SURVEILLANCE REQUIREMENTS (Continued)

4.2.1.2 The below factors shall be included in the calculation of peak full power LHGR:

a. Heat flux power peaking factor, F_q^N, measured using the incore detection system at a power $\geq$10%.

b. The multiplier for xenon redistribution is a function of core lifetime as given in the CORE OPERATING LIMITS REPORT. In addition, if Control Rod Group C is inserted outside the operating band for 100% allowable power, allowable power may not be regained until power has been at a reduced level defined below for a least twenty-four hours with Control Rod Group C within the operating band for 100% allowable power.

Reduced Power = Allowable fraction of full power times multiplier given in the CORE OPERATING LIMITS REPORT.

Exceptions: 1. If the rods are inserted outside the operating band for 100% allowable power and power does not go below the reduced power calculated above, hold at the lowest attained power level for at least twenty-four hours with Control Rod Group C within the operating band for 100% allowable power before returning to allowable power.

2. If the rods are inserted outside the operating band for 100% allowable power and zero power is held for more than forty-eight hours, no reduced power level need be held on the way to the allowable fraction of full power.

c. Shortened stack height factor, 1.009.

d. Measurement uncertainty:*

1. 1.05, when at least 17 incore detection system neutron detector thimbles are OPERABLE, or

2. 1.068, when less than 17, and greater than or equal to 12, incore detection system neutron detector thimbles are OPERABLE, or

3. 1.080, when less than 12, and greater than or equal to 9, incore detection system neutron detection thimbles are OPERABLE.

SURVEILLANCE REQUIREMENTS

4.2.2.1 F_q shall be determined to be within its limit by:

a. Using the incore detection system to obtain a power distribution map:

1. Prior to initial operation above 75% of RATED THERMAL POWER after each fuel loading, and

2. At least once per 1000 Effective Full Power Hours.

b. Increasing the measured F_q component of the power distribution map by:

1. 4% to account for engineering tolerances,

2. 5% when at least 17 incore detection system neutron detector thimbles are OPERABLE, to account for measurement uncertainty,

3. 6.8% when less than 17, and greater than or equal to 12, incore detection system neutron detector thimbles are OPERABLE, to account for measurement uncertainty,

4. 8.0%, when less than 12, and greater than or equal to 9, incore detection system neutron detector thimbles are OPERABLE, to account for measurement uncertainty, and

5. 3% to account for fuel densification.

4.2.2.2 When F_q is measured pursuant to Specification 4.10.2.2, an overall measured F_q shall be obtained from a power distribution map and increased by:

1. 4% to account for engineering tolerances,

2. 5% when at least 17 incore detection system neutron detector thimbles are OPERABLE, to account for measurement uncertainty,

3. 6.8% when less than 17, and greater than or equal to 12, incore detection system neutron detector thimbles are OPERABLE, to account for measurement uncertainty, and

4. 8.0%, when less than 12, and greater than or equal to 9, incore detection system neutron detector thimbles are OPERABLE, to account for measurement uncertainty, and

5. 3% to account for fuel densification

4.2.2.3 The provisions of Specification 4.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.2.3.1 $F^N_{\Delta H}$ shall be determined to be within its limit by using the incore detection system to obtain a power distribution map:

a. Prior to operation above 75% RATED THERMAL POWER after each fuel loading, and

b. At least once per 1000 Effective Full Power Hours.

c. The provisions of Specification 4.0.4 are not applicable.

4.2.3.2 The measured $F^N_{\Delta H}$ of 4.2.3.1 above shall be increased, for measurement uncertainty, by:

a. 5%, when at least 17 incore detection system neutron detector thimbles are OPERABLE; or

b. 6.8%, when less than 17, and greater than or equal to 12, incore detection system neutron detector thimbles are OPERABLE; or

c. 8.0%, when less than 12, and greater than or equal to 9, incore detection system neutron detector thimbles are OPERABLE.

INCORE DETECTION SYSTEM

LIMITING CONDITIONS FOR OPERATION

3.3.3.2 The incore detection system shall be OPERABLE with:

a. At least twelve (12) neutron detector thimbles OPERABLE.

b. A minimum of two (2) OPERABLE neutron detector thimbles per core quadrant, and

c. Sufficient OPERABLE incore neutron detectors, with:

1. Sufficient drive and readout equipment to map the OPERABLE movable neutron detector thimbles, and/or

2. Sufficient readout equipment to map the OPERABLE fixed neutron detector thimbles.

Exception: For Cycle 21 items a. and b. above are not required if there are at least nine (9) neutron detector thimbles OPERABLE and a minimum of one (1) OPERABLE neutron detector thimble per quadrant.

APPLICABILITY: When the incore detection system is used for core power distribution measurements.

ACTION

With the incore detection system inoperable, do not use the system for the above applicable monitoring or calibration functions. The provisions of Specifications 3.0.3 and 3.0.4 are not applicable.

SURVEILLANCE REQUIREMENTS

4.3.3.2 The incore neutron detectors shall be demonstrated OPERABLE by:

a. Normalizing each movable detector output to be used within 24 hours prior to its use for core power distribution measurements.

b. Having three out of five OPERABLE fixed neutron detectors per string.

The limits on power level and control rod position following control rod insertion were selected to prevent exceeding the maximum allowable linear heat generation rate limits specified in the CORE OPERATING LIMITS REPORT within the first few hours following return to power after the insertion. With Yankee's highly damped core, the 24 hour hold allows sufficient time for the initial xenon maldistribution to accommodate itself to the new power distribution. The restriction on control rod location during these 24 hours assures that the return to allowable fraction of full power will not cause additional redistribution due to rod motion.

After 48 hours at zero power, the average xenon concentration has decayed to about 20% of the full power concentration. Since the xenon concentrations are so low, an increase in power directly to maximum allowable power creates transient peaking well below the value imposed by the xenon redistribution multiplier. Thus, any increase in power peaking due to this operation is below the value accounted for in the calculation of the LHGR.

These conclusions are based on plant tests and on calculations performed with the SIMULATE three dimensional nodal code used in the analysis of Core XI (reference cycle) described in Proposed Change No. 115, dated March 29, 1974.

The Factors d, e, and f in Specification 4.2.1.2 will be combined statistically as the "root-sum-square" of the individual parameters. This method for combining parameter uncertainties is valid due to the independence of the parameters involved. Factor d accounts for uncertainty in the power distribution measurement with the incore detection system. Factor e accounts for uncertainty in the calorimetric measurement for determining core power level. Factor f accounts for uncertainty in engineering and fabrication tolerances of the fuel. Together these factors, when combined statistically, yield an uncertainty of 9.4% for less than 12, and greater than or equal to 9, operating incore thimbles, 8.5% for less than 17 and greater than or equal to 12 operating incore thimbles, and 7.1% for greater than or equal to 17 operating thimbles. This factor and Factors a, b, c, and g will be combined multiplicatively to obtain peak LHGR values.

3/4.2.2 and 3/4.2.3 HEAT FLUX HOT CHANNEL FACTOR AND NUCLEAR ENTHALPY RISE HOT CHANNEL FACTOR

The limits on heat flux and enthalpy hot channel factors ensure that 1) the design limits on peak local power density and minimum DNBR are not exceeded, and 2) in the event of a LOCA the peak fuel clad temperature will not exceed the 2200°F ECCS acceptance criteria limit.

Each of these hot channel factors are measurable but will normally only be determined periodically as specified in Specification 4.2.2.1 and 4.2.3.1. This periodic surveillance is sufficient to insure that the hot channel factor limits are maintained provided:

a. Control rods in a single group move together with no individual rod insertion differing by more than ±8 inches from any other rod in the group.

b. Control rod groups are sequenced with overlapping groups as described in Specification 3.1.3.5.

c. The control rod insertion limits of Specification 3.1.3.5 is maintained.

The relaxation in $F^N_{\Delta H}$ as a function of THERMAL POWER allows changes in the radial power shape for all permissible rod insertion limits. $F^N_{\Delta H}$ will be maintained with its limits provided Conditions a through c above are maintained.

When an F_q measurement is taken, experimental error, engineering tolerance, and fuel densification must be allowed for. 8.0% for less than 12, and greater than or equal to 9, operating incore thimbles, 6.8%, for less than 17, and greater than or equal to 12 operating incore thimbles, and 5% for greater than 17 operating incore thimbles are the appropriate allowances for a full core map taken with the incore detection system, 4% is the appropriate allowance for engineering tolerance and 3% is the appropriate allowance for fuel densification.

When $F^N_{\Delta H}$ is measured, experimental error must be allowed for and 8.0% for less than 12, and greater than or equal to 9, operating incore thimbles, 6.8%, for less than 17, and greater than or equal to 12 operating incore thimbles, and 5% for greater than 17 operating incore thimbles are the appropriate allowances for a full core map taken with the incore detection system.

3/4.2.4 DNB PARAMETERS

The limits on the DNB related parameters assure that each of the parameters are maintained within the normal steady state envelope of operation assumed in the transient and accident analyses. The limits are consistent with the accident analysis assumptions and have been analytically demonstrated adequately to maintain a minimum DNBR of 1.30 throughout each analyzed transient. The cold leg temperature assumed in the analysis is based on the loop average temperature limit and design MCS operating conditions. This results in a cold leg temperature of 520°F at full power, increasing linearly to 531°F at 50% power. Below 50% power, the cold leg temperature increases linearly to 536°F at zero power. The cold leg temperature assumed in the analysis is conservatively 4°F in excess of the value determined from the average temperature limit to allow for uncertainty in plant measurement. The drop in the average temperature limit below 50% power ensures acceptable results for low power main steam line breaks. The Main Coolant System pressure assumed in the analysis is 1925 psig, conservatively 25 psig less than the limit to allow for uncertainty in plant measurement. The assumed operating deadband of ± 50 psig is applied to the nominal 2000 psig limit, yielding a minimum operation limit of 1950 psig.

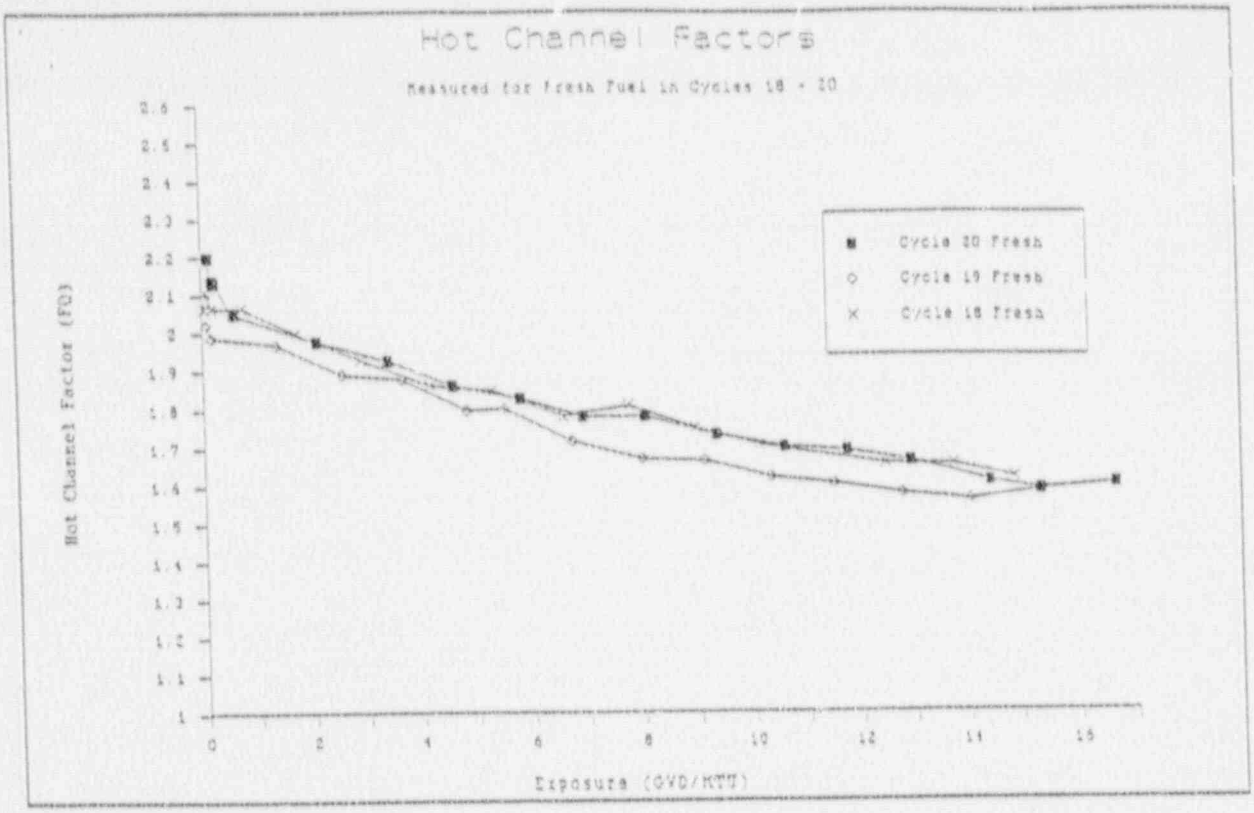
ATTACHMENT A

The Yankee loading patterns and power distributions have been very similar for several cycles. As an indication of this, Figure A-1 shows the measured values of F_q by fuel batch for Cycles 18 through 20. As can be seen, there are only minor differences between cycles. Cycle 21 values are also expected to be within the same range. This is shown in Figure A-2 which shows a comparison of the predicted F_q values for Cycles 20 and 21. As can be seen, these cycles are very similar.

The analytical model used to predict the core power distribution has been consistent over the past several cycles. As an illustration of the accuracy of the model, Figures A-3 through A-5 show a comparison of the measured and predicted reaction rates taken during Cycles 18 through 20. These comparisons are early in cycle life where the differences are usually greatest. As can be seen, the predictions are quite accurate. The average absolute differences between the measured and predicted reaction rates as a function of cycle exposure are provided for Cycles 18 to 20 in Figure A-6.

Also provided in Figures A-7 through A-10 are the comparisons of measured to predicted reaction rates for the first four incore flux measurements for Core 21. The differences are all within acceptable criteria, showing that the Core 21 power distribution is well characterized.

Figure A-1


Hot Channel Factors
Measured for Fresh Fuel in Cycles 18 - 20
Hot Channel Factor (FQ)
Exposure (GWD/MTU)
Cycle 20 Fresh
Cycle 19 Fresh
Cycle 18 Fresh

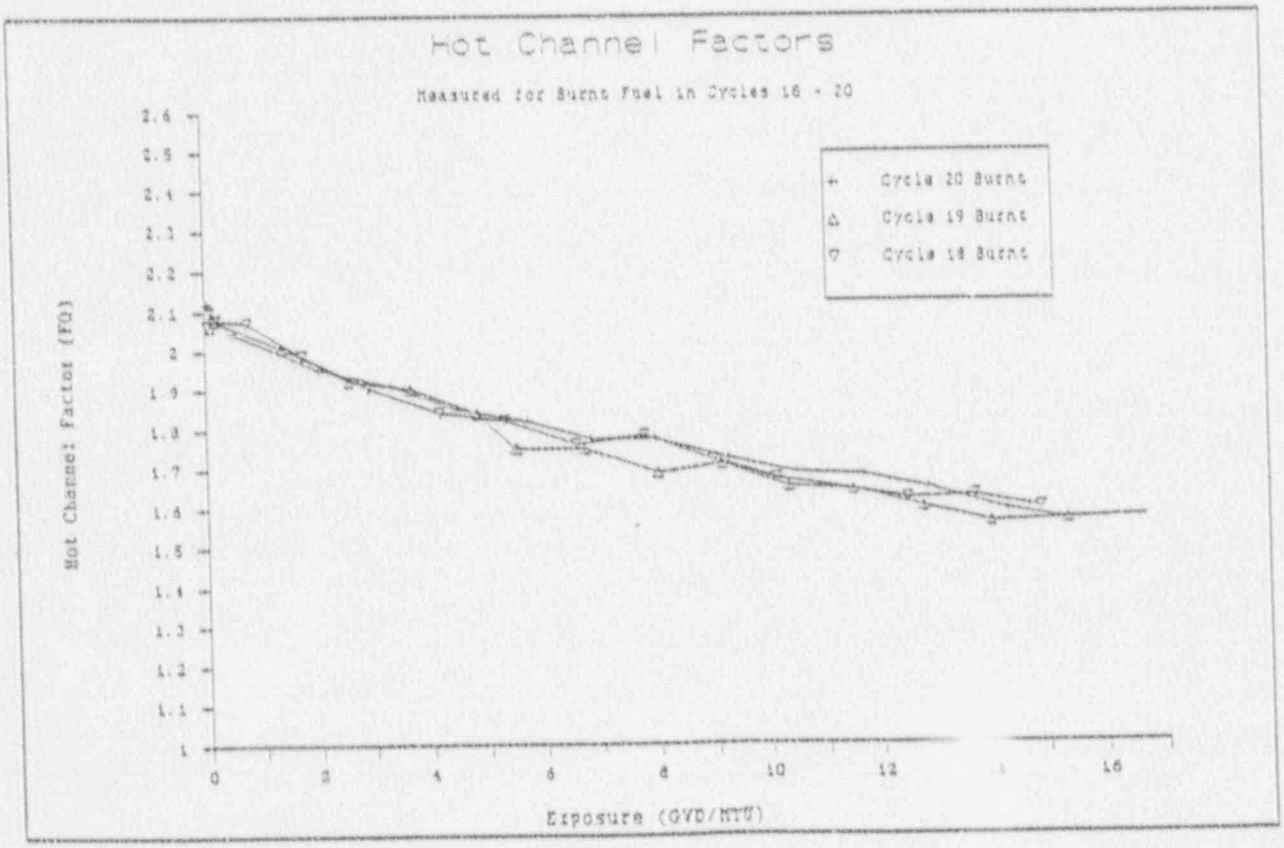
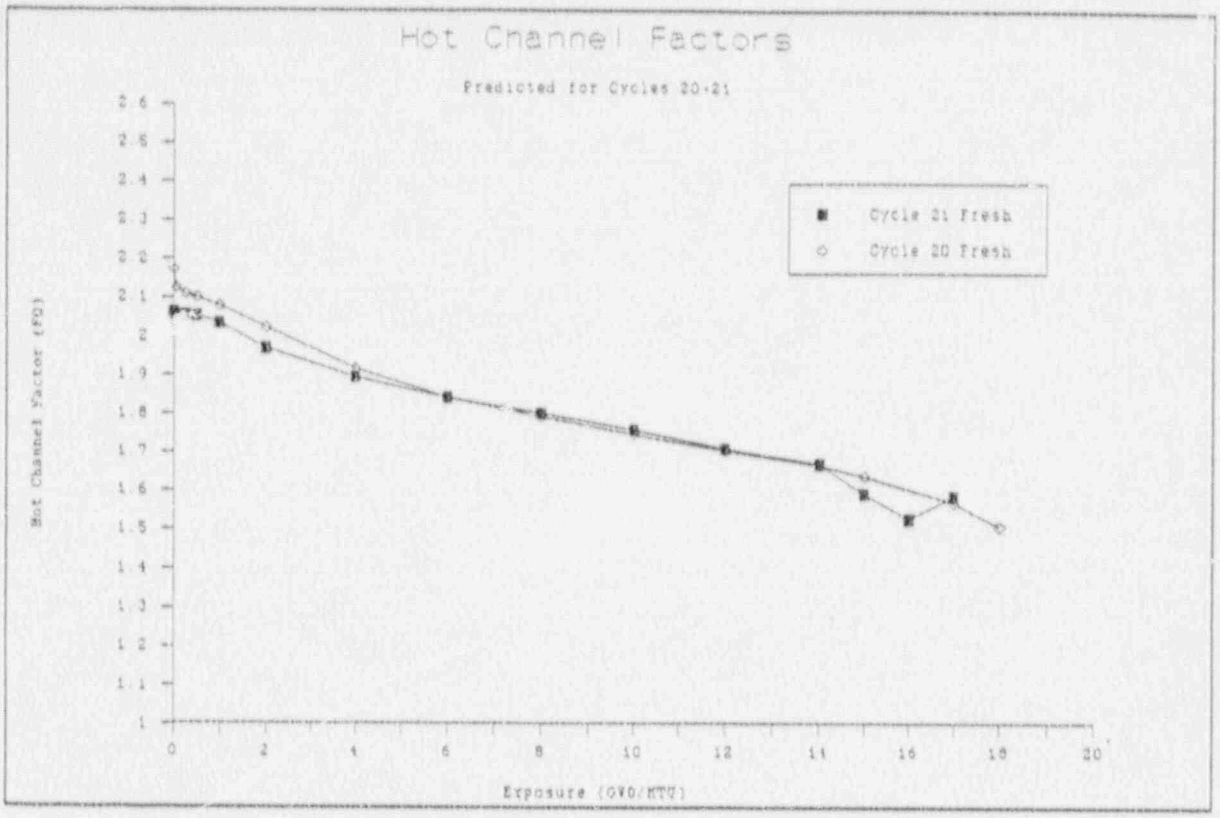

Hot Channel Factors
Measured for Burnt Fuel in Cycles 18 - 20
Hot Channel Factor (FQ)
Exposure (GWD/MTU)
Cycle 20 Burnt
Cycle 19 Burnt
Cycle 18 Burnt

Figure A-2


Hot Channel Factors
Predicted for Cycles 20-21
Cycle 21 Fresh
Cycle 20 Fresh
Hot Channel Factor (FQ)
Exposure (GWD/MTU)

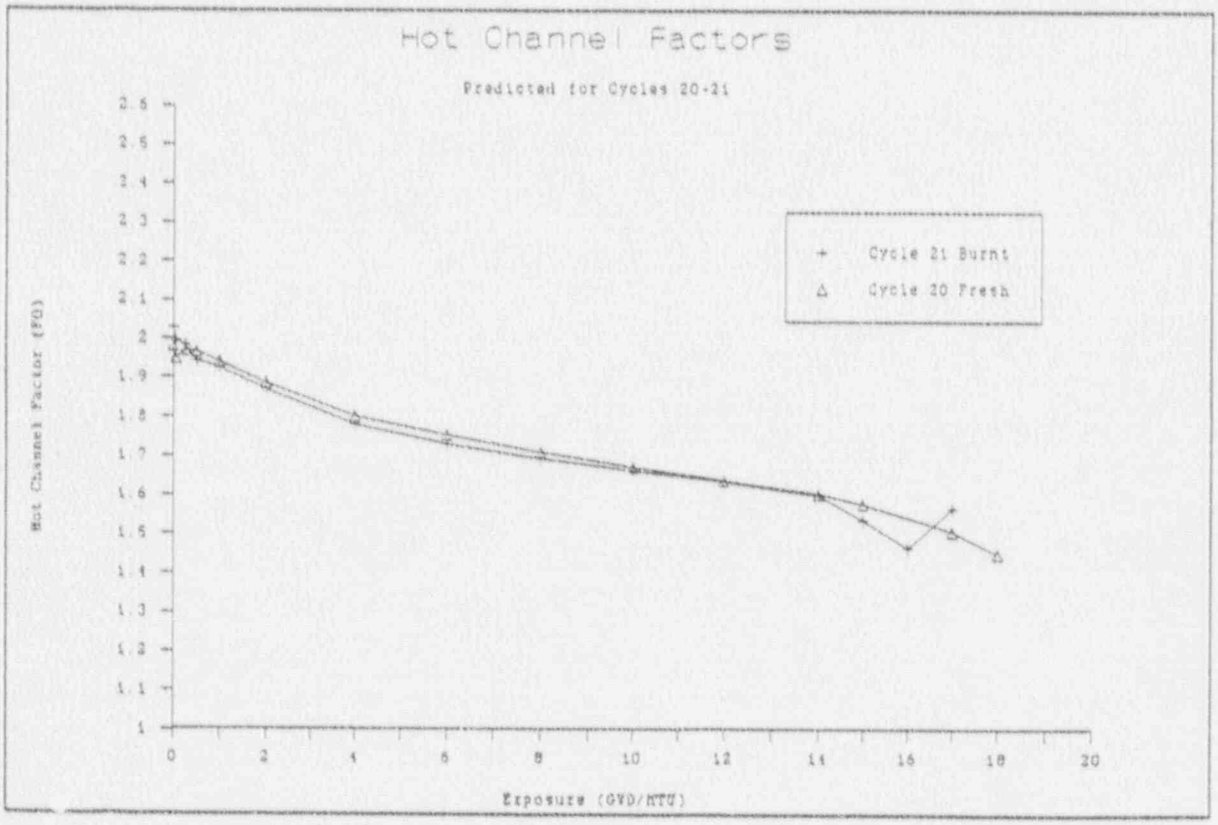

Hot Channel Factors
Predicted for Cycles 20-21
Cycle 21 Burnt
Cycle 20 Fresh
Hot Channel Factor (FQ)
Exposure (GWD/MTU)

FIGURE A-3

INCORE RUN YR-18-009

600.0 MWT GROUP C AT 80.500 INCHES 750. MWD/MTU

COMPARISON OF MEASURED AND PREDICTED SIGNALS

MEASURED SIGNAL........
PREDICTED SIGNAL........
% DIFFERENCE................

				.665 .687 -3.2					
					1.105 1.148 -3.7				
			1.047 1.049 -.2			.978 .974 .4			
		.984 .975 .9		1.117 1.079 3.5					
			1.073 1.036 3.6				1.058 1.054 .4		
						1.060 1.031 2.8			
					1.113 1.083 2.7		.981 .985 -.4		
						1.052 1.062 -1.0			
		.644 .671 -4.1		1.123 1.165 -3.6					

AVERAGE ABSOLUTE DIFFERENCE BETWEEN
MEASURED AND PREDICTED IS 2.172 PERCENT

RMS ERROR IS 2.619

FIGURE A-4

INCORE RUN YR-19-209

599.7 MWT GROUP C AT 81.000 INCHES 1373. MWD/MTU

COMPARISON OF MEASURED AND PREDICTED SIGNALS

MEASURED SIGNAL........
PREDICTED SIGNAL........
% DIFFERENCE................

				.684 .704 -2.8					
					.972 .991 -1.9				
						1.029 1.014 1.4			
		1.013 1.022 -.9		1.146 1.121 2.2					
			1.153 1.123 2.6						
						1.145 1.121 2.1			
					1.136 1.127 .8		1.016 1.021 -.4		
			1.020 1.025 -.4			.986 1.003 -1.7			
		.700 .728 -3.8							

AVERAGE ABSOLUTE DIFFERENCE BETWEEN
MEASURED AND PREDICTED IS 1.766 PERCENT

RMS ERROR IS 2.024

FIGURE A-5

INCORE RUN YR-20-008

600.0 MWT GROUP C AT 84.000 INCHES 526. MWD/MTU

COMPARISON OF MEASURED AND PREDICTED SIGNALS

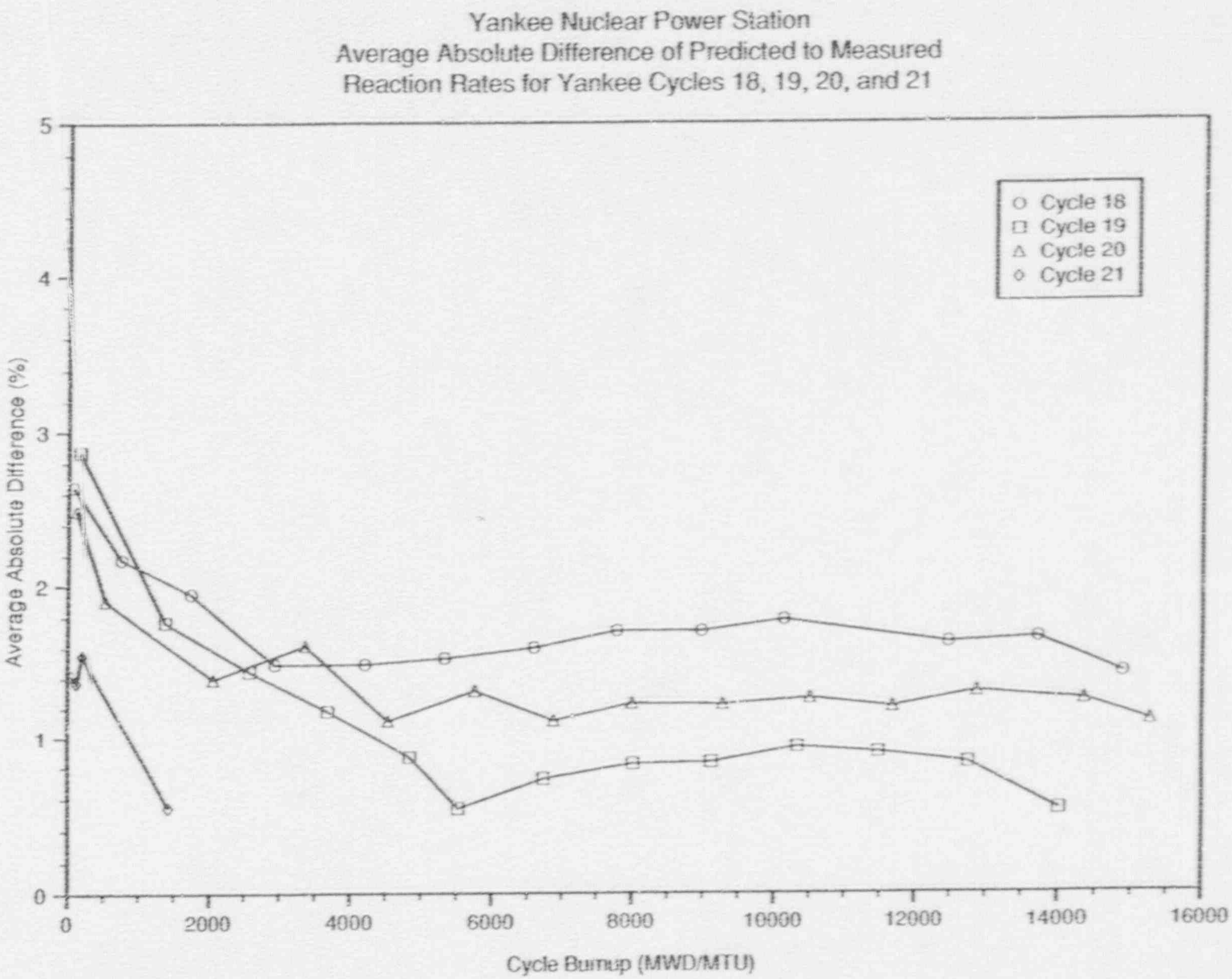
MEASURED SIGNAL........
PREDICTED SIGNAL........
% DIFFERENCE................

				.699 .720 -2.8					
					1.173 1.204 -2.6		.699 .689 -3.0		
			1.136 1.117 1.8			1.002 1.004 -.2			
		.999 .999 .0		1.107 1.077 2.8				1.087 1.092 -.5	
			1.063 1.032 3.0				1.072 1.070 .3		
		1.134 1.095 3.6				1.051 1.027 2.4			
					1.099 1.078 2.0		.999 1.004 -.5		
						1.062 1.084 -2.0			
		.672 .702 -4.2		1.217 1.246 -2.4					
					.757 .761 -.4				

AVERAGE ABSOLUTE DIFFERENCE BETWEEN
MEASURED AND PREDICTED IS 1.906 PERCENT

RMS ERROR IS 2.283

Figure A-6



Yankee Nuclear Power Station
Average Absolute Difference of Predicted to Measured
Reaction Rates for Yankee Cycles 18, 19, 20, and 21
Cycle 18
Cycle 19
Cycle 20
Cycle 21
Average Absolute Difference (%)
0
1
2
3
4
5
0
2000
4000
6000
8000
10000
12000
14000
16000
Cycle Burnup (MWD/MTU)

FIGURE A-7

INCORE RUN YR-21-004
381.8 MWT GROUP C AT 80.000 INCHES 50 MWD'MTU
COMPARISON OF MEASURED AND PREDICTED SIGNALS

MEASURED SIGNAL........
PREDICTED SIGNAL........
% DIFFERENCE.................

				.739 .755 -2.2					
					1.241 1.281 -3.1				
			1.068 1.073 -.5						
		.968 .966 .2		1.043 1.020 2.2					
			1.004 .977 2.8				1.022 1.022 .0		
		1.120 1.099 1.9							
					1.033 1.019 1.3		.966 .967 -.1		
						.985 .993 -.9			
					.813 .828 -1.9				

AVERAGE ABSOLUTE DIFFERENCE BETWEEN
MEASURED AND PREDICTED IS 1.420 PERCENT

RMS ERROR IS 1.749

FIGURE A-8

INCORE RUN YR-21-005
554.0 MWT GROUP C AT 83.625 INCHES 125. MWD/MTU

COMPARISON OF MEASURED AND PREDICTED SIGNALS

MEASURED SIGNAL........
PREDICTED SIGNAL........
% DIFFERENCE...............

				.735 .748 -1.7					
					1.235 1.267 -2.5				
			1.068 1.075 -.7						
		.969 .966 .3		1.049 1.026 2.2					
			1.008 .983 2.5				1.023 1.024 -.0		
		1.123 1.103 1.8							
					1.038 1.025 1.3		.959 .967 -.9		
						.984 .994 -1.0			
					.809 .822 -1.5				

AVERAGE ABSOLUTE DIFFERENCE BETWEEN
MEASURED AND PREDICTED IS 1.371 PERCENT

RMS ERROR IS 1.581

FIGURE A-9

INCORE RUN YR-21-007
582.0 MWT GROUP C AT 86.625 INCHES 200. MWD/MTU

COMPARISON OF MEASURED AND PREDICTED SIGNALS

MEASURED SIGNAL........
PREDICTED SIGNAL........
% DIFFERENCE...............

				.732 .748 -2.1					
					1.227 1.268 -3.2				
			1.068 1.073 -.5						
		.967 .963 .4		1.048 1.028 1.9					
			1.015 .986 3.0				1.025 1.022 .2		
		1.127 1.104 2.1							
					1.043 1.028 1.5		.958 .964 -.6		
						.983 .992 -.9			
					.806 .823 -2.1				

AVERAGE ABSOLUTE DIFFERENCE BETWEEN
MEASURED AND PREDICTED IS 1.549 PERCENT

RMS ERROR IS 1.828

FIGURE A-10

INCORE RUN YR-21-011
599.8 MWT GROUP C AT 85.125 INCHES 1420. MWD/MTU

COMPARISON OF MEASURED AND PREDICTED SIGNALS

MEASURED SIGNAL........
PREDICTED SIGNAL........
% DIFFERENCE................

				.730 .727 .3					
					1.208 1.220 -1.0				
			1.070 1.082 -1.1						
		.977 .970 .8		1.046 1.043 .3					
			1.011 1.004 .8				1.023 1.027 -.4		
		1.124 1.115 .9							
					1.043 1.042 .0		.970 .969 .1		
						.991 .997 -.6			
					.806 .803 .3				

AVERAGE ABSOLUTE DIFFERENCE BETWEEN
MEASURED AND PREDICTED IS .546 PERCENT

RMS ERROR IS .648