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YANKEE ATOMIC ELECTRIC COMPANY

20 Turnpike Road Westborough, Massachusetts 01581

December , 1976

United States Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Office of Nuclear Reactor Regulation
A. Schwencer, Chief
Operating Reactors Branch No. 1

Subject: Effects of Increased Fission Gas Releases in the Safety Analysis for the Yankee Nuclear Power Station

References: (1) License No. DPR-3 (Docket No. 50-29)
(2) Letter, A. Schwencer, US NRC to R. H. Groce, YAEC, November 29, 1976

Dear Sir:

Reference (2) requested an evaluation of the effects of increased fission gas releases from fuel rods with high exposures on the safety analysis for Yankee Rowe.

The information which you requested for Yankee Rowe is given below:

a. Yankee Rowe Core 12 is comprised of 40 Exxon and 36 Gulf assemblies. The Gulf fuel rod with maximum local exposure has surpassed the 20,000 MWD/MTU mark with its current local exposure being approximately 42,500 MWD/MTU. The highest exposed Exxon fuel rod is currently operating at approximately 18,700 MWD/MTU and it is anticipated that this rod will exceed 20,000 MWD/MTU in about 20 days.

b. Fuel performance calculations for Yankee Rowe are performed using the GAPEX computer code which was developed by Exxon Nuclear Company. This code is described in the Exxon document XN-73-25, "GAPEX: A Computer Program for Predicting Pellet-to-Cladding Heat Transfer Coefficients". As described in the above report, the GAPEX code overestimates the fission gas release rate and is thus conservative for calculating fission gas partial pressures and thermal conductivities. Furthermore, GAPEX is very conservative in estimating fuel rod pressures because it substantially overestimates the gas temperature in the plenum. Thus, the calculations presented here are conservative.

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The correction technique for high burnup fission gas release rates specified in the enclosure to the NRC letter (Reference 2) was incorporated into the GAPEX code as requested. Since Yankee Rcwe Core 12 currently contains Gulf and Exxon fuels, separate calculations were made for both fuel types to predict fission gas release, fuel rod pressure and fuel volumetric average temperature. The results of these calculations are shown in Tables 1 and 2 for Gulf fuel and Table 3 for Exxon fuel. In the case of the Gulf fuel, calculations were made for both the peak power rod and the peak burnup rod in Core 12. As shown in Tables 1 and 2, the peak burnup rod has the higher fission gas release.

Examination of Tables 1, 2 and 3 shows that below 20,000 MWD/MTU there is no burnup effect as expected. Above 20,000 MWD/MTU, the Tables show that the modified gas release model predicts higher fission gas releases, higher fuel rod pressures, and only slightly higher fuel temperatures. In none of the cases examined does the fuel pin pressure exceed the nominal system pressure of 2015 psia during the entire Core 12 lifetime.

c. As a result of the larger fission gas releases at high fuel burnups, a gap conductance lesser in magnitude than that previously determined is calculated to occur. This will result in fuel temperatures slightly higher at high burnup than those previously predicted. Calculations, however, indicate that the fuel temperatures will remain less than the beginning of life (BOL) fuel temperatures and thus the fuel performance analyses for transients other than LOCA, which were based on BOL fuel characteristics, remain unchanged.

During recent conversations with NRC Technical Staff, it was agreed that the increased fission gas release would present no adverse effect on the Yankee Rowe Core 12 LOCA analysis. The basis for this conclusion is that the fuel rod with the highest exposure (Gulf fuel) will rupture at a point in the transient when the clad temperature is well below the threshold temperature for extreme $Zr-H_2O$ exothermic reaction, thereby precluding any detrimental increase in clad temperature. The peak exposure Exxon fuel pin is currently operating at less than 20,000 MWD/MTU (local burnup) and as such, its associated analysis remains unaffected.

A quantitative study which will specifically address the affect of increased fission gas release on the LOCA analysis will be completed in mid-January and formally submitted by January 28, 1977. This study will address the performance of both Exxon and Gulf fuels with and without the increased fission gas release at the end of core life for Yankee Rowe Core 12.

d. As seen in Tables 1, 2 and 3, no fuel pin pressure is predicted to exceed the nominal system pressure of 2015 psia during the fuel lifetime.

While this letter constitutes our reply to your request, it is not to be construed as acceptance of the applicability of the modified fission gas release model to the Yankee Rowe fuel. An appropriate empirical basis for a fission gas release model at high burnups should be derived from the spent fuel in residence at various light water reactors. YAEC would be interested in discussing with the NRC a possible program to analyze the highly burned Yankee Rowe fuel.

We trust that you will find the above information satisfactory. However, if any further questions regarding this matter should arise, please direct them to Mr. W. J. Szymczak at our Engineering Office, 20 Turnpike Road, Westborough, Massachusetts 01581, extension 2844.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

D. E. Vandenburgh

D. E. Vandenburgh
Senior Vice President

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Table 1

Fission Gas Release Study
YR Core 12 Gulf Fuel/Peak Burnup Rod

	Local Exposure, MWD/MTU	Vol. Avg. Fuel Temp. °F		Pin Pressure psia		Release Fraction		Gram - moles Gap and Plenum	
		A*	B*	A	B	A	B	A	B
+	28324	1085	1111	664	916	.00484	.0103	.00891	.0122
	31739	1085	1113	665	935	.00484	.0152	.00893	.0124
	36761	1086	1118	667	986	.00484	.0278	.00896	.0131
	41783	1086	1127	670	1089	.00484	.0506	.00899	.0144
	46804	1086	1142	672	1287	.00484	.0899	.00902	.0169
++	51826	1087	1155	674	1639	.00484	.1526	.00905	.0214

* A - Existing model

* B - NRC Correction

\+ Burnup at BOC

++ Anticipated burnup at discharge

Table 2

Fission Gas Release Study
YR Core 12 Gulf Fuel/Peak Power Rod

	Local Exposure MWD/MTU	Vol. Avg. Fuel Temp. °F		Gap Pressure psia		Release Fraction		Gram - moles Gap & Plenum	
		A*	B*	A	B	A	B	A	B
+	8334	1295	-	323	-	.0240	-	.00411	--
	11663	1252	-	325	-	.0240	-	.00421	--
	17495	1149	-	327	-	.0240	-	.00437	--
	23327	1133	1136	337	352	.0240	.0309	.00453	.00473
	29158	1131	1148	349	431	.0240	.0537	.00470	.00578
	34990	1134	1181	362	615	.0240	.0997	.00487	.00814
++	35865	1134	1187	364	656	.0240	.1094	.00489	.00867

* A - Existing model

* B - NRC correction beyond 20000 MWD/MTU

\+ Burnup at BOC

++ Anticipated burnup at discharge

Table 3

Fission Gas Release Study
YR Core 12 Exxon Fuel/Peak Power Rod

Local Exposure, MWD/MTU	Vol. Avg. Fuel Temp. °F		Gap Pressure psia		Release Fraction		Gram moles in Gap & Plenum	
	A*	B*	A	B	A	B	A	B
+ 0	1691	-	334	-	.0394	-	.00360	-
6453	1400	-	338	-	.0394	-	.00390	-
12906	1304	-	353	-	.0394	-	.00420	-
19359	1211	-	366	-	.0394	-	.00449	-
25812	1196	1207	388	488	.0394	.0611	0479	.00550
++ 29367	1199	1224	402	544	.0394	.0854	.00495	.00664

* A - Existing model

* B - NRC correction

\+ Burnup at BOC

++ Anticipated burnup at EOC

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(3 SIGNED CYS. RECEIVED)
(6 PAGES)

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