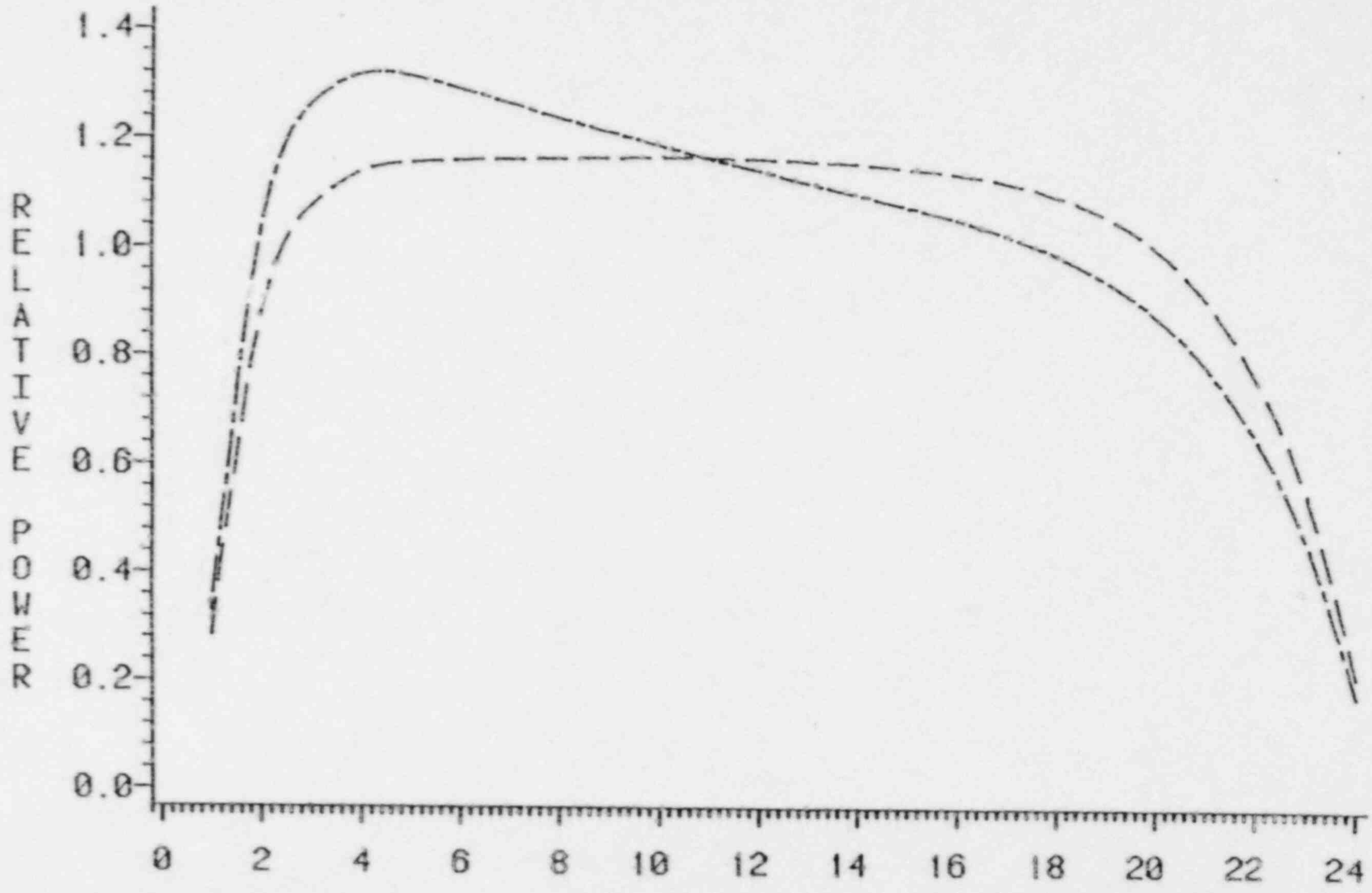
	Fuel Type			
	BP/P8X8R		8X8R	
	$MCPR_A$	$MCPR_B$	$MCPR_A$	$MCPR_B$
Non-Pressurization (BOC to EOC)	0.05		0.05	
Pressurization (BOC to EOC-2,000 MWD/ST)				
LRw/oB	0.05	NL*	0.05	NL
FWCF	NL	0.06	NL	0.06
(EOC-2,000 MWD/ST to EOC)				
LRw/oB	0.04	0.04	0.04	0.04
FWCF	NL	NL	NL	NL

*NL = Not Limiting

FIGURE 1

GE HALING AXIAL POWER DISTRIBUTION

— — =B1C4 - —— - =B1C5*

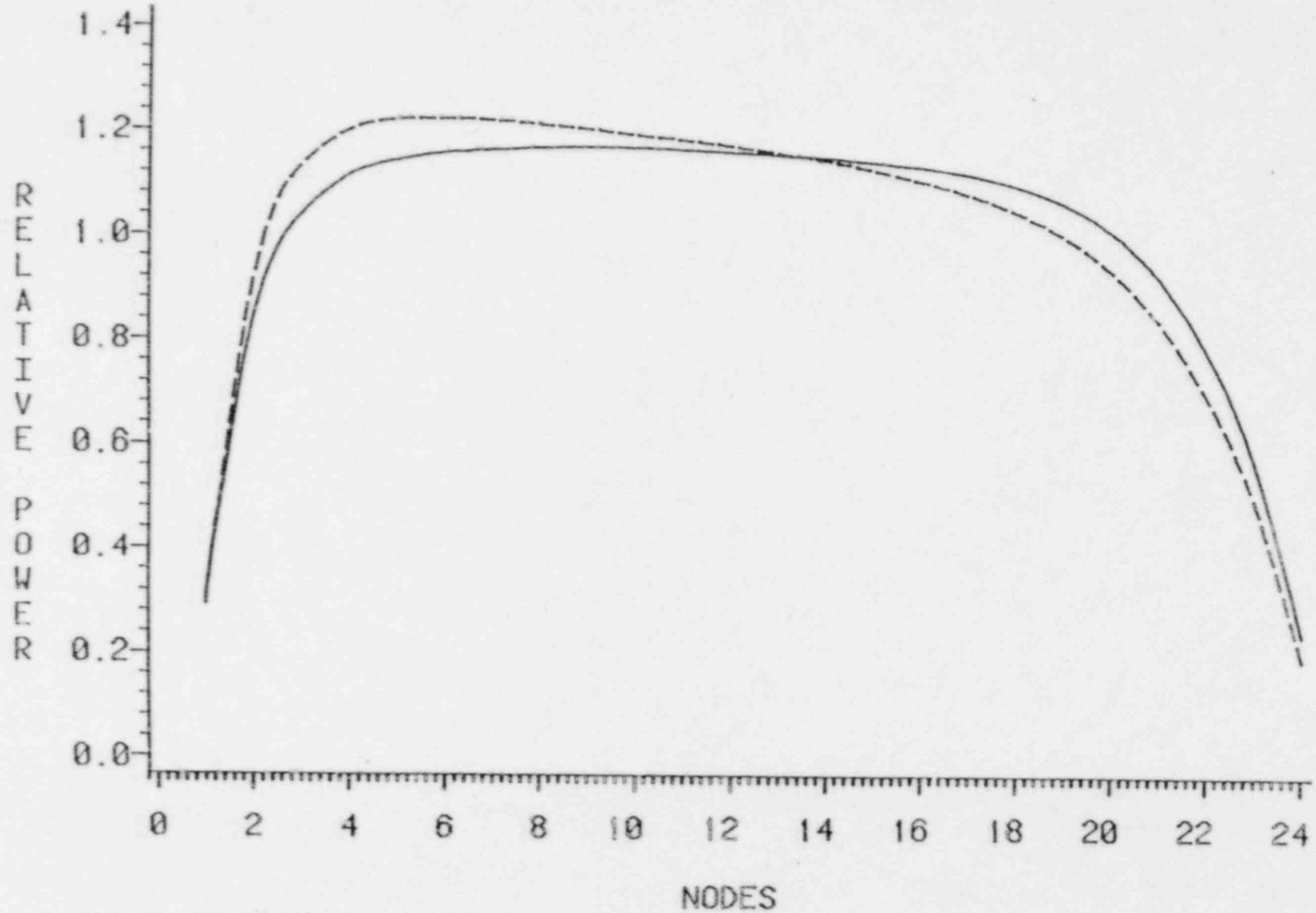


* DATA FROM REFERENCES (5) and (6)

FIGURE 2

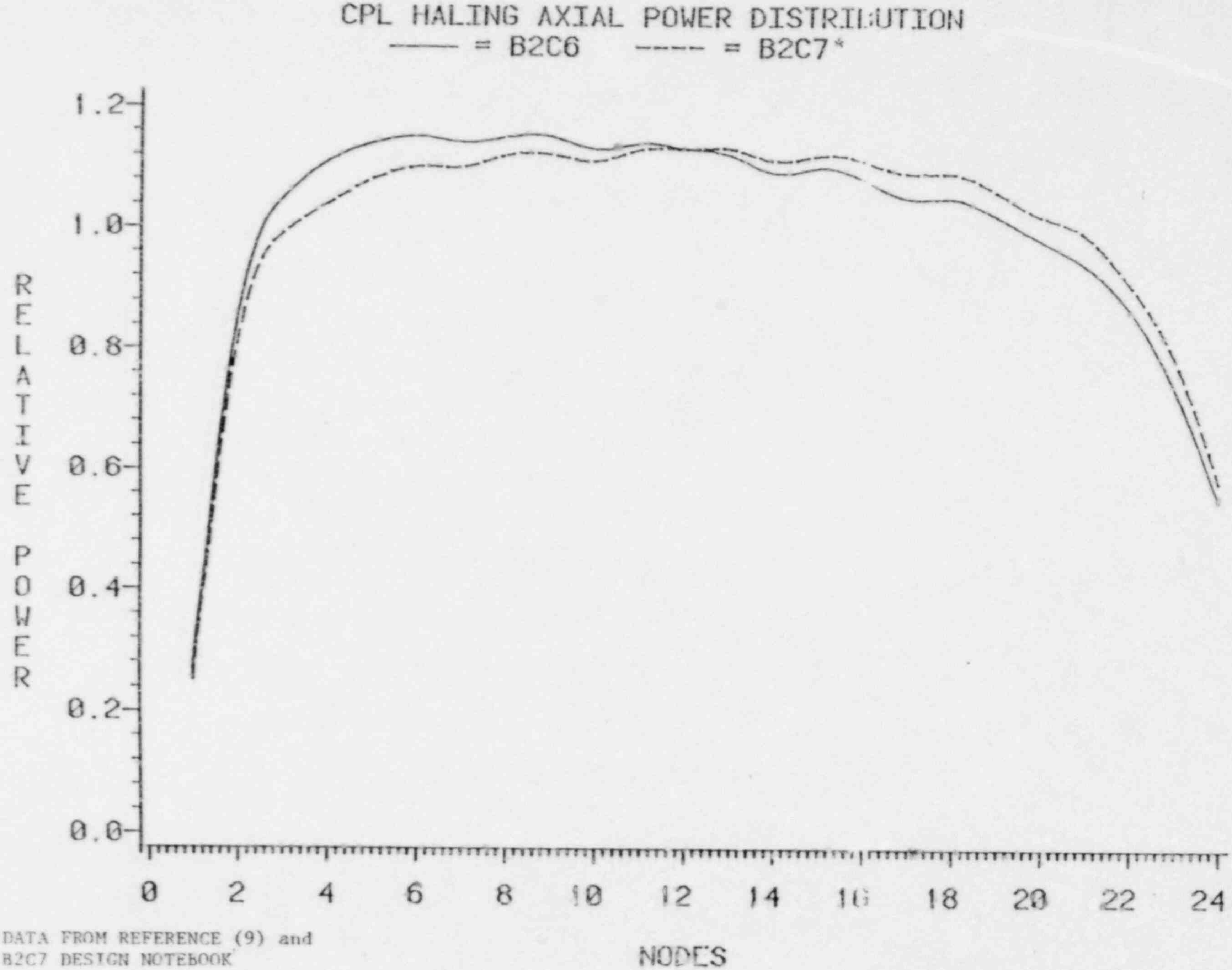
GE HALING AXIAL POWER DISTRIBUTION

——— = B2C5 ---- = B2C6*



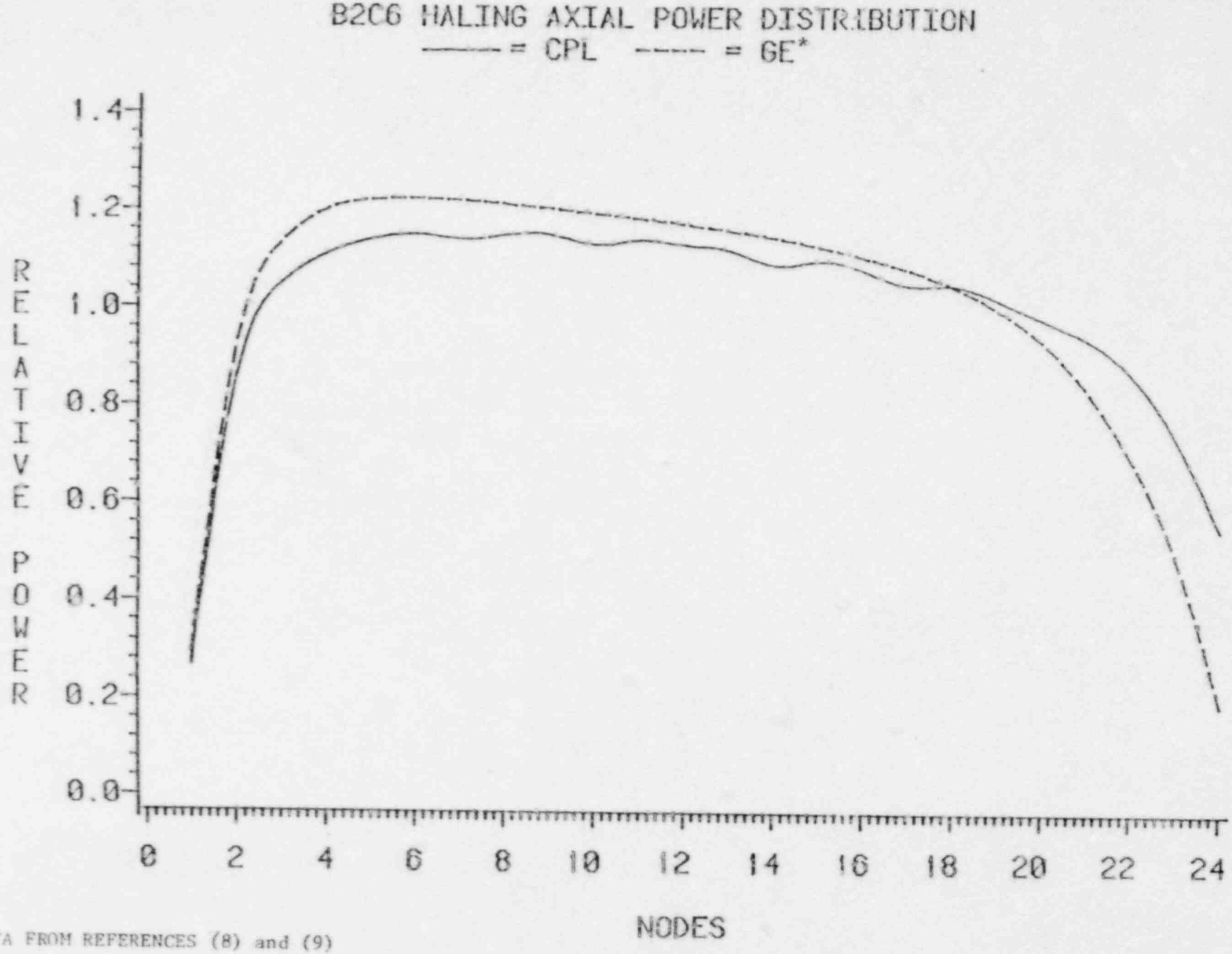
* DATA FROM REFERENCES (7) and (8)

FIGURE 3



* DATA FROM REFERENCE (9) and B2C7 DESIGN NOTEBOOK

FIGURE 4



* DATA FROM REFERENCES (8) and (9)