NUCLEAR ENERGY BUSINESS GROUP • GENERAL ELECTRIC COMPANY
SAN JOSE, CALIFORNIA 95125

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NOTE: Correct all copies of the applicable publication as specified below.

ITEM	REFERENCES (SECTION, PAGE PARAGRAPH, LINE)	INSTRUCTIONS (CORRECTIONS AND ADDITIONS)
01	Title Page	Replace with new Title Page.
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11	Page 2-3	Replace with new page 2-3.
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14	Page 2-18	Replace with new page 2-18.
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18	Page 2-51a	Replace with new page 2-51a.
19	Pages 2-53 thru 2-54b	Replace with new pages 2-53 through 2-54b.
20	Pages 2-56 & 2-57	Replace with new pages 2-56 and 2-57.
21	Page 2-61a	Replace with new page 2-61a.

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22	Page 2-68b	Replace with new page 2-68b.
23	Page 2-76	Replace with new page 2-76.
24	Pages 2-184f thru 2-184hhhhh	Replace with new pages 2-184f through 2-184hhhhh.
25	Page 2-187	Replace with new page 2-187.
26	Page 2-189	Replace with new page 2-189.
27	Page 2-197a	Replace with new page 2-197a.
28	Page 2-200a	Replace with new page 2-200a.
29	Pages 3-13 thru 3-15	Replace with new pages 3-13 through 3-15.

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April 1983

LICENSING TOPICAL REPORT

GENERAL ELECTRIC STANDARD APPLICATION FOR REACTOR FUEL

Approved: G. G. Sherwood
G. G. Sherwood, Manager
Nuclear Safety & Licensing Operation

NUCLEAR ENERGY PROJECTS DIVISION • GENERAL ELECTRIC COMPANY
SAN JOSE, CALIFORNIA 95125

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NOTICE

Proprietary information of the General Electric Company has been removed from the text. Its location in the text is marked by bars in the margin. Revisions are indicated by brackets.

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1. INTRODUCTION

This report presents generic information relative to the fuel design and analyses of General Electric Boiling Water Reactor plants for which General Electric provides fuel. The report is comprised of the fuel design, fuel thermal-mechanical analysis, and nuclear and hydraulic analyses methods. This report provides information that is independent of a plant-specific application. Plant-specific information and methods used to determine reactor limits are given in the country-specific supplement accompanying this base document.

The generic information contained in this document is supplemented by plant cycle-unique information and analytical results. This cycle-unique information includes a listing of the fuel to be loaded in the core and safety analysis results. This information is documented in the plant FSAR for initial core loadings and in a separate plant-unique cycle-dependent submittal for each reload. The format for the reload submittal is given in the country-specific supplement to this document. 12/81A

All approved changes, whether administrative or safety-related, will be placed in the normal text, redated with either the incorporation date or SER date, respectively, and the page heading will reflect the revision number (-1, -2, etc.). All amendments which are administrative in nature (i.e., did not require formal approval) will be designated with an "A" in the margin when incorporated into the normal text.

The fuel designs presently covered in this report include the 8x8, 8x8 Retrofit (8x8R), Prepressurized 8x8 Retrofit (P8x8R) and Prepressurized 8x8 Retrofit with barrier (BP8x8R). 4/83 A detailed description of these fuel designs, as well as the models and results of the generic analyses performed to assure the structural adequacy of the reload fuel, is described in Section 2. Plant-unique nuclear and hydraulic analyses which are performed for each individual reload are documented in Sections 3 and 4, respectively.

cross section at a particular elevation and one for the bundle. The lattice designations used are 8DRLxxxAA, where:

8 - designates the fuel bundle design;

D - may actually be D, C or S and denotes that the design is for a D, C or S lattice type core;

R - denotes the 8x8 retrofit fuel design;

L - indicates that it is the lattice description and not the bundle;

xxx - is the lattice cross-section average enrichment (U-235 weight percent); and

AA - is a one- or two-letter suffix which differentiates between lattices with the same average enrichments that are different in some other respect, such as enrichment distribution or gadolinium content and distribution.

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The 8x8R bundle designation used is 8DRBxxxAA, where B replaces L in the lattice description and designates that it is a bundle.

For the prepressurized 8x8 retrofit fuel design, a P is placed in front of the lattice and bundle description. For the prepressurized 8x8 retrofit fuel design with barrier, a "B" is placed in front of the lattice and bundle description.

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The reload bundle U-235 enrichments for each 8x8R and P8x8R fuel bundle designation which is available for 145.24-in. and/or 150-in. active fuel length are given in Table 1-1.

Table 1-1

LATTICE AND BUNDLE AVERAGE ENRICHMENTS FOR 8x8R, P8x8R AND BP8x8R FUELS

	145.24-in. Active Fuel Length		150-in. Active Fuel Length	
Lattice	Bundle	U-235 Enrichment (wt%)	Bundle	U-235 Enrichment (wt%)
8DRL254	8DRB239	2.39	8DRB239	2.39
8DRL282L	8DRB265L	2.65	8DRB265L	2.65
8DRL282L	---	---	8DPB271/8DRB271	2.71
8DRL282H	8DRB265H	2.65	8DRB265H	2.65
8DNL282L&H	8DNB277/8DRB277	2.77	---	---
8DRL301	8DRB282	2.82	8DRB283	2.83
8DNL301	---	---	8DPB289/8DRB289	2.89
8DRL303	---	---	8DPB291/8DRB291	2.91
8DRL303L	---	---	8DRB284L	2.84
P8DRL254	P8DRB239	2.39	P8DRB239	2.39
P8DRL282L	P8DRB265L	2.65	P8DRB265L	2.65
P8DRL282H	P8DRB265H	2.65	P8DRB265H	2.65
P8DRL282L	---	---	P8DPB271/P8DRB271	2.71
P8DNL282L&H	P8DNB277/P8DRB277	2.77	---	---
P8DRL071	---	---	P8DRB071	0.71
P8DRL183	---	---	P8DRB175	1.75
P8DRL233	---	---	P8DRB221	2.21
P8DRL301	P8DRB282	2.82	P8DRB283	2.83
P8DRL301	---	---	P8DPB289/P8DRB289	2.89
P8DRL303	---	---	P8DPB291/P8DRB291	2.91
P8DRL303L	---	---	P8DRB284L	2.84
P8DRL303H	---	---	P8DRB284H	2.84
P8DRL303LA	---	---	P8DRB284LA	2.34
P8DRL303LB	P8DRB284LB	2.84	---	---
P8DRL305	---	---	P8DRB285	2.85
P8DRL319	---	---	P8DRB299	2.99
8CRL283L	---	---	8CRB266L	2.66
8CRL303LB	---	---	8CRB284LB	2.84
8CRL303L	---	---	8CRB285L	2.85
P8CRL283L	---	---	P8CRB266L	2.66
P8CRL280LA	---	---	P8CRB266LA	2.66
P8CRL280	---	---	P8CRB263	2.63
P8CRL280H	---	---	P8CRB263H	2.63
P8CRL280L	---	---	P8CRB263L	2.63
P8CRL303L	---	---	P8CRB285L	2.85
P8CRL303LA	---	---	P8CRB284LA	2.84
P8CRL303LB	---	---	P8CRB284LB	2.84
P8CRL303	---	---	P8CRB284	2.84
P8CRL303H	---	---	P8CRB284H	2.84

Table 1-1

LATTICE AND BUNDLE AVERAGE ENRICHMENTS FOR 8x8R, P8x8R AND BP8x8R FUELS
(Continued)

	145.24-in. Active Fuel Length		150-in. Active Fuel Length	
Lattice	Bundle	U-235 Enrichment (wt%)	Bundle	U-235 Enrichment (wt%)
P8CRL303HA	---	---	P8CRB285HA	2.85
P8CRL303HB	---	---	P8CRB284HB	2.84
P8CRL233	---	---	P8CRB219	2.19
P8CRL183	---	---	P8CRB176	1.76
P8CRL071	---	---	P8CRB071	0.711
P8CRL296	---	---	P8CRB278	2.78
P8CRL261	---	---	P8CRB248	2.48
P8CRL264	---	---	P8CRB248	2.48
P8CRL171	---	---	P8CRB163	1.63
P8CRL096	---	---	P8CRB094	0.94
P8DRL284	P8DRB266	2.66	---	---
P8DRL302H	P8DRB283	2.83	---	---
P8DRL321L	---	---	P8DRB301L	3.01
P8DRL303HA	---	---	P8DRB284HA	2.84
P8DRL303LB	---	---	P8DRB284LB	2.84
P8DRL303LC	---	---	P8DRB284LC	2.84
P8DRL303LD	P8DRB284LD	2.84	---	---
P8DRL303Z	---	---	P8DRB284Z	2.84
P8SRL303L	---	---	P8SRB284L	2.84
P8SRL303	---	---	P8SRB284	2.84
P8SRL303H	---	---	P8SRB284H	2.84
P8SRL280	---	---	P8SRB263	2.63
P8SRL280H	---	---	P8SRB263H	2.63
P8SRL233	---	---	P8SRB219	2.19
P8SRL210	---	---	P8SRB200	2.00
P8SRL183	---	---	P8SRB176	1.76
P8SRL160	---	---	P8SRB154	1.54
P8SRL071	---	---	P8SRB071	0.711
BP8DRL254	BP8DRB239	2.39	BP8DRB239	2.39
BP8DRL282L	BP8DRB265L	2.65	BP8DRB265L	2.65
BP8DRL282H	BP8DRB26[illegible]	2.65	BP8DRB265H	2.65
BP8DRL282L	---	---	BP8DRB271	2.71
BP8DRL282LN&HN	BP8DRB277	2.77	---	---
BP8DRL301	BP8DRB282	2.82	BP8DRB283	2.83
BP8DRL301	---	---	BP8DRB289	2.89
BP8DRL303	---	---	BP8DRB291	2.91
BP8DRL303L	---	---	BP8DRB284L	2.84
BP8DRL303H	---	---	BP8DRB284H	2.84

Table 1-1

LATTICE AND BUNDLE AVERAGE ENRICHMENTS FOR 8x8R, P8x8R AND BP8x8R FUELS
(Continued)

	145.24-in. Active Fuel Length		150-in. Active Fuel Length	
Lattice	Bundle	U-235 Enrichment (wt%)	Bundle	U-235 Enrichment (wt%)

4/83

Table 1-1

LATTICE AND BUNDLE AVERAGE ENRICHMENTS FOR 8x8R, P8x8R AND BP8x8R FUELS
(Continued)

	145.24-in. Active Fuel Length		150-in. Active Fuel Length	
Lattice	Bundle	U-235 Enrichment (wt%)	Bundle	U-235 Enrichment (wt%)

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2. FUEL MECHANICAL DESIGN

2.1 FUEL ASSEMBLY DESCRIPTION

The fuel assembly, shown in Figure 2-1, consists of a fuel bundle and a channel which surrounds it. Fuel bundle designs are designated as either 8x8, 8x8R, P8x8R, or BP8x8R. Fuel assembly parameters for each fuel bundle type are given in Table 2-1. The 8x8 fuel bundle contains 63 fuel rods and one water rod. The 8x8R, P8x8R and BP8x8R fuel bundles contain 62 fuel rods and two water rods. The rods of all bundle types are spaced and supported in a square (8x8) array by the upper and lower tieplates, as well as fuel rod spacers. The lower tieplate has a nose piece which has the function of supporting the fuel assembly in the reactor. The upper tieplate has a handle for transferring the fuel bundle from one location to another. The identifying assembly serial number is engraved on the top of the handle. No two assemblies bear the same serial number. A boss projects from one side of the handle to aid in ensuring proper fuel assembly orientation. Both upper and lower tieplates are fabricated from Type-304 stainless steel. Zircaloy fuel rod spacers equipped with Inconel-X springs are employed to maintain rod-to-rod spacing. Finger springs located between the lower tieplate and the channel are utilized on some fuel assemblies to control the bypass flow through that flow path.

Application of the appropriate fuel assembly to the BWR type or project is accomplished by adherence to a design control program wherein each mechanical configuration is reviewed for applicability to the identified product line (BWR type) and each nuclear standard is reviewed for applicability to identified project requirements (see Section 2.7).

2.1.1 Fuel Rods

Each fuel rod consists of high density ceramic uranium dioxide fuel pellets stacked within Zircaloy cladding which is evacuated, backfilled with helium and sealed with Zircaloy end plugs welded in each end.

The

which fit into bosses in the tieplates. An expansion spring is located over the upper end plug shank of each rod in the assembly to keep the rods seated in the lower tieplate while allowing independent axial expansion by sliding within the holes of the upper tieplate. Additional expansion spring design information is given in Section VII of Reference 2-3. 12/81A

2.1.2 Water Rods

The 8x8 fuel bundle contains one water rod and the 8x8R, P8x8R and BP8x8R fuel bundles contain two water rods. 4/83 These rods are hollow Zircaloy tubes with several holes punched around the circumference near each end to allow coolant to flow through. Three holes with a diameter of ________ for the 8x8 and 0.116 in. for the 8x8R, P8x8R and BP8x8R fuel designs are located at the bottom of the water rod, and eight holes with a diameter of _____ in. are located at the top. 4/83

One water rod in each bundle positions the Zircaloy fuel spacers axially. 12/81A This spacer-positioning water rod is equipped with a square bottom end plug and with spacer positioning tabs which are welded to the exterior (Figures 2-4 and 2-5). 12/81A The rod and spacers are assembled by sliding the rod through the appropriate spacer cell with the welded tabs oriented in the direction of the corner of the spacer cell. It is then rotated so that the tabs are above and below the spacer structure. Once in position the water rod is prevented from rotating by the engagement of its square lower end plug with the lower tieplate hole.

2.1.3 Other Fuel Assembly Components

The primary function of the fuel spacer is to provide lateral support and spacing of the fuel rods, with consideration of thermal-hydraulic performance, fretting wear, strength, neutron economy, and producibility. The spacer represents an optimization of all these considerations. Details of the mechanical design of the 8x8, 8x8R, P8x8R and BP8x8R spacers are shown in Figures 2-6 and 2-7. 4/83

Finger springs shown in Figure 2-8 are employed to control the bypass flow through the channel-to-lower tieplate flow path for some fuel assemblies.

the gadolinia-urania fuel rods are designed to provide margins similar to standard UO_2 rods. The calculated LHGR values as a function of exposure are given in Tables 2-3 and 2-3a. Differences between beginning of life and end of life are primarily due to changes in: 7/81A

The values calculated as resulting in 1% plastic strain in the cladding are used during specific plant evaluations of transients due to single operator error or equipment malfunctions to ensure that the safety limit is not exceeded. See Section S.2 of the country-specific supplemental report. 12/81A

Based on these results, it has been determined that the power required to produce 1% plastic strain in the cladding is equal to or greater than 175% of the design maximum steady-state power throughout life for all rod types in the assembly for the 8x8 fuel design, and greater than 160% for the 8x8R and 145% for the P8x8R and BP8x8R designs. These ratios consider the presence of a calculated power spiking penalty being added to the MLHGR. 4/83

2.4.2 Design Evaluations

The integral design model used in the thermal analyses treats a fuel rod as a number of distinct axial nodes. Analyses at each axial node are based on a solid right circular cylinder pellet geometry divided into annular ring nodes with concentric cladding.

Specific analytical results for the 8x8, 8x8R, P8x8R and BP8x8R fuel designs are given below. No criteria are specified, as results of the evaluations documented in Subsections 2.4.2.2 through 2.4.2.6 are used as input to the mechanical evaluations given in Subsection 2.5. 4/83 7/81A

Parameters reviewed to ensure that the generic fuel analyses are applicable for each plant reload core are given in Subsection 2.7.

2.4.2.1 Effects of Fuel Densification

Evaluations to determine the effects of fuel densification are made using the models described in References 2-7 and 2-8. Possible effects due to fuel densification are: (1) power spikes due to axial gap formation; (2) increase in linear heat generation rate (LHGR) because of pellet length shortening; (3) creep collapse of the cladding due to axial gap formation; and (4) changes in stored energy due to decreased pellet-cladding thermal conductance resulting from increased radial gap size.

2.4.2.1.1 Power Spiking

The power spiking allowance, calculated using the referenced methods, resulted in a power spiking penalty at the top of the core which is less than or equal to 2.2% for the 8x8, 8x8R, P8x8R and BP8x8R designs. The power spiking penalty as a function of elevation from the bottom of the core is conservatively expressed by: 4/83 7/81A

$$\left(\frac{\Delta P}{P}\right)_x = \left(\frac{\Delta P}{P}\right)_L \frac{X}{L} \qquad (2-2)$$

However, for conservatism, this allowance for impairment of heat transfer resulting from a buildup of surface deposits was used for this analysis.

The model used to calculate the fuel cladding temperature is documented in Reference 2-25.

Fuel cladding temperatures as a function of heat flux for the 8x8, 8x8R, P8x8R and BP8x8R designs are shown in Figures 2-12 and 2-13 for the beginning-of-life conditions and in Figures 2-14, 2-15, and 2-15a for late-in-life conditions. 4/83 7/81A

2.4.2.3 Fission Gas Release

The fuel rod internal pressure is calculated using the perfect gas law. Fuel rod internal pressure is due to the helium, which is backfilled at one atmosphere pressure for the 8x8 and 8x8R designs and three atmospheres pressure for the P8x8R and BP8x8R designs during rod fabrication, the volatile content of the UO_2, and the fraction of gaseous fission products which are released from the UO_2. In defining the hot plenum volume used to compute fuel rod internal gas pressure, nominal tolerances are assumed. The available fission gas retention volume is determined based upon the following assumptions: 4/83 12/81A

a. Nominal (P8x8R and BP8x8R) as-built plenum volume; 4/83 12/81A 7/81A 8/82A

b. Maximum expected fuel cladding differential expansion.

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2.4.2.4 Fuel and Cladding Expansion

The fuel rod is designed to accommodate predicted fuel and cladding differential expansion. Assuming no cladding restraint, the total relative axial expansion of fuel and cladding is calculated as the difference in the cladding axial thermal expansion and the fuel axial thermal expansion and irradiation swelling.

The axial thermal expansion of the fuel cladding is calculated based on cladding average temperature and cladding longitudinal thermal expansion coefficient given in Subsection 2.3.1. Similarly, the axial fuel thermal expansion is a function of the average fuel temperature and the fuel thermal expansion coefficient.

2.5.3 Fuel Assembly Normal and Transient Load Evaluations

The fuel assembly and its component parts are analyzed to ensure mechanical integrity after exposure to normal and transient operational loadings. The evaluations performed for the fuel rod, water rod, spacer, and upper and lower tie plate are given below. Fuel rod evaluations are performed for dimensional stability, creep collapse, stress, deflection, fatigue, water-log rupture, and flow-induced vibrations.

The fuel assembly and fuel components are designed to assure dimensional stability in service. The fuel cladding and channel specifications include provisions to preclude dimensional changes due to residual stresses. In addition, the fuel assembly is designed to accommodate dimensional changes that occur in service due to thermal differential expansion and irradiation effects. For example, the fuel rods are free to expand axially independent of each other.

Mechanical analyses have been performed to assess the effects of the differential thermal expansion between the tie plates and spacer grids. The differential thermal expansion introduces a bending stress of less than 400 psi at the end of the fuel tube. Additional information regarding the model employed in this calculation is presented in Section 4 of Reference 2-15.

2.5.3.1 Fuel Rod Evaluations

2.5.3.1.1 Cladding Creep Collapse

A cladding creep collapse analysis has been performed employing the finite element model documented in Reference 2-16. Figure 2-16 presents the cladding midwall temperature versus time employed in the analysis. The temperature vs time shown in the figure reflects the assumptions that at a location of the fuel rod, the fuel is operating at 13.4 kW/ft plus the calculated power spiking penalty, up to an exposure of 4000 MWd/t. At that point in time, a gap is assumed to form as a result of densification, and the cladding temperature therefore decreases. No credit was taken for internal gas pressure due to released fission gas or volatiles. The internal pressure due to helium backfill during fabrication was considered. Based on the analysis results, cladding collapse was not calculated to occur for either the 8x8, 8x8R, P8x8R or BP8x8R fuel designs.] 4/83

2.5.3.1.2 Stress Evaluations

The computer program used for the stress analysis of fuel rods is linear and elastic; plasticity, creep, or relaxation are not included. The maximum shear stress theory of failure is used, with all radial stresses assumed to be zero. The radial, longitudinal, and circumferential directions are assumed to be the principal stress directions. Tensile stresses are considered positive, and compressive stresses are considered negative. It is assumed that stress superposition is valid and that all stresses are within the range of Hooke's Law deformation, except the pellet-cladding interaction stress during transient overpower. Stress subscripts are defined in Figure 2-17.

An example of fuel description input parameters used in the 8x8R, P8x8R and BP8x8R analyses is given in Tables 2-7a, 2-7b, and 2-7c. Thermal analysis inputs are given in Subsection 2.4. Cladding material properties used in the analyses are given in Subsection 2.3. At beginning of life, the unirradiated mechanical properties given in Subsection 2.3 are used. At subsequent times in life, saturated irradiated mechanical properties are assumed unless the temperature is high enough that the irradiation effects on cladding mechanical properties are assumed to be annealed out. For the latter condition, unirradiated mechanical properties are used. 7/81A 4/83

Three regions of the cladding (at the spacer, between the spacers, and at the end plug weld) are analyzed for three different conditions at the beginning of life and at the end of chosen exposure steps. The three conditions considered are: (1) rated power and steady-state design pressures; (2) rated power and transient design pressures; and transient power.

The loads applied to the fuel rods include pressure differentials, flow-induced vibration, spacer contact, thermal mismatch (of cladding and relative to lower end plug), radial and circumferential thermal gradients, end plug misalignment, and pellet-cladding interaction. These loads result in the stresses given in Table 2-18. Equations used to calculate each stress are given in Table 2-8. Nomenclature for these equations is given in Table 2-9. There are two analyses performed for each time point and condition analyzed.

For the 8x8, 8x8R and P8x8R fuel designs, the first analysis uses the cladding differential pressure resulting from maximum coolant pressure and zero psia internal gas pressure ________________________________ fuel rod internal pressure at operating temperature due to the helium fillgas); the second analysis uses the cladding differential pressure resulting from minimum coolant pressure and maximum internal gas pressure. 4/83

The equivalent stress intensity is calculated for each stress category given in Table 2-6, at each of the three regions of cladding, for the inside and outside surfaces, for each time point analyzed. The stress combinations at each region of cladding is given in Table 2-19. The equivalent stress intensity is defined as the difference between the most positive and least positive principal stresses in a triaxial field. The resulting stress intensity for each stress combination is divided by the appropriate normal or abnormal stress intensity limit given in Table 2-6 to obtain a design ratio. The strengths in the design limits are evaluated at the temperature of the location where stresses are being summed. For Stress Category 1, this is the mean cladding temperature; for Stress Categories 2, 3, and 4, it is the temperature of the applicable cladding surface. No design ratio is allowed to exceed unity.

This large set of numbers is summarized by showing the maximum design ratio at each rod location for each time point analyzed. Example analytical results for the 8x8R fuel design are given in Table 2-10.

2.5.3.1.3 Deflection Evaluation

The operational fuel rod deflections considered are a result of manufacturing tolerances, flow-induced vibration, thermal effects, and axial load. The deflection equations are given in Table 2-11. Nomenclature for these equations is given in Table 2-9. The deflections were combined and compared with the fuel rod-to-fuel rod and fuel rod-to-channel spacing deflection limits given in Subsection 2.5.1. This comparison demonstrated that the fuel rod clearance criterion was met. 7/81A

2.5.3.1.4 Fatigue Evaluation

The fatigue analysis utilizes the linear cumulative damage rule (Miner's hypothesis[2-17]).

In the analysis, thermal stresses are assumed to be proportional to power, based on reference values at 100% power. Because fatigue damage is calculated as a state function, and not a path function, explicit time histories of pressure and temperature are not required. The cyclic condition relating to overpower transients would result from an operator error or equipment malfunction, and would therefore be expected to be of short duration (less than 8 hours).

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The cyclic loads considered in cladding fatigue analysis are coolant pressure and thermal gradients. The analysis is based on the cycles and maximum and minimum coolant pressures shown in Table 2-13 and the stresses determined in Subsection 2.5.3.1.2. Beginning-of-life thermal gradients are used because 8/82A 7/81A

The fuel rod natural frequency is approximately 35 Hz, so the predicted vibrational amplitude is ________. ____ ____.

2.5.3.2 Water Rod

The water rods experience less axial growth than the fueled rods during thermal cycling. Therefore, loads can be induced in the spacer positioning water rod, if the positioning device (tab) on the water rod engages the spacer grid. Any additional growth after engagement requires the fueled rods to slide through the spacer grid and thereby creates friction forces which must be reacted by the spacer positioning rod. The 14-tab water rod has sufficient margin against the spacer positioning rod sustaining any significant load due to spacer friction forces. This is accomplished by providing additional space between the spacer positioning tabs above that required to clear the divider.

The strength of the spacer grid positioning device was tested using a fixture similar to the one shown in Figure 2-18 for the 8x8, 8x8R, P8x8R and BP8x8R 14-tab water rod designs. Uncoupling of the positioning device occurred when the loads induced on the spacer divider were of such magnitude that the divider rotated and allowed the tab to pass. This could result in minor damage to the divider and smearing of the edge of the water rod tab. Both the tab and divider remained intact. The estimated hot load carrying capability of the spacer grid positioning device is about 3 times the load which can be imparted by friction between the fuel rods and spacers.] 4/83

In the 8x8, 8x8R, P8x8R and BP8x8R designs, the spacer grid positioning device is not located at the geometric center of the spacer grid. In Figures 2-4 and 2-5, the location of the geometric center of the spacer grid has been identified. The distance from the geometric center to the tab for the 14-tab water rod is shorter than the distance to the tab of the previous design, 7-tab, water rod which resulted in approximately a 25% reduction in the maximum force required to slide the spacer over fuel rods with a load being applied to the water rod. This was substantiated by testing with the test fixture shown in Figure 2-19.] 4/83

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Table 2-1 (Continued)

FUEL ASSEMBLY DESIGN SPECIFICATIONS

PARAMETERS COMMON TO ALL ASSEMBLY DESIGNS FOR EACH BUNDLE TYPE

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Table 2-1 (Continued)

PARAMETERS VARYING WITH FUEL ASSEMBLY DESIGN AND REACTOR TYPE, 8x8R, P8x8R, AND BP8x8R BUNDLE DESIGNS

8/82A 4/83

REACTOR TYPE	BWR/2,3	BWR/4,5,6	BWR/6
Active Fuel Length (in.)	145.24	150	150
Heat Transfer Area (ft^2)	94.9	98.0	98.0
Spacer Pitch (in.)	19.55	20.15	20.15
Finger Springs	*	yes	yes
Lower Tieplate Bypass Flow Holes	*	yes	yes

12/81A 12/81A

Nominal Fuel Weights:

FUEL BUNDLE	Weight of UO_2, Kg 145.24 AFL	Weight of UO_2, Kg 150 AFL	Weight of U, Kg 145.24 AFL	Weight of U, Kg 150 AFL
8DRB239/P8DRB239	200.6	207.2	176.9	182.6
8DRB265L/P8DRB265L	200.5	207.1	176.3	182.5
8DRB265H/P8DRB265H	200.3	206.9	176.6	182.3
8DRB282/P8DRB282	200.2	---	176.5	---
8DRB283/P8DRB283	---	206.7	---	182.2
8DRB284L/P8DRB284L	---	206.7	---	182.2
8DRB289/P8DRB289, 8DPB289/P8DPB289	---	206.7	---	182.2
8DRB271/P8DRB271, 8DPB271/P8DPB271	---	206.9	---	182.3
P8DRB291/P8DRB291, 8DRB291/P8DRB291	---	206.7	---	182.2
8DRB277/P8DRB277, 8DNB277/P8DNB277	200.2	---	176.4	---
P8DRB284H	---	206.5	---	182.0
P8DRB284LB	200.4	---	176.7	---
P8DRB284LA	---	207.0	---	182.4
P8DRB285	---	206.6	---	182.1
P8DRB299	---	206.5	---	182.0
P8CRB263	---	207.1	---	182.5
8CRB266L/P8CRB266L	---	207.1	---	182.5
P8CRB266LA	---	207.0	---	182.4
P8CRB263L	---	207.1	---	182.5
P8CRB263H	---	206.9	---	182.3
P8CRB284	---	206.9	---	182.3
P8CRB284LA	---	207.1	---	182.5
8CRB284LB/P8CRB284LB	---	207.0	---	182.5

8/82A 12/81A 7/81A 8/82A 7/81A 12/81A 7/81A

*On selected fuel assemblies for bypass flow control.

Table 2-1 (Continued)

PARAMETERS VARYING WITH FUEL ASSEMBLY DESIGN AND REACTOR
TYPE, 8x8R, P8x8R, AND BP8x8R BUNDLE DESIGNS 8/82A 4/83

FUEL BUNDLE	145.24 AFL	150 AFL	145.24 AFL	150 AFL	Revision
P8CRB284H	---	206.7	---	182.2	7/81A
P8CRB284HB	---	206.6	---	182.1	
8CRB285L/P8CRB285L	---	207.1	---	182.5	
P8CRB285HA	---	206.9	---	182.4	
P8DRB301L	---	206.6	---	182.1	10/81
P8DRB283H	199.9	---	176.2	---	
P8DRB284HA	---	206.3	---	181.9	
P8DRB284LB	---	206.8	---	182.3	
P8DRB284LC	---	206.6	---	182.1	
P8DRB284LD	200.3	---	176.6	---	
P8DRB266	200.4	---	176.7	---	
P8DRB284Z	200.3	---	176.6	---	
P8SRB263	---	207.0	---	182.4	
P8SRB263H	---	206.9	---	182.3	
P8SRB284L	---	206.9	---	182.3	
P8SRB284	---	206.7	---	182.2	
P8SRB284H	---	206.6	---	182.1	
P8DRB221	---	207.0	---	182.5	8/82A
P8DRB175	---	207.3	---	182.7	12/81A
P8DRB071	---	207.6	---	183.0	
P8CRB219	---	207.0	---	182.5	
P8CRB176	---	207.3	---	182.8	8/82A
P8CRB071	---	207.6	---	183.0	8/82A
P8SRB219	---	207.0	---	182.5	
P8SRB200	---	207.2	---	182.6	
P8SRB176	---	207.3	---	182.8	
P8SRB154	---	207.5	---	182.9	
P8SRB071	---	207.6	---	183.0	
P8CRB278	---	207.2	---	182.7	8/82A
P8CRB248	---	206.9	---	182.4	
P8CRB163	---	207.2	---	182.7	
P8CRB094	---	207.6	---	183.0	

Table 2-1 (Continued)

PARAMETERS VARYING WITH FUEL ASSEMBLY DESIGN AND REACTOR TYPE, 8x8R, P8x8R, AND BP8x8R BUNDLE DESIGNS

FUEL BUNDLE	145.24 AFL	150 AFL	145.24 AFL	150 AFL

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Table 2-1 (Continued)

PARAMETERS VARYING WITH FUEL ASSEMBLY DESIGN AND REACTOR TYPE, 8x8R, P8x8R, AND BP8x8R BUNDLE DESIGNS

FUEL BUNDLE	145.24 AFL	150 AFL	145.24 AFL	150 AFL

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Table 2-3

LINEAR HEAT GENERATION RATE
OF CALCULATED 1% PLASTIC DIAMETRAL STRAIN
FOR 8x8 AND 8x8R FUEL

7/81A 7/81A

Exposure (MWd/t)	LHGR at Calculated 1% Plastic Strain (kW/ft)*	
	UO_2	Gd**
0	≥24.7	≥21.9
20,000	≥23.0	≥20.4
40,000	≥19.6	≥17.3

7/81A

Table 2-3a

LINEAR HEAT GENERATION RATE OF CALCULATED 1% PLASTIC
DIAMETRAL STRAIN FOR P8x8R AND BP8x8R FUEL

4/83

Exposure (MWd/mt)	LHGR at Calculated 1% Plastic Strain (kw/ft)*

7/81A 8/82A

*The values reported have been reduced by an amount equal to the calculated power spiking penalty (%).
**Results for gadolinia are applicable for maximum concentration used in reload fuel design.

Table 2-4

LINEAR HEAT GENERATION RATE AT CALCULATED INCIPIENT CENTER MELTING

7/81A

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7/81A

Table 2-7c

BP8x8R FUEL DESCRIPTION PARAMETERS
(GE COMPANY PROPRIETARY)

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Table 2-13b

LOAD CYCLES
(GE COMPANY PROPRIETARY)
(BP8x8R FUEL)

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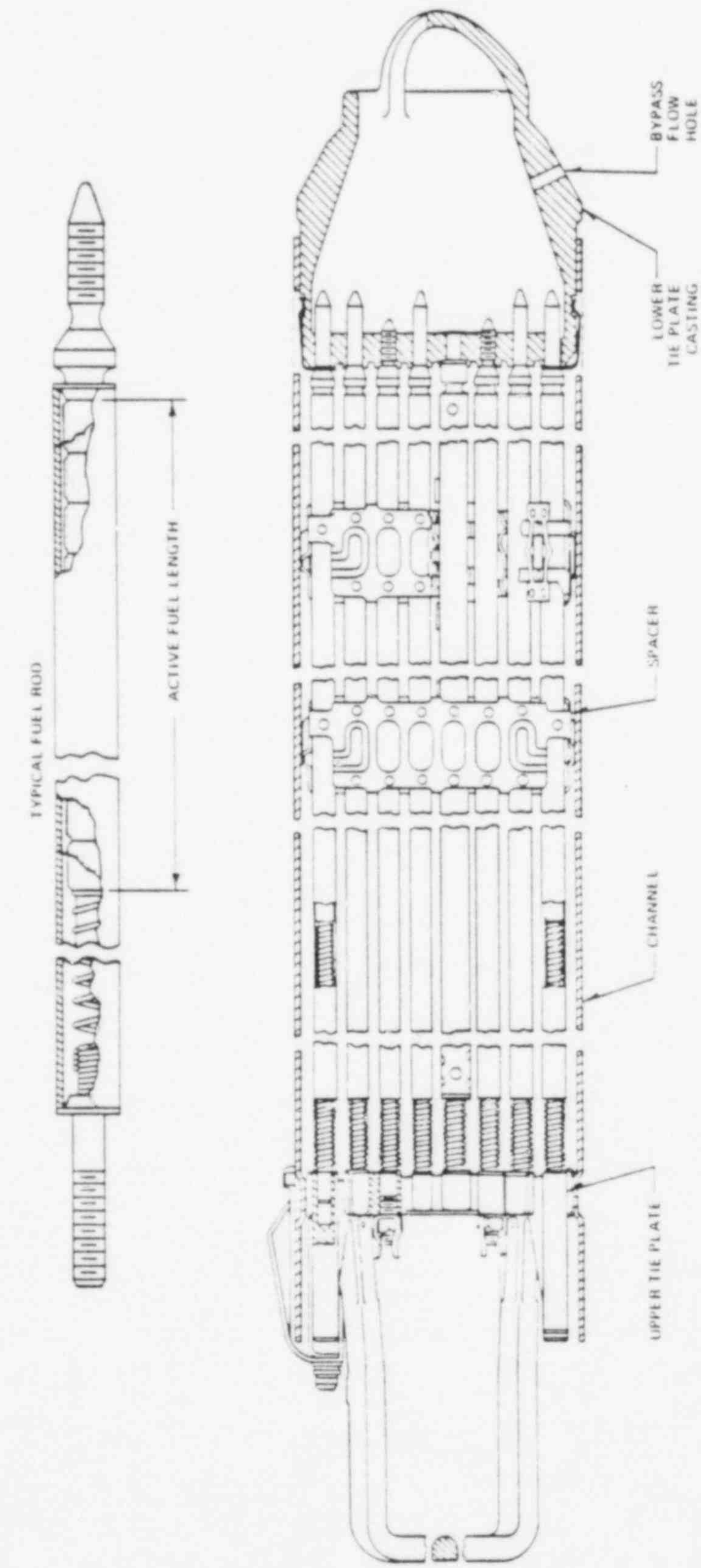

Figure 2-1. 8x8R, P8x8R and BP8x8R Fuel Assemblies

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Figure 2-2.60a. Enrichment Distribution for BP8DRB239 Fuel Bundle
(GE COMPANY PROPRIETARY)

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Figure 2-2.60b. Gadolinium Distribution for BP8DRB239 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.61a. Enrichment Distribution for BP8DRB239 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.61b. Gadolinium Distribution for BP8DRB239 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.62a. Enrichment Distribution for BP8DRB265L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.62b. Gadolinium Distribution for BP8DRB265L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.63a. Enrichment Distribution for BP8DRB265L Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.63b. Gadolinium Distribution for BP8DRB265L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.64a. Enrichment Distribution for BP8DRB265H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.64b. Gadolinium Distribution for BP8DRB265H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.63a. Enrichment Distribution for BP8DRB265H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.65b. Gadolinium Distribution for BP8DRB265H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.66a. Enrichment Distribution for BP8DRB282 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.66b. Gadolinium Distribution for BP8DRB282 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.67a. Enrichment Distribution for BP8DRB283 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.67b. Gadolinium Distribution for BP8DRB283 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.68a. Enrichment Distribution for BP8DRB284L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.68b. Gadolinium Distribution for BP8DRB284L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.69a. Enrichment Distribution for BP8DRB284H Fuel Bundle
(GE COMPANY PROPRIETARY)

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Figure 2-2.69b. Gadolinium Distribution for BP8DRB284H Fuel Bundle
(GE COMPANY PROPRIETARY)

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Figure 2-2.70a. Enrichment Distribution for BP8DPB289/BP8DRB289 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.70b. Gadolinium Distribution for BP8DPB289/BP8DRB289 Fuel Bundles (GE COMPANY PROPRIETARY)

Figure 2-2.71a. Enrichment Distribution for BP8DNB277/BP8DRB277 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.71b. Gadolinium Distribution for BP8DNB277/BP8DRB277 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.72a. Enrichment Distribution for BP8DRB284LA Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.72b. Gadolinium Distribution for BP8DRB284LA Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.73a. Enrichment Distribution for BP8DRB285 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.73b. Gadolinium Distribution for BP8DRB285 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.74a. Enrichment Distribution for BP8DRB299 Fuel Bundles
(GE COMPANY PROPRIETARY)

Figure 2-2.74b. Gadolinium Distribution for BP8DRB299 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.75a. Enrichment Distribution for BP8DRB284LB Fuel Bundles (GE COMPANY PROPRIETARY)

Figure 2-2.75b. Gadolinium Distribution for BP8DRB284LB Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.76a. Enrichment Distribution for BP8CRB263 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.76b. Gadolinium Distribution for BP8CRB263 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.77a. Enrichment Distribution for BP8CRB266LA Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.77b. Gadolinium Distribution for BP8CRB266LA Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.78a. Enrichment Distribution for BP8CRB263L Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.78b. Gadolinium Distribution for BP8CRB263L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.79a. Enrichment Distribution for BP8CRB263H Fuel Bundles
(GE COMPANY PROPRIETARY)

Figure 2-2.79b. Gadolinium Distribution for BP8CRB263H Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.80a. Enrichment Distribution for BP8CRB284 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.80b. Gadolinium Distribution for BPSCRB284 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.31a. Enrichment Distribution for BP8CRB284LA Fuel Bundles (GE COMPANY PROPRIETARY)

Figure 2-2.81b. Gadolinium Distribution for BP8CRB284LA Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.82a. Enrichment Distribution for BP8CRB284LB Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.82b. Gadolinium Distribution for BPSCRB284LB Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.83a. Enrichment Distribution for BP8CRB284H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.83b. Gadolinium Distribution for BP8CRB284H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.84a. Enrichment Distribution for BP8CRB284HB Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.84b. Gadolinium Distribution for BP8CRB284HB Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.85a. Enrichment Distribution for BP8CRB285L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.85b. Gadolinium Distribution for BP8CRB285L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.86a. Enrichment Distribution for BP8CRB285HA Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.86b. Gadolinium Distribution for BP8CRB285HA Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.87a. Enrichment Distribution for BP8DRB266 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.87b. Gadolinium Distribution for BP8DRB266 Fuel Bundles
(GE COMPANY PROPRIETARY)

Figure 2-2.88a. Enrichment Distribution for BP8DRB283H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.88b. Gadolinium Distribution for BP8DRB263H Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.39a. Enrichment Distribution for BP8DRB284HA Fuel Bundles (CE COMPANY PROPRIETARY)

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Figure 2-2.89b. Gadolinium Distribution for BP8DRB284HA Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.90a. Enrichment Distribution for BP8DRB284LB Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.90b. Gadolinium Distribution for BP8DRB284LB Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.91a. Enrichment Distribution for BP8DRB284LC Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.91b. Gadolinium Distribution for BP8DRB284LC Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.92a. Enrichment Distribution for BP8DRB284LD Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.92b. Gadolinium Distribution for BP8DRB284LD Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.93a. Enrichment Distribution for BP8DRB284Z Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.93b. Gadolinium Distribution for BP8DRB284Z Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.94a. Enrichment Distribution for BP8DRB301L Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.94b. Gadolinium Distribution for BP8DRB301L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.95a. Enrichment Distribution for BP8SRB263H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.95b. Gadolinium Distribution for BP8SRB263H Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.96a. Enrichment Distribution for BP8SRB263 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.96b. Gadolinium Distribution for BP8SRB263 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.97a. Enrichment Distribution for BP8SRB284L Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.97b. Gadolinium Distribution for BP8SRB284L Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.98a. Enrichment Distribution for BP8SRB284 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.98b. Gadolinium Distribution for BP8SRB284 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.99a. Enrichment Distribution for BP8SRB284H Fuel Bundles (GE COMPANY PROPRIETARY)

Figure 2-2.99b. Gadolinium Distribution for BP8SRB284H Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.100. Enrichment Distribution for BP8CRB071 and BP8SRB071 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.101. Enrichment Distribution for BP8CRB094 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.102a. Enrichment Distribution for BP8SRB154 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.102b. Gadolinium Distribution for BP8SRB154 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.103a. Enrichment Distribution for BP8CRB163 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.103b. Gadolinium Distribution for BP8CRB163 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.104a. Enrichment Distribution for BP8CRB176 and BP8SRB176 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.104b. Gadolinium Distribution for BP8CRB176 and BP8SRB176 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.105a. Enrichment Distribution for BP8SRB200 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.105b. Gadolinium Distribution for BP8SRB200 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.106a. Enrichment Distribution for BP8CRB219 and BP8SRB219 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.106b. Gadolinium Distribution for BP8CRB219 and BP8SRB219 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.107a. Enrichment Distribution for BP8DRB221 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.107b. Gadolinium Distribution for BP8DRB221 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.108a. Enrichment Distribution for BP8CRB248 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.108b. Gadolinium Distribution for BP8CRB248 Fuel Bundles
(GE COMPANY PROPRIETARY)

Figure 2-2.109a. Enrichment Distribution for BP8CRB278 Fuel Bundles
(GE COMPANY PROPRIETARY)

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Figure 2-2.109b. Gadolinium Distribution for BP8CRB278 Fuel Bundles (GE COMPANY PROPRIETARY)

Figure 2-2.110a. Enrichment Distribution for BPDPB271/BPDRB271 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-1.110b. Gadolinium Distribution for BPDPB271/BPDRB271 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.111a. Enrichment Distribution for BPDPB291/BPDRB291 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.111b. Gadolinium Distribution for BP8PB291/BPDRB291 Fuel Bundles (GE COMPANY PROPRIETARY)

Figure 2-2.112a. Enrichment Distribution for BP8DRB175 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.112b. Gadolinium Distribution for BP8DRB175 Fuel Bundles
(GE COMPANY PROPRIETARY)

Figure 2-2.113. Enrichment Distribution for BP8DRB071 Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.114a. Enrichment Distribution for BP8CRB266L Fuel Bundles (GE COMPANY PROPRIETARY)

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Figure 2-2.114b. Gadolinium Distribution for BP8CRB266L Fuel Bundles
(GE COMPANY PROPRIETARY)

Figure 2-5. Schematic of 14-Tab Water Rod-Spacer Positioning Arrangement, 8x8R, P8x8R and BP8x8R Fuel Bundles (GE COMPANY PROPRIETARY)] 4/83

Figure 2-7. 8x8R, P8x8R and BP8x8R Fuel Spacer
(GE COMPANY PROPRIETARY)

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Figure 2-13b. Cladding Temperature Versus Heat Flux at Beginning of Life (BOL), BP8x8R Fuel (GE COMPANY PROPRIETARY)

Figure 2-15b. Cladding Temperature Versus Heat Flux at End of Life (EOL), BP8x8R Fuel
(GE COMPANY PROPRIETARY)

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will be satisfied if the uncontrolled fuel bundle k_∞ calculated in the normal reactor core configuration meets the following condition for General Electric designed fuel storage racks:

a. $k_\infty \leq 1.31$ for regular spent fuel storage racks with an interrack spacing $\geq$ 11.875 inches. 7/81A

b. $k_\infty \leq 1.30$ for regular spent fuel storage racks with an interrack spacing ≥ 11.71 inches. 7/81A

c. $k_\infty \leq 1.35$ for high density fuel storage racks.

These criteria apply to the storage racks at all plants but the following, listed with their acceptable peak uncontrolled fuel bundle k_∞: 12/81A

Plant	Maximum k_∞
Nine Mile Point 1	1.25
Quad Cities 2	1.256

The peak uncontrolled lattice k_∞'s calculated in a normal reactor core configuration for various mid-axial lattice types are shown below (maximum k_∞ indicates the peak reactivity point in the exposure and temperature range in the uncontrolled state above 65°C, which assures added conservatism): 7/81

Lattice Type	Maximum k_∞	Exposure (GWd/t)
8D250	1.236	5.0
8D262	1.241	5.0
8D274L	1.238	5.0
8D274H	1.216	7.0
8D219L	1.159	0.0
8D219H	1.119	8.0
8DRL303/P8DRL303/BP8DRL303	1.213	10.0
8DRL301/P8DRL301/BP8DRL301	1.228	7.0
8DRL282L/P8DRL282L/BP8DRL282L	1.239	5.0
8DRL282H/P8DRL282H/BP8DRL282H	1.218	7.0
8DNL282L/P8DNL282L/BP8DNL282L	1.226	8.0

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Lattice Type	Maximum k_∞	Exposure (GWd/t)
8DNL282H/P8DNL282H/BP8DRL282H	1.212	8.0
8DRL254/P8DRL254/BP8DRL254	1.220	8.0
P8DRL071/BP8DRL071	0.920	5.0
P8DRL183/BP8DRL183	1.171	3.0
P8DRL233/BP8DRL233	1.217	5.0
P8DRL303H/BP8DRL303H	1.212	10.0
P8DRL303LA/BP8DRL303LA	1.239	7.0
P8DRL303LB/BP8DRL303LB	1.234	7.0
P8DRL305/BP8DRL305	1.215	10.0
P8DRL319/BP8DRL319	1.174	9.0
P8CRL280L/BP8CRL280L	1.171	7.0
P8CRL280LA/BP8CRL280LA	1.169	7.0
P8CRL280/BP8CRL280	1.191	5.0
P8CRL280H/BP8CRL280H	1.169	7.0
8CRL283L/P8CRL283L/BP8CRL283L	1.228	8.0
8CRL303L/P8CRL303L/BP8CRL303L	1.187	7.0
P8CRL303LA/BP8CRL303LA	1.209	5.0
8CRL303LB/P8CRL303LB/BP8CRL303LB	1.199	6.0
P8CRL303/BP8CRL303	1.188	7.0
P8CRL303H/BP8CRL303H	1.187	7.0
P8CRL303HA/BP8CRL303HA	1.206	5.0
P8CRL303HB/BP8CRL303HB	1.185	7.0
8DRL302H	1.207	10.0
8DRL303HA	1.234	8.0
8DRL303LB	1.257	5.0
8DRL284	1.222	7.0
8DRL303LC	1.236	8.0
8DRL303Z	1.208	10.0
8DRL303LD	1.235	8.0
8DRL321L	1.234	10.0
P8SRL280/BP8SRL280	1.221	3.0
P8SRL280H/BP8SRL280H	1.220	8.0
P8SRL303L/BP8SRL303L	1.243	7.0
P8SRL303/BP8SRL303	1.241	8.0

Lattice Type	Maximum k_∞	Exposure (GWd/t)
P8SRL303H/BP8SRL303H	1.241	8.0
P8CRL233/BP8CRL233	1.212	5.0
P8CRL183/BP8CRL183	1.169	3.0
P8SRL233/BP8SRL233	1.213	5.0
P8SRL210/BP8SRL210	1.197	5.0
P8SRL183/BP8SRL183	1.172	3.0
P8SRL160/BP8SRL160	1.169	0.0
P8SRL071/BP8SRL071	0.922	5.0
P8CRL296/BP8CRL296	1.251	7.0
P8CRL261/BP8CRL261	1.211	0.0
P8CRL264/BP8CRL264	1.211	0.0
P8CRL171/BP8CRL171	1.139	3.0
P8CRL096/BP8CRL096	0.986	3.0
P8CRL071/BP8CRL071	0.922	5.0

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The peak uncontrolled k_∞ values show that the fuel storage criteria will be satisfied for the Type A and Type B rack spacing and for the high density fuel storage rack (Reference 3-11) designed by the General Electric Company.

3.3.2.1.5 Reactivity Coefficients

Reactivity coefficients, the differential changes in reactivity produced by differential changes in core conditions, are useful in calculating relative stability and evaluating response of the core to external disturbances. The base initial condition of the system and the postulated initiating event determine which of the several defined coefficients are significant in evaluating the response of the reactor.

The coefficients of interest, relative to BWR systems, are discussed herein individually with references to the types of events in which they significantly affect the response.