PDR

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

November 5, 1984

Docket Nos: 50-369, 50-370
and 50-413, 50-414

Mr. H. B. Tucker, Vice President
Nuclear Production Department
Duke Power Company
422 South Church Street
Charlotte, North Carolina 28242

Dear Mr. Tucker:

Subject: Request for Additional Information Regarding Topical Report on Physics Methodology for Reloads: McGuire and Catawba Nuclear Station

In response to your letter of July 18, 1984, the NRC staff, with the technical assistance of Brookhaven National Laboratory (BNL), is reviewing Duke Power Company topical report DPC-NF-2010 which describes the nuclear physics methodology for reload design at the McGuire and Catawba Nuclear Stations. We find that additional information identified in the enclosure is needed to complete this review.

A reply at your earliest opportunity and no later than November 30, 1984, is needed for the staff to meet your requested review completion date of January 1985. A copy of your reply should also be forwarded directly to BNL at the address below.

Should you have questions or need to meet with the staff regarding the enclosure, contact Darl S. Hood at (301) 492-8408.

Sincerely,

Elinor G. Adensam

Elinor G. Adensam, Chief
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Enclosure:
As stated

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See next page

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REQUEST FOR ADDITIONAL INFORMATION ON DUKE POWER COMPANY TOPICAL REPORT DPC-NF-2010

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1. Please provide additional information regarding the NUC-MARGINS code and its use in the Dropped Rod Analysis. Provide short descriptions of the input, output, calculational models used, benchmark calculations performed and the conservatisms assumed in the analysis.

2. Identify the nominal and various off-nominal cross-section sets that are generated in order to evaluate the different reactivity coefficients and defects.

3. Provide a short description of the PDQEDIT code and describe the verification program that was undertaken to test data generated with PDQEDIT for use in SNA-CORE.

4. Comment on the reasons for the 3.1% non-conservative bias in the calculated peak axial powers (Section 11.5.4). Describe the model refinements, if any, that have been undertaken to reduce this bias.

5. Duke Power Company's contention that no uncertainty in calculated pin powers needs to be accounted for has not been adequately established. One possible way to establish the uncertainty is to perform a standard problem. A standard problem recently developed at Brookhaven National Laboratory for a licensee to assess its ability to calculate typical PWR fuel assemblies, is attached. A solution of this problem or other justification for the assumed uncertainty should be provided.

6. Please provide the updates to DPC-NF-2010, if any, that will make it consistent with the methodologies currently being used by Duke Power.

FUEL ASSEMBLY STANDARD PROBLEM

The standard problem is to be calculated in two dimensions in an iterated-source mode using reflecting boundary conditions in the horizontal plane neglecting axial leakage. The following series of assembly depletion and reactivity defect calculations are to be calculated.

I. DEPLETION CALCULATIONS

Provide the following edited quantities for an assembly with and without burnable poison rods at BOL, 500, 5000, 10000, 20000, 30000 and 40000 Mwd/MT*:

1. Relative pin powers

2. Assembly volume averaged fuel pellet isotopics; U^{235}, U^{238}, Pu^{239}, Pu^{240}, Pu^{241}, Pu^{242} and calculated fission product densities [atom/barn-cm]

3. Assembly total reaction rates (A-absorption, F-fission)

   a. Fuel

U^{235} (A)	Pu^{240} (A)
U^{235} (F)	Pu^{240} (F)
U^{238} (A)	Pu^{241} (A)
U^{238} (F)	Pu^{241} (F)
Pu^{239} (A)	Pu^{242} (A)
Pu^{239} (F)	Pu^{242} (F)

   b. Clad (A)
   c. Burnable Poison (A)
   d. Water (A)
   e. Control Rod (A)

4. Assembly Characteristics

   a. k_∞ - Infinite Multiplication Factor
   b. M^2 - Migration Area [cm^2]
   c. B_M^2 - Material Buckling [cm^{-2}]
   d. β - Delayed Neutron Fraction
   e. Two-Group Inverse Neutron Velocity† [cm/sec]

5. Two-Group Collapsed Assembly Averaged Cross Sections†

   D [cm], Σ_a[cm^{-1}], Σ_r[cm^{-1}],

   $\nu\Sigma_f$[cm^{-1}], $\kappa\Sigma_f$[watt/cm], Σ_f[cm^{-1}]

* These are editing points and do not necessarily correspond to the depletion steps.

† Thermal breakpoint assumed at 0.625 [eV]

FUEL ASSEMBLY STANDARD PROBLEM

II. REACTIVITY DEFECT CALCULATIONS

Provide the following reactivity defects (%Δ k/k) for an assembly with and without burnable poison rods at BOL and EOL (30,000 Mwd/MT):

	REACTIVITY DEFECT (%Δ k/k)*	UNPERTURBED CASE†	PERTURBED CASE
1.	Fuel Temperature (T_{fuel})	T_{fuel}^{base}	$T_{moderator}^{base}$
2.	Moderator Temperature ($T_{moderator}$)	$T_{moderator}^{base}$	$T_{moderator}^{base}$ -25°K
3.	Moderator & Fuel Temperature†† ($T_{Moderator}$ & T_{Fuel})	$T_{moderator}^{base}$	68°F
		T_{fuel}^{base}	68°F
4.	Moderator & Fuel Temperature†† ($T_{Moderator}$ & T_{Fuel})	$T_{moderator}^{base}$	300°F
		base fuel	300°F
5.	Boron Concentration (N_{boron})	N_{boron}^{base}	0 ppm
6.	Xenon Concentration (N_{xenon})	Equilibrium	0
7.	Control Rod #	Unrodded	Rodded

* It is recommended that a full flux solution be carried out for each state-point.

† Unperturbed parameters are at their base values indicated in the Standard Problem definition.

\# In the case of the W (17x17) assembly only the unpoisoned assembly is required.

†† Pressure is to be maintained at base value.

DATA FOR FUEL ASSEMBLY STANDARD PROBLEM

17 x 17 W Type Fuel Assembly

1. General Characteristics

Power density (W/Gm-U)	38.4
Average fuel temperature (°K)	968
Average clad-temperature (°K)	600
Moderator temperature (°K)	560
Soluble boron concentration (ppm)	400
Average core pressure (psia)	2250
Xenon concentration	Equilibrium
Samarium concentration	Equilibrium

2. Configuration (1/8 assembly)

```
4
1 1
1 1 1
2 1 1 3
1 1 1 1 1
1 1 1 1 1 2
3 1 1 2 1 1 1
1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1
```

1 - Fuel Rod
2 - Burnable Poison Rod (BPR)
3 - Guide Thimble
4 - Instrument Thimble

Note: 1. For an unrodded or unpoisoned case replace all BPRs (2) with guide thimbles (3).

2. For a rodded case replace all BPRs (2) with control rods inserted in guide thimbles (3).

3. Fuel Assembly Data

Rod array	17 x 17
Fuel rods per assembly	264
Rod pitch (in)#	0.496
Assembly pitch (in)**	8.466 x 8.466
Assembly length (in)	151.0
Active fuel length (in)	144.0
Number of spacer grids†	8
Compositon of spacer grid	Inconel 718
Weight of spacer grids (lb)	12
Number of guide thimbles	24
Number of instrument thimbles	1

All dimensions are given at cold (68°F) conditions.
† Seven in active length.
** Center to center assembly pitch.

4. Fuel Rod Data

Clad O.D. (in)	0.374
Clad thickness (in)	0.0225
Diametral gap (in)	0.0065
Clad material	Zircaloy-4

5. Fuel Pellet Data

Material	UO_2 - Undished
Density (% of theoretical)	95
Enrichment (w/o)	2.6
Diameter (in)	0.3225

6. Burnable Poison Rod Data (See Figure 1)

Number per assembly	16
Material	Borosilicate Glass
Density (Borosilicate glass) (gm/cm^3)	2.28
Outside clad O.D. (in)	0.381
Outside Clad I.D. (in)	0.348
Absorber O.D. (in)	0.344
Absorber I.D. (in)	0.185
Inner-tube O.D. (in)	0.1805
Inner-tube I.D. (in)	0.170
Clad material	Stainless Steel
Inner-tube material	Stainless Steel
Boron loading (w/o B_2O_3 in glass rod)	12.5
Weight of Boron-10 (lb/ft)	0.000419

7. Guide Thimbles and Instrument Thimble Data

Number of guide thimbles	24
Number of instrument thimbles	1
Composition of thimbles	Zircaloy-4
Guide Thimble O.D. (in)	0.482
Guide Thimble I.D. (in)	0.450
Instrument Thimble O.D. (in)	0.482
Instrument Thimble I.D. (in)	0.450

8. Control Rod Data

Neutron absorber (w/o)	5% Cd, 15% In, 80% Ag
Absorber diameter (in)	0.341
Absorber density (lb/in^3)	0.367
Cladding material	304 Stainless Steel
Clad O.D. (in)	0.381
Clad thickness (in)	0.0185
Number of control rods	24

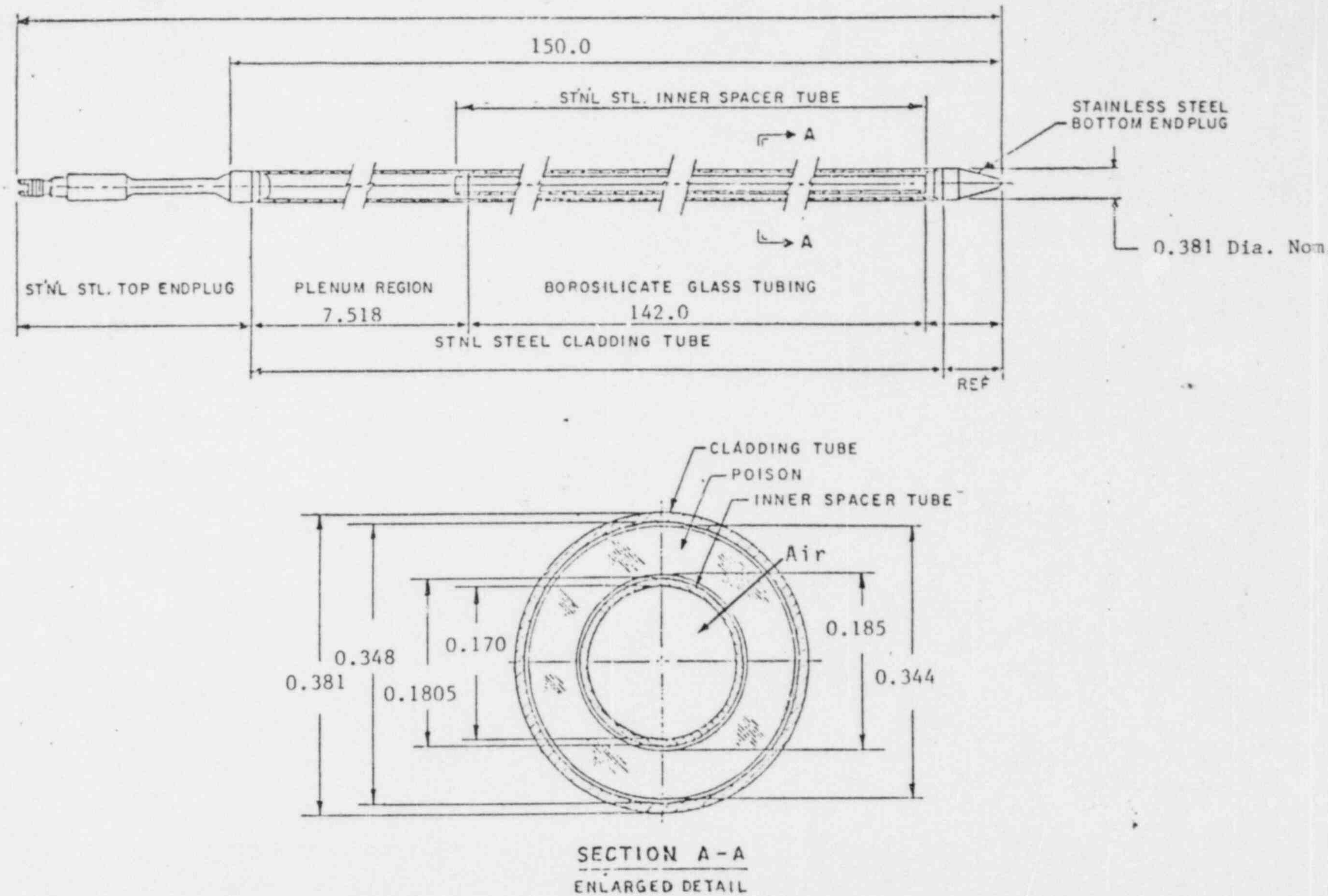

Figure 1. Burnable Poison Rod Configuration

DESCRIPTION OF CALCULATIONS AND METHODS

1. Name of code/code source/version
2. Reference for calculational method
3. Assembly solution method (Diffusion Theory, Collision Probability, Integral Transport, Monte Carlo, etc.)
4. Pin-cell solution method (if distinct from assembly solution method)
5. Spatial mesh assembly/pin-cell (nxm)
6. Neutron cross sections (ENDF/B or other identification)
7. Number of fast/thermal groups in assembly/pin-cell solution
8. Depletion steps