RELOAD SAFETY EVALUATION

R. E. GINNA NUCLEAR PLANT

CYCLE 19

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1.0 INTRODUCTION AND SUMMARY

1.1 INTRODUCTION

This report presents an evaluation for R. E. Ginna Cycle 19, which demonstrates that the core reload will not adversely affect the safety of the plant. The Cycle 19 evaluation was accomplished utilizing the methodology described in WCAP-9273-A, "Westinghouse Reload Safety Evaluation Methodology."[1]

R. E. Ginna is operating in Cycle 18 with a mixed fuel core comprised of Westinghouse Optimized Fuel Assemblies (OFAs) and Exxon Nuclear Corporation (ENC) fuel assemblies. It is planned, for Cycle 19, to refuel the R. E. Ginna core with fresh Westinghouse 14x14 OFAs, and Westinghouse and ENC irradiated assemblies. In a licensing submittal[2] to the NRC, approval was requested for the transition from ENC fuel to Westinghouse OFA and associated proposed changes to the R. E. Ginna Technical Specifications. This submittal justified the compatibility of Westinghouse OFAs with ENC fuel assemblies in a mixed-fuel core, and contained bounding reference analyses which are applicable to the Cycle 19 safety evaluation. NRC approval was received via Reference 3.

In a licensing submittal to the NRC[4], approval was requested for an increase in the maximum allowable steam generator tube plugging level. The changes to the R. E. Ginna Technical Specifications required as a result of the increased tube plugging were also included with this submittal[4]. The evaluation presented in this report is based on the analysis and results described in the steam generator 15% tube plugging license submittal[4] as well as the OFA licensing submittal[2].

All of the accidents comprising the licensing bases[2,4,5] which could potentially be affected by the fuel reload have been reviewed for the Cycle 19 design described herein. Justifications for the applicability of previous safety analyses are provided.

1.2 GENERAL DESCRIPTION

The R. E. Ginna Cycle 19 reactor core is comprised of 121 fuel assemblies arranged in the core loading pattern configuration shown in Figure 1. During the Cycle 18/19 refueling, the feed regions (21A, and 21B) will consist of 28 OFAs. Of the twelve Region 21A assemblies, four contain 32 part-length IFBAs per assembly and eight contain 40 part-length IFBAs per assembly. The Region 21B assemblies contain 24 fuel rods per assembly with part-length IFBAs. Eight ENC Region 10.and four ENC Region 11 fuel assemblies from the spent fuel pit will be inserted into the Cycle 19 reactor core. A summary of the Cycle 19 fuel and IFBA inventory is given in Table 1.

Consistent with the use of the Westinghouse Improved Thermal Design Procedure (ITDP)[6] for the analyses[2,4] of both Westinghouse and ENC fuel, the core design parameters utilized for Cycle 19 are as follows:

Core Power (MWt)	1520
System Pressure (psia)	2250
Vessel Average Temperature (°F)	573.5
Minimum Measured Flow (gpm).	89,600/Loop*
Average Linear Power Density (kw/ft) (based on average active fuel stack length of 141.4 inches)	5.80

1.3 CONCLUSION

From the evaluation presented in this report, it is concluded that the Cycle 19 design does not result in the safety limits for any incident being exceeded. This conclusion is based on the following:

1. Cycle 18 burnup of 12,000 +300/-500 MWD/MTU.

* An evaluation[4] has been performed which shows that all safety limits are satisfied for 15% steam geneator tube plugging with a corresponding 86,900 gpm/loop minimum measured flow and a 85,100 gpm/loop thermal design flow.

2. Cycle 19 burnup will not exceed 10800 MWD/MTU which includes an allowance for a 500 MWD/MTU EOC power coastdown. During a power coastdown the following applies:

   (a) Coastdown by the normal programed power reduction,
   (b) The low-low T_{avg} setpoint is not changed, and
   (c) The T_{avg} program for rod control is not changed.

3. There is adherence to the following:

   (a) plant operating limitations as given in the Technical Specifications,
   (b) the proposed changes in the 15% steam generator tube plugging licensing amendment[(4)], and
   (c) the Bank D RIL conditions at HFP given in Section 2.2 of this report.

2.0 REACTOR DESIGN

2.1 MECHANICAL DESIGN

The Cycle 19 feed fuel assemblies consist of Region 21 W OFAs. Thirteen ENC fuel assemblies are inserted into the Cycle 19 core, one demonstration assembly from the Cycle 18 core and 12 assemblies from the spent fuel pit. The mechanical description and justification of the compatibility of the W OFAs with ENC fuel assemblies in a transition core were presented in the licensing submittal[2].

The mechanical design of the Region 21 fuel assemblies is the same as the Region 20 fuel assemblies.

Ten Enhanced Performance Rod Cluster Control Assemblies (EP-RCCAs) will be inserted into the Cycle 19 core. They are of the same design as the ten EP-RCCAs inserted into the Cycle 18 core. These RCCAs have a thin chrome electroplate applied to a specified length of absorber rodlet cladding in contact with the reactor internal guides to provide increased resistance to cladding wear. In addition, the absorber diameter is reduced slightly at the lower extremity of the rodlets in order to accommodate absorber swelling and minimize cladding interaction with the absorber.

Table 1 presents a comparison of pertinent design parameters of the various fuel regions. The Westinghouse fuel has been designed utilizing the Westinghouse improved fuel performance models[7, 8]. The fuel is designed and operated so that clad flattening will not occur, as predicted by the Westinghouse clad flattening model [9]. For all Westinghouse fuel regions, the fuel rod internal pressure design basis, which is discussed and shown acceptable in Reference 10, is satisfied.

Westinghouse has had considerable experience with Zircaloy clad fuel, as described in Reference 11. This report also describes the operating experience that has been obtained from OFAs and IFBA fuel rods.

2.2 NUCLEAR DESIGN

The nuclear design of the Cycle 19 transition core used the standard calculational methods described in the Westinghouse Reload Safety Evaluation Methodology.[1] Although the physics characteristics are slightly different for the OFA when compared to the ENC fuel assembly, evaluations show that the differences are within the normal changes seen from cycle to cycle.

Table 2 provides a comparison of the Cycle 19 kinetics characteristics with the evaluation limits based on the accident analyses submitted to the NRC.[2,4] It can be seen from the Table 2 parameters that all of the Cycle 19 values fall within the evaluation limits. These parameters are evaluated in Section 3.0.

Table 3 provides the end-of-life control rod worth and requirements at the most limiting condition during the cycle. The available shutdown margin exceeds the minimum required.

If Cycle 18 operates to the high end of its burnup window (12,300 MWD/MTU), the maximum calculated HFP $F_{\Delta H}$, with Bank D at the HFP insertion limit (20% inserted), is 0.33% (including 8% design allowance, Reference 12) above the 1.66 Technical Specification limit. The violation is expected to be in the Cycle 19 burnup range from 5250 to 9500 MWD/MTU. There is no violation if the Bank D insertion is not greater than 17.75% or the Cycle 18 burnup is 12,150 MWD/MTU or less.

To preclude a potential violation of the $F_{\Delta H}$ limit, Bank D insertion should be limited to 17.75% (5 steps above the current RIL) at full power as shown in Figure 2. This limit needs only to be applied for the Cycle 19 burnup range from 5250 to 9500 MWD/MTU if Cycle 18 operates to a burnup greater than 12,150 MWD/MTU. This temporary change in the insertion limit poses no adverse impact on other core safety parameters or technical specifications.

2.3 THERMAL AND HYDRAULIC DESIGN

No significant variation in the thermal margins will result from the Cycle 19 reload. The DNB core limits and safety analyses used for Cycle 19 are based on the conditions in Section 1.2. Sufficient DNB margin exists to satisfy the design criteria for the Cycle 19 reload.

3.0 POWER CAPABILITY AND ACCIDENT EVALUATION

3.1 POWER CAPABILITY

The plant power capability for Cycle 19 is evaluated considering the consequences of those UFSAR incidents on the licensing basis accident analysis[2,4]. It is concluded that the core reload will not adversely affect the ability to safely operate at the current 1520 MWt rated power during Cycle 19. For overpower transients, the fuel centerline temperature limit of 4700°F can be accommodated with margin in the Cycle 19 core. The revised Fuel Thermal Safety Model, incorporated into the improved fuel models [8], was used for fuel temperature evaluations. The LOCA limit at 1520 MWt for Westinghouse fuel is met by maintaining [F_Q(z)xP] at or below [2.32* xK(Z)]. This limit is satisfied by the power control maneuvers allowed by the Technical Specifications, which assure that the Final Acceptance Criteria (FAC) limits are met for a spectrum of small and large break LOCAs.

3.2 ACCIDENT EVALUATION

The effects of the reload, including the mechanical design features described in Section 2.1, on the design basis and postulated incidents analyzed in the UFSAR were examined. In all cases it was found that the effects can be accommodated within the conservatism of the initial assumptions used in the applicable safety analysis.

A core reload can affect accident analysis input parameters in the following areas: core kinetic characteristics, control rod worths, and core peaking factors. Cycle 19 parameters in each of these areas were examined as discussed below to ascertain whether new accident analyses were required.

3.2.1 Kinetics Parameters

A comparison of Cycle 19 core physics parameters with current evaluation limits is given in Table 2. All the kinetics values remain within the bounds of the analysis limits.

* The maximum F_Q value allows a maximum of 15 percent steam generator tube plugging.

3.2.2 Control Rod Worths

Changes in control rod worths may affect differential rod worths, shutdown margin, ejected worths, and trip reactivity. Table 2 shows that the maximum differential rod worth of two RCCA control banks moving together in their highest worth region for Cycle 19 is less than or equal to the analysis limit. Table 3 shows that the Cycle 19 shutdown margin requirements are satisfied. Cycle 19 ejected rod worths are within the bounds of the analysis limits.

Cycle 19 has a normalized trip reactivity insertion rate which is slightly different from the current limit. The effects of this reduced normalized trip reactivity rate have been evaluated for those accidents affected and compared to previous analyses. The only significant non-conservative deviations, with respect to the current limit between the two trip insertion curves, occur for the last 25 percent of rod insertion. The remaining portion of the trip insertion curve is conservative with respect to the current limit.

Slow transients are relatively insensitive to the trip reactivity insertion rate. Fast transients are evaluated to confirm that the limiting transient conditions are unchanged. Results show that the previous analyses remain applicable.

3.2.3 Core Peaking Factors

Evaluation of peaking factors for the rod out of position, dropped RCCA, and dropped bank incidents show that the DNBR is maintained above the appropriate safety analysis limit DNBR value listed in Table 4 for each fuel type.

The hypothetical steamline break transients were evaluated for Cycle 19. This evaluation showed that the predicted results are within the bounds of the submitted analysis.[2]

4.0 REFERENCES

1. Bordelon, F. M., et al., "Westinghouse Reload Safety Evaluation Methodology," WCAP-9273-A, July 1985.

2. Letter from J. E. Maier (RGE) to H. R. Denton (NRC), December 20, 1983, Subject: "R. E. Ginna Application for Reload License Amendment Using Westinghouse Optimized Fuel Assemblies."

3. NRC Safety Evaluation Report," Use of Westinghouse Optimized Fuel Assembly (OFA) as reload fuel for R. E. Ginna", Docket Number 50-244, May 1, 1984.

4. R. W. Kober (RGE) to C. Stahl (NRC), October 27, 1987, Subject: R. E. Ginna Application for Licensing Amendment for 15% Steam Generator Tube Plugging Level.

5. Updated Final Safety Analysis Report - R. E. Ginna, Docket Number 50-244.

6. Chelemer, H., et. al., "Improved Thermal Design Procedure," WCAP-8567, July 1975.

7. Miller, J. V. (Ed), "Improved Analytical Model Used in Westinghouse Fuel Rod Design Computations," WCAP-8785, October 1976.

8. Weiner, R. A., et. al., "Improved Fuel Performance Models for Rod design and Safety Evaluations," WCAP-11873-A, August 1988.

9. George, R.A., et al., "Revised Clad Flattening Model," WCAP 8381, July 1974.

10. Risher, D.H., et al., "Safety Analysis for the Revised Fuel Rod Internal Pressure Design Basis," WCAP 8964-A, August 1978.

11. Foley, J. and Skaritka, J., "Operational Experience with Westinghouse Cores (through December 31, 1987)," WCAP-8183, Revision 16, August 1988.

12. Spier, E. M., et. al., "Evaluation of Nuclear Hot Channel Factor Uncertainties," Section 7.0, WCAP-7308-L-P-A, June 1988.

13. Motley, F. E., et al., "New Westinghouse Correlation WRB-1 for Predicting Critical Heat Flux in Rod Bundles with Mixing Vane Grids," WCAP-8762, July 1976.

TABLE 1

R. E. GINNA CYCLE 19 FUEL PARAMETERS

Region	LTA[1] (XT)	10(L)	11(M)	18(U)	19A(V)	19B(V)	19C(V)
Enrichment (w/o)	3.70	3.09	3.21	3.399[2]	3.401[2]	3.611[2]	3.401[2]
Density (% theoretical)	94.0	94.0	94.0	95.36	95.09	94.94	95.09
No. of Assemblies	1	8	4	8	16	16	4
Region Loading (MTU)	0.325	2.970	1.485	2.843	5.640	5.620	1.400
Approximate Burnup at Beginning of Cycle 19 (GWD/MTU)	43	29	31	32	27	28	24
Length of Natural U Axial Blankets (3)							
Top (inches)	-	-	-	6.2	6.2	6.2	6.2
Bottom (inches)	-	-	-	6.2	6.2	6.2	6.2
Number of IFBA [4] Fuel Rods	-	-	-	-	640[5]	-	

(1) Exxon Annular demo
(2) Enrichment in the enriched region
(3) Only W fuel contains axial blankets
Exxon fuel has no axial blanket
(4) IFBA - Integral Fuel Burnable Absorber
Thin boride coating on surface of fuel pellets
(5) 92 inches IFBA axial length - centered
(6) 104 inches IFBA axial length - centered

TABLE 1 (Cont'd)

R. E. GINNA CYCLE 19 FUEL PARAMETERS

Region	20A1(W)	20A2(W)	20B(W)	21A(Y)	21A(Y)	21B(Y)
Enrichment (w/o)	3.404[2]	3.404[2]	4.008[2]	3.60[2]	3.60[2]	4.0[2]
Density (% theoretical)	95.37	95.37	95.37	95.00	95.00	95.00
No. of Assemblies	12	8	16	4	8	16
Region Loading (MTU)	4.230	2.820	5.620	1.410	2.820	5.640
Approximate Burnup at Beginning of Cycle 19 (GWD/MTU)	16	16	14	0	0	0
Length of Natural U Axial Blankets (3)						
Top (inches)	6.2	6.2	6.2	6.2	6.2	6.2
Bottom (inches)	6.2	6.2	6.2	6.2	6.2	6.2
Number of IFBA (4) Fuel Rods	192[5]	192[5]	-	128[6]	320[6]	384[6]

(1) Exxon Annular demo
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TABLE 2

KINETICS CHARACTERISTICS
R. E. GINNA - CYCLE 19

	Reference Analysis Values (2,4)	Cycle 19**
Moderator Temperature Coefficient, (PCM/°F)*	+5 to -42.9	+5 to -42.9
Doppler Coefficient (PCM/°F)*	-2.9 to -0.91	-2.9 to -0.91
Delayed Neutron Fraction β_{eff}	.0043 to .0073	.0043 to .0073
Maximum Prompt Neutron Lifetime (μ sec)	26	≤26
Maximum Differential Rod Worth of Two Banks Moving Together at HZP (PCM/sec)*	97.5	≤97.5

* 1 PCM = 1.0×10^{-5} $\Delta\rho$

** Actual values fall within the bounds indicated

TABLE 3

SHUTDOWN REQUIREMENTS AND MARGINS
R. E. GINNA - CYCLE 19

	Cycle 19 EOC
Control Rod Worth (percent $\Delta\rho$)	
All Rods Inserted Less Worst Stuck Rod 2 loops in operation	5.96
(A) Less 10%	5.36
Control Rod Requirements (percent $\Delta\rho$)	
Reactivity Defects (Doppler, T_{avg}, Void, Redistribution)	2.52
Rod Insertion Allowance	0.64*
(B) Total Requirements	3.16
Shutdown Margin [(A)-(B)] (percent $\Delta\rho$)	2.20
Required Shutdown Margin (percent $\Delta\rho$)	1.80

* Based on current Bank D RIL of 20% at full power.

TABLE 4

THERMAL-HYDRAULIC DESIGN BASES FOR THE RGE CYCLE 19 SAFETY EVALUATION

a. PLANT PARAMETERS

Parameter	ITDP Value	Non-ITDP Value
Reactor Power, MWt	1520	1520 ± 2%
Primary Flow, gpm	179,200 (173,800)*	174,000 (170,200)*
Pressure, psia	2280	2250 ± 30 psia
T_{in}, °F	543.7	543.7 ± 4°F
Radial Peaking Factor ($F_{\Delta H}^N$)	1.60[1+0.3(1-P)]	1.66[1+0.3(1-P)]

b. FUEL RELATED PARAMETERS

Parameter	14x14 Exxon Fuel	14x14 W OFA
DNB Correlation	W-3	WRB-1(13)
Safety Analysis Design Limit	1.62 Typical Cell	1.52 Typical Cell
	1.54 Thimble Cell	1.51 Thimble Cell
Thermal Design Procedure	ITDP	ITDP

* An evaluation(4) has been performed for 15% steam generator tube plugging: This flow reduction was offset by using available plant DNBR margin. All DNB safety limits were met.

FIGURE 1

R. E. GINNA CYCLE 19
CORE LOADING PATTERN

180

		M	L	K	J	I	H	G	F	E	D	C	B	A	
	1						10 L16	11 M23	10 L29						
	2				19B V27	19A V06	21B Y15	21A Y01	21B Y18	19A V02	19B V25				
	3			19C V20	21B Y20	20B W35	20A W19	19B V33	20A W13	20B W22	21B Y26	19C V18			
	4		19B V30	21B Y27	19B V36	20B W32	19A V05	21A Y06	19A V10	20B W31	19B V26	21B Y14	19B V29		
	5		19A V04	20B W28	20B W33	20A W08	20A W09	18 U07	20A W04	20A W07	20B W21	20B W34	19A V12		
	6	10 L30	21B Y28	20A W16	19A V13	20A W11	18 U29	21A Y08	18 U25	20A W01	19A V07	20A W14	21B Y16	10 L15	
90	7	11 M24	21A Y02	19B V24	21A Y09	18 U28	21A Y10	17B XT03	21A Y11	18 U03	21A Y05	19B V31	21A Y03	11 M22	270
	8	10 L13	21B Y23	20A W15	19A V08	20A W12	18 U13	21A Y12	18 U12	20A W03	19A V03	20A W20	21B Y24	10 L32	
	9		19A V16	20B W25	20B W26	20A W02	20A W06	18 U01	20A W05	20A W10	20B W23	20B W27	19A V11		
	10		19B V22	21B Y21	19B V21	20B W24	19A V15	21A Y07	19A V14	20B W36	19B V32	21B Y22	19B V35		
	11			19C V19	21B Y17	20B W29	20A W17	19B V23	20A W18	20B W30	21B Y19	19C V17			
	12				19B V34	19A V09	21B Y13	21A Y04	21B Y25	19A V01	19B V28				
	13						10 L31	11 M21	10 L14						

0 DEG.

KEY:

R = REGION NUMBER
ID = FUEL ASSEMBLY IDENTIFICATION

FIGURE 2
R. E. GINNA CYCLE 19
CONTROL ROD INSERTION LIMITS AS A FUNCTION OF POWER