ATTACHMENT 7

Letter from M. E. Warner (NMC)

To

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Westinghouse Revised Thermal Design Procedure Instrument Uncertainty Methodology - Kewaunee Nuclear Plant (Power Uprate to 1757 MWt-NSSS Power with Feedwater Venturis and 54F Replacement Steam Generators)

Westinghouse

WCAP-15592
Rev. 0

Westinghouse Revised Thermal Design Procedure Instrument Uncertainty Methodology Kewaunee Nuclear Plant (Power Uprate to 1757 MWt-NSSS Power with Feedwater Venturis and 54F Replacement Steam Generators)

July 2002

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I. INTRODUCTION

This report was completed to support the transition to Westinghouse nuclear fuel with Replacement Steam Generators, and at an uprated condition of 1757 MWt - NSSS power using the feedwater venturis for the Kewaunee Nuclear Plant (KNP). The fuel product to satisfy the intended requirements is the Westinghouse 14 x 14 422 Vantage + fuel assembly. To utilize this new fuel assembly at the uprated conditions, a new accident analysis was required in addition to recalculating and revising the Instrument Uncertainty Methodology.

Four operating parameter uncertainties are used in the uncertainty analysis of the Revised Thermal Design Procedure (RTDP). These parameters are Pressurizer Pressure, Primary Coolant Temperature (T_{avg}), Reactor Power, and Reactor Coolant System (RCS) Flow. They are frequently monitored and several are used for control purposes. Reactor power is monitored by the performance of a secondary side heat balance (power calorimetric measurement) at least once every 24 hours. RCS flow is monitored by the performance of a calorimetric RCS flow measurement at the beginning of each cycle. The RCS Cold Leg loop flow indicators are evaluated against the calorimetric RCS flow measurement. Pressurizer pressure is a controlled parameter and the uncertainty reflects the control and indication system. T_{avg} is a controlled parameter via the temperature input to the rod control system, and the uncertainty reflects this control and indication system. The RTDP[1] is used to predict the plant's DNBR design limit. The RTDP methodology considers the uncertainties in the system operating plant parameters, fuel fabrication and nuclear and thermal parameters and includes the use of various DNB correlations. Use of the RTDP methodology requires that variances in the plant operating parameters are justified. The purpose of the following evaluation is to define the specific Kewaunee Nuclear Plant instrument uncertainties for the four primary system operating parameters which are used to predict the plant safety analysis DNBR design limit via the RTDP, and to determine the starting points of certain plant parameters in some of the accident analyses.

Westinghouse has been involved with the development of several techniques to treat instrumentation uncertainties. An early version used the methodology outlined in WCAP-8567, "Improved Thermal Design Procedure," [2,3,4] which is based on the conservative assumption that the uncertainties can be described with uniform probability distributions. Another approach is based on the more realistic assumption that the uncertainties can be described with random, normal, two-sided probability distributions.[5] This approach is used to substantiate the acceptability of the protection system setpoints for many Westinghouse plants, e.g., D. C. Cook 2[6], V. C. Summer, Wolf Creek, Millstone Unit 3 and others. The second approach is now utilized for the determination of all instrumentation uncertainties for the RTDP parameters and protection functions.

The purpose of this WCAP is to document the determination of pressure, temperature, power and RCS flow uncertainties that are applicable for the Kewaunee Nuclear Plant for power levels up to 1757 MWt - NSSS power when using the feedwater venturis, for 18-month fuel cycles + 25% per the plant Technical Specifications, and for a full power T_{avg} window from 556.3 to 573.0°F.

II. METHODOLOGY

The methodology used to combine the uncertainty components for a channel is the square root of the sum of the squares of those groups of components that are statistically independent. Those uncertainties that are dependent are combined arithmetically into independent groups, which are then systematically combined. The uncertainties used are considered to be random, two-sided distributions. The sum of both sides is equal to the range for that parameter, e.g., Rack Drift is typically [ ]$^{+a,c}$, the range for this parameter is [ ]$^{+a,c}$. This technique has been utilized before as noted above, and has been endorsed by the NRC staff [7,8,9,10] and various industry standards [11,12].

The relationships between the error components and the channel instrument error allowance are variations of the basic Westinghouse Setpoint Methodology[13] that are based on KNP-specific procedures and processes, and are defined as follows:

1. For precision parameter indication using Special Test Equipment or a digital voltmeter (DVM) at the input to the racks;

$$CSA = \{(SMTE + SCA)^2 + (SPE)^2 + (STE)^2 + (SMTE + SD)^2 + (SRA)^2 + (RDOUT)^2\}^{1/2} + BIAS \qquad \text{Eq. 1}$$

2. For parameter indication utilizing the plant process computer;

$$CSA = \{(SMTE + SCA)^2 + (SPE)^2 + (STE)^2 + (SMTE + SD)^2 + (SRA)^2 + (RMTE + RCA)^2 + (RTE)^2 + (RMTE + RD)^2 + (RMTE + RCA)^2_{comp} + (RMTE + RD)^2_{comp}\}^{1/2} + BIAS \qquad \text{Eq. 2}$$

3. For parameters with closed-loop automatic control systems, the calculation takes credit for [the long-term steady-state error equal to zero due to the integral (reset) capability]$^{+a,c}$.

$$CSA = \{(PMA)^2 + (PEA)^2 + (SMTE + SCA)^2 + (SPE)^2 + (STE)^2 + (SMTE + SD)^2 + (SRA)^2 + (RMTE + RCA)^2 + (RTE)^2 + (RMTE + RD)^2 + (REF)^2 + (CMTE + CA)^2 + (RMTE + RCA)^2_{IND} + (RMTE + RD)^2_{IND} + (RDOUT)^2_{IND}\}^{1/2} + BIAS \qquad \text{Eq. 3}$$

where:

CSA	=	Channel Statistical Allowance
PMA	=	Process Measurement Accuracy
PEA	=	Primary Element Accuracy
SRA	=	Sensor Reference Accuracy
SCA	=	Sensor Calibration Accuracy
SMTE	=	Sensor Measurement and Test Equipment Accuracy
SPE	=	Sensor Pressure Effects
STE	=	Sensor Temperature Effects
SD	=	Sensor Drift
RCA	=	Rack Calibration Accuracy
RMTE	=	Rack Measurement and Test Equipment Accuracy
RTE	=	Rack Temperature Effects
RD	=	Rack Drift
RDOUT	=	Readout Device Accuracy
CA	=	Controller Allowance
CMTE	=	Controller Measurement and Test Equipment Accuracy
COMP	=	Plant Computer
REF	=	Reference signal for automatic control system
IND	=	Indicator.

PMA and PEA terms are not included in Equations 1 and 2 since the equations are to determine instrumentation uncertainties only. PMA and PEA terms are included in the determination of control system uncertainties.

The parameters above are defined in References 5 and 12 and are based on ISA S51.1-1979[14]. However, for ease in understanding they are paraphrased below:

PMA	- non-instrument related measurement uncertainties, e.g., temperature stratification of a fluid in a pipe.
PEA	- uncertainties due to a metering device, e.g., elbow, venturi, orifice.
SRA	- reference (calibration) accuracy for a sensor/transmitter.
SCA	- calibration tolerance for a sensor/transmitter based on plant procedures.
SMTE	- measurement and test equipment used to calibrate a sensor/transmitter.
SPE	- change in input-output relationship due to a change in static pressure for a differential pressure (d/p) transmitter.
STE	- change in input-output relationship due to a change in ambient temperature for a sensor or transmitter.
SD	- change in input-output relationship over a period of time at reference conditions for a sensor or transmitter.
RCA	- calibration accuracy for all rack modules in loop or channel assuming the loop or channel is string calibrated, or tuned, to this accuracy.
RMTE	- measurement and test equipment used to calibrate rack modules.
RTE	- change in input-output relationship due to a change in ambient temperature for the rack modules.

RD - change in input-output relationship over a period of time at reference conditions for the rack modules.

RDOUT - the measurement accuracy of a special local test gauge, a data acquisition system, a digital voltmeter or multimeter on its most accurate applicable range for the parameter measured, or 1/2 the smallest increment on an indicator (readability).

CA - allowance of the controller rack module(s) that performs the comparison and calculates the difference between the controlled parameter and the reference signal.

CMTE - measurement and test equipment used to calibrate the controller rack module(s) that perform(s) the comparison between the controlled parameter and the reference signal.

A/D - allowance for conversion accuracy of an analog signal to a digital signal for process computer use.

REF - the reference signal uncertainty for a closed-loop automatic control system.

IND - allowance for the uncertainty associated with the use of an indication meter. Control board indicators are typically used.

BIAS - a one directional uncertainty for a sensor/transmitter or a process parameter with a known magnitude.

A more detailed explanation of the Westinghouse methodology noting the interaction of several parameters is provided in References 6 and 13.

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III. INSTRUMENTATION UNCERTAINTIES

The instrumentation uncertainties will be discussed first for the two parameters which are controlled by automatic systems, i.e., Pressurizer Pressure and T_{avg} (through automatic rod control).

1. PRESSURIZER PRESSURE

Pressurizer pressure is controlled by a closed-loop automatic control system that compares the measured vapor space pressure to a reference value. This uncertainty calculation accounts for the closed-loop control system design where [ ]$^{+a,c}$. The control channel uncertainties for the automatic control system include allowances for the pressure transmitters, the process racks/indicators, and the control system reference setpoint. The pressurizer pressure control system reference setpoint is generated by the setting of a variable potentiometer on the Main Control Board manual/automatic station. The reference setpoint (Pref) is adjusted and verified by the plant operators with the control board indicators. This uncertainty calculation also includes the control board indicators for performance verification of the automatic control system.

On Table 1, the calculated electronics uncertainty for this function using Equation 3 is [ ]$^{+a,c}$ with a [ ]$^{+a,c}$ bias. In addition to the control system uncertainty, an allowance is made for pressure overshoot or undershoot due to the interaction and thermal inertia of the heaters and spray. An allowance of [ ]$^{+a,c}$ is made for this effect. The total control system uncertainty including indication is [ ]$^{+a,c}$ with a [ ]$^{+a,c}$ bias which results in a standard deviation of [ ]$^{+a,c}$ for a normal, two-sided probability distribution.

The Technical Specification DNB Parameter for pressurizer pressure has been determined for the following methods of surveillance:

Control Board Indicators (average of 4 channels)	> 2217 psig
Computer Indications (average of 4 channels)	> 2219 psig

TABLE 1

PRESSURIZER PRESSURE CONTROL SYSTEM AND INDICATION UNCERTAINTIES

All Values in % Span*

[ ]+a,c

REF	=	
PMA	=	
PEA	=	
SRA	=	
SCA	=	
SMTE	=	
STE	=	
SD	=	
BIAS	=	
RCA	=	
RMTE	=	
RTE	=	
RD	=	
RCA_{IND}	=	
$RMTE_{IND}$	=	
RD_{IND}	=	
$RDOUT_{IND}$	=	
CA	=	
CMTE	=	

RANGE = 1700 - 2500 psig, *SPAN = 800 psi
CHANNELS P-429, -430, -431 & -449

ELECTRONICS UNCERTAINTY = [
PLUS

CONTROLLER UNCERTAINTY =]+a,c

Note A: Module PM-429A = [
Module PM-429D =
Note B: Module PC-431K =]+a,c

2. $\underline{T_{avg}}$

T_{avg} is controlled by a system that compares the high T_{avg} from the loops with a reference derived from the Turbine First Stage Impulse Chamber Pressure. T_{avg} is the average of the narrow range T_H and T_C values for a loop. The high loop T_{avg} is then used for rod control. Allowances are made (as noted on Table 2) for hot and cold leg temperature streaming, RTDs, turbine pressure transmitter, process racks/indicators and controller. Based on one T_H and one T_C RTD per channel to calculate T_{avg} and with the RTDs located in the hot and cold leg bypass manifolds, the calculated electronics uncertainty using Equation 3 is [ ]$^{+a,c}$. Assuming a normal, two-sided probability distribution results in an electronics standard deviation (s_1) of [ ]$^{+a,c}$.

However, this does not include the deadband of [ ]$^{+a,c}$ associated with the automatic control. The T_{avg} controller accuracy is the combination of the instrumentation accuracy and the deadband. The probability distribution for the deadband has been determined to be [ ]$^{+a,c}$. The variance for the deadband uncertainty is then:

$(s_2)^2$ = [ ]$^{+a,c}$ = [ ]$^{+a,c}$

Combining the variance for instrumentation and deadband results in a controller variance of:

$(s_T)^2 = (s_1)^2 + (s_2)^2$ = [ ]$^{+a,c}$

The controller s_T = [ ]$^{+a,c}$ for a total random uncertainty of [ ]$^{+a,c}$.

A bias of [-1.0°F]$^{+a,c}$ for T_{cold} streaming (in terms of T_{avg}) based on a conservative [ ]$^{+a,c}$ T_{cold} streaming uncertainty is included in Table 2. Another bias of [ ]$^{+a,c}$ for the turbine first stage impulse chamber pressure transmitter is included in Table 2. Therefore, the total uncertainty of the controller with the biases is [ ]$^{+a,c}$ random and [ ]$^{+a,c}$ bias.

The Technical Specification DNB Parameter for T_{avg} has been determined for the following methods of surveillance:

Control Board Indicators (average of 4 channels)	< 576.7°F
Computer Indications (average of 4 channels)	< 576.5°F

TABLE 2

T_{AVG} ROD CONTROL SYSTEM AND INDICATION UNCERTAINTIES

+a,c

		% T_{avg} Span*	% Turbine Pressure Span** (P-485,-486)
PMA_1	=		
PMA_2	=		
PMA_3	=		
SRA	=		
SCA	=		
SMTE	=		
STE	=		
SD	=		
BIAS	=		
R/E	=		
R/E_MTE	=		
R/E_RD	=		
RCA	=		
RMTE	=		
RTE	=		
RD	=		
RCA_{IND}	=		
$RMTE_{IND}$	=		
RD_{IND}	=		
$RDOUT_{IND}$	=		
CA	=		
CMTE	=		

*	Tavg span	= 100 °F	(range: 520-620°F)
**	Turbine pressure span	= 650 psi	(range: 0-650 psig)
***	% R/E span &&		
&&	R/E span	= 150 °F	(range 500-650°F for Hot Leg) (range 500-650°F for Cold Leg)
	# Hot Leg RTDs	= 1/Channel	#Cold Leg RTDs = 1/Channel

+a,c

Note A:	Module TM401BB	=	
	Module TM401C	=	
	Module TM401EE	=	
	Module TM401D	=	
	Module TM401H	=	
	Module TM401M	=	
	Module TC401L	=	
Note B:	Module PM485A	=	
	Module TM401P	=	
	Module TM401N	=	
	Module TM401I	=	

TABLE 2 (Continued)

T_{AVG} ROD CONTROL SYSTEM AND INDICATION UNCERTAINTIES

Electronics Uncertainty	=	[
Electronics Sigma	=	
Controller Sigma	=	
Controller Uncertainty	=	
Controller Bias	=	]+a,c

**** Includes the controller deadband of [ ]+a,c.

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3. RCS FLOW

3.1 Calorimetric RCS Flow Measurement Uncertainty (Using Venturi on the Feedwater Bypass Loop)

The Technical Specifications require an RCS flow measurement during steady-state power operation to be satisfied by an RCS flow measurement following each refueling between 90% and 100% of Rated Thermal Power (RTP). A calorimetric RCS flow measurement is performed at the beginning of every fuel cycle between 90% and 100% RTP operation, typically every 18 months, to verify RCS flow and to normalize the RCS flow instrument channels. Interim surveillances performed with the plant computer ensure that the RCS flow is maintained above the assumed safety analysis values, i.e., Minimum Measured Flow (MMF).

It is assumed for this uncertainty analysis that a calorimetric RCS flow measurement is performed within 30 days of calibrating the measurement instrumentation. Therefore, except where necessary due to sensor location, drift effects are limited to 30 days. The feedwater bypass loop will be used for the calorimetric RCS flow measurement at the beginning of each fuel cycle. No allowances have been made for feedwater bypass loop venturi fouling. Instrument drift allowances are identified for this uncertainty analysis for hot and cold leg RTDs, feedwater RTDs, and for feedwater flow, feedwater pressure, steam pressure and pressurizer pressure transmitters.

The calorimetric RCS flow measurement is performed by determining the steam generator thermal output (corrected for the RCP heat input and the loop's share of primary system heat losses) and the enthalpy rise (Delta-h) of the primary coolant. Assuming that the primary and secondary sides are in equilibrium, the RCS total vessel flow is the sum of the individual primary loop flows, i.e.,

$$W_{RCS} = \Sigma_{i=1}^{N}(W_L)_i. \qquad \text{Eq. 4}$$

The individual primary loop volumetric flows are determined by correcting the thermal output of each steam generator for steam generator blowdown (if not secured), subtracting the RCP heat addition, adding the loop's share of the primary side system losses, dividing by the primary side enthalpy rise and multiplying by the cold leg specific volume. The equation for this calculation is:

$$W_L = \frac{(A)\{Q_{SG} - Q_P + (Q_L/N)\}(V_C)}{(h_H - h_C)} \qquad \text{Eq. 5}$$

where;

W_L	=	Loop flow (gpm)
A	=	Constant conversion factor 0.1247 gpm/(ft^3/hr)
Q_{SG}	=	Steam generator thermal output (BTU/hr)
Q_P	=	RCP heat addition (BTU/hr)
Q_L	=	Primary system net heat losses (BTU/hr)
V_C	=	Specific volume of the cold leg at T_C (ft^3/lb)

N	=	Number of primary side loops
h_H	=	Hot leg enthalpy (BTU/lb)
h_C	=	Cold leg enthalpy (BTU/lb).

The thermal output of each steam generator is determined by a secondary side calorimetric measurement that is defined as:

$$Q_{SG} = (h_s - h_f)W_f \qquad \text{Eq. 6}$$

where;

h_s	=	Steam enthalpy (BTU/lb)
h_f	=	Feedwater enthalpy (BTU/lb)
W_f	=	Feedwater flow (fraction of feedwater bypass loop flow based on loop feedwater flow measurements)(lb/hr).

The steam enthalpy is based on the measurement of steam generator outlet steam pressure assuming saturated conditions. The feedwater enthalpy is based on the measurement of feedwater temperature and a calculated feedwater pressure. Total feedwater flow is determined by a delta-p measurement on the feedwater bypass loop and the following calculation:

$$W_f = (K)(F_a)\{(\rho_f)(\Delta p)\}^{1/2} \qquad \text{Eq. 7}$$

where;

K	=	Feedwater venturi flow coefficient
F_a	=	Feedwater venturi correction for thermal expansion
ρ_f	=	Feedwater density (lb/ft^3)
Δp	=	Feedwater venturi pressure drop (inches H_2O).

A calibrated feedwater flow venturi is installed on the feedwater bypass loop to determine total feedwater flow. The feedwater venturi flow coefficient is the product of a number of constants including as-built dimensions of the venturi and calibration tests performed by the vendor. The thermal expansion correction is based on the coefficient of expansion of the venturi material and the difference between feedwater temperature and calibration temperature. Feedwater density is based on the measurement of feedwater temperature and a calculated feedwater pressure. The venturi pressure drop is obtained from the output of the differential pressure transmitter connected to the venturi.

RCP heat addition is determined by calculation, based on the best estimate of coolant flow, pump head, and pump hydraulic efficiency.

The primary system net heat losses are determined by calculation, considering the following system heat inputs (+) and heat losses (-):

Charging flow (+)
Letdown flow (-)
Seal injection flow (+)

RCP thermal barrier cooler heat removal (-)
Pressurizer spray flow (-)
Pressurizer surge line flow (+)
Component insulation heat losses (-)
Component support heat losses (-)
CRDM heat losses (-).

A single calculated sum for 100% RTP operation is used for these losses or heat inputs.

The hot leg and cold leg enthalpies are based on the measurement of the hot leg temperature, cold leg temperature and pressurizer pressure. The cold leg specific volume is based on measurement of the cold leg temperature and pressurizer pressure.

The calorimetric RCS flow measurement is thus based on the following plant measurements:

Steamline pressure (P_s)
Feedwater temperature (T_f)
Feedwater pressure (P_f)
Feedwater venturi differential pressure (Δp)
Hot leg temperature (T_H)
Cold leg temperature (T_C)
Pressurizer pressure (P_p)
Steam generator blowdown flow (if not secured)*
* However, steam generator blowdown operation will have minimal effect on the calorimetric RCS flow measurement uncertainty.

and on the following calculated values:

Feedwater venturi flow coefficient (K)
Feedwater venturi thermal expansion correction (F_a)
Feedwater density (ρ_f)
Feedwater enthalpy (h_f)
Steam enthalpy (h_s)
Moisture carryover (impacts h_s)
Primary system net heat losses (Q_L)
RCP heat addition (Q_p)
Hot leg enthalpy (h_H)
Cold leg enthalpy (h_C).

These measurements and calculations are presented schematically in Figure 1. The derivation of the measurement and flow uncertainties on Table 5 are noted below.

Secondary Side

The secondary side uncertainties are in four principal areas, feedwater flow, feedwater enthalpy, steam enthalpy and net pump heat addition. These areas are specifically identified on Table 5.

For the measurement of feedwater flow, the feedwater venturi is calibrated by the vendor in a hydraulics laboratory under controlled conditions to an accuracy of [ ]$^{+a,c}$. The calibration data that substantiates this accuracy is provided to the plant by the vendor. An additional uncertainty factor of [ ]$^{+a,c}$ is included for installation effects, resulting in a conservative overall flow coefficient (K) uncertainty of [ ]$^{+a,c}$. Since RCS loop flow is proportional to steam generator thermal output which is proportional to feedwater flow, the flow coefficient uncertainty is expressed as [ ]$^{+a,c}$. It should be noted that no allowance is made for venturi fouling. The venturi should be inspected, and cleaned if necessary, prior to performance of the calorimetric measurement. If fouling is present but not removed, it's effects must be treated as a flow bias.

The uncertainty applied to the feedwater venturi thermal expansion correction (F_a) is based on the uncertainties of the measured feedwater temperature and the coefficient of thermal expansion for the venturi material, usually 304 stainless steel. For this material, a change of ±1°F in the nominal feedwater temperature range changes F_a by [ ]$^{+a,c}$ and the steam generator thermal output by the same amount.

Based on data introduced into the ASME Code, the uncertainty in F_a for 304 stainless steel is ±5%. This results in an additional uncertainty of [ ]$^{+a,c}$ in feedwater flow. Westinghouse uses the conservative value of [ ]$^{+a,c}$.

Using the NBS/NRC Steam Tables it is possible to determine the sensitivities of various parameters to changes in feedwater temperature and pressure. Table 3 notes the instrument uncertainties for the hardware used to perform the measurements. Table 4 lists the various sensitivities. As can be seen on Table 5, feedwater temperature uncertainties have an impact on feedwater flow and feedwater enthalpy. Feedwater pressure uncertainties impact feedwater flow and feedwater enthalpy.

Feedwater venturi Δp uncertainties are converted to % feedwater flow using the following conversion factor:

$$\% \text{ flow} = (\Delta p \text{ uncertainty})(1/2)(\text{transmitter span}/ 90)^2$$

The feedwater flow transmitter span is shown on Table 3.

Using the NBS/NRC Steam Tables, it is possible to determine the sensitivity of steam enthalpy to changes in steam pressure and steam quality. Table 3 notes the uncertainty in steam pressure and Table 4 provides the sensitivity. For steam quality, the Steam Tables were used to determine the sensitivity at a moisture content of [ ]$^{+a,c}$. This value is noted on Table 4.

The net pump heat addition uncertainty is derived from the combination of the primary system net heat losses and pump heat addition and are summarized for a two loop plant as follows:

- System heat losses (MWt)
- Component conduction and convection losses (MWt)
+ Pump heat adder (MWt)
= Net Heat input to RCS of + 8.0 MWt

The uncertainty on system heat losses, which is essentially all due to charging and letdown flows, has been estimated to be [ ]$^{+a,c}$ of the calculated value. Since direct measurements are not possible, the uncertainty on component conduction and convection losses has been assumed to be [ ]$^{+a,c}$ of the calculated value. Reactor coolant pump hydraulics are known to a relatively high confidence level, supported by system hydraulics tests performed at Prairie Island Unit 2 and by input power measurements from several other plants. Therefore, the uncertainty for the pump heat addition is estimated to be [ ]$^{+a,c}$ of the best estimate value. Considering these parameters as one quantity, which is designated the net pump heat addition uncertainty, the combined uncertainties are less than [ ]$^{+a,c}$ of the total, which is [ ]$^{+a,c}$ of core power.

Primary Side

The primary side uncertainties are in three principal areas, hot leg enthalpy, cold leg enthalpy and cold leg specific volume. These are specifically noted on Table 5. Three primary side parameters are actually measured, T_H, T_C and pressurizer pressure. Hot Leg enthalpy is influenced by T_H, pressurizer pressure and hot leg temperature streaming. The uncertainties for the instrumentation are noted on Table 3 and the sensitivities are provided on Table 4. The hot leg streaming is split into random and systematic components. For Kewaunee where the RTDs are located in RTD bypass loop manifolds, the hot leg temperature streaming uncertainty components are [ ]$^{+a,c}$ random and [ ]$^{+a,c}$ systematic.

The cold leg enthalpy and specific volume uncertainties are impacted by T_C and pressurizer pressure. Table 3 notes the T_C instrument uncertainty and Table 4 provides the sensitivities.

Parameter dependent effects are identified on Table 5. Westinghouse has determined the dependent sets in the calculation and the direction of interaction, i.e., whether components in a dependent set are additive or subtractive with respect to a conservative calculation of RCS flow. The same work was performed for the instrument bias values. As a result, the calculation explicitly accounts for dependent effects and biases with credit taken for sign (or direction of impact).

Using Table 5, the 2 loop uncertainty equation (with biases) is as follows:

[ ]+a,c

Based on the number of loops; number, type and measurement method of RTDs, and the vessel Delta-T, the flow uncertainty is:

# of loops	flow uncertainty (% flow)
2	[ ]+a,c

TABLE 3

FLOW CALORIMETRIC INSTRUMENTATION UNCERTAINTIES (% SPAN)

+a,c

	FW Temp.	FW Pres.	FW Δp	Steam Pres.	T_H	T_C	PRZ Pres.
SRA =							
SCA =							
SMTE =							
SPE =							
STE =							
SD =							
BIAS =							
R/E =							
RCA =							
RMTE =							
RTE =							
RD =							
A/D =							
A/D_MTE =							
A/D_TE =							
A/D_D =							
RDOUT =							
CSA =							

+a,c

	FW Temp.	FW Pres.	FW Δp	Steam Pres.	T_H	T_C	PRZ Pres.
# OF INSTRUMENTS USED	1/Loop	1/plant	1/plant	3/Loop	2/Loop	2/Loop	4
	°F	psi	% Δp	psi	°F	°F	psi
INST SPAN =	200(1)	1600(2)	103.3% flow(3)	1400(4)	150(5)	150(5)	800(6)
INST UNC. (RANDOM) =							
INST UNC. (BIAS) =							
NOMINAL =	435.3 °F	869 psia	90% Flow	769 psia	608.5°F	542.1°F	2250 psia

(1) Temperature (TE-15043, -15044) is measured with RTDs and the plant computer. TE-14137 (RTD), TT-22050 (transmitter) and digital acquisition system measure feedwater bypass loop temperature for density correction.
(2) Pressure (PT-21196) is measured with a transmitter and digital acquisition system on the feedwater bypass loop.
(3) Flow (FT-23153) is measured with a transmitter and digital acquisition system on the feedwater bypass loop venturi.
(4) Pressure (PT-21094, -21095, -21096, -21097, -21098, -21099) is measured with transmitters, the process instrumentation, and the plant computer.
(5) Temperature is measured with digital voltmeters at the output of the R/E process instrumentation modules.
(6) Pressure (PT-21079, -21080, -21081, -21082) is measured with transmitters, the process instrumentation and the plant computer.

TABLE 4

FLOW CALORIMETRIC SENSITIVITIES

FEEDWATER FLOW				+a,c
F_a				
TEMPERATURE	=			
MATERIAL	=			
DENSITY				
TEMPERATURE	=			
PRESSURE	=			
DELTA P	=			
FEEDWATER ENTHALPY				
TEMPERATURE	=			
PRESSURE	=			
h_s	=	1199.9	BTU / lbm	
h_f	=	414.1	BTU / lbm	
Δh (SG)	=	785.9	BTU / lbm	
STEAM ENTHALPY				+a,c
PRESSURE	=			
MOISTURE	=			
HOT LEG ENTHALPY				
TEMPERATURE	=			
PRESSURE	=			
h_H	=	625.0	BTU / lbm	
h_C	=	537.1	BTU / lbm	
Δh (VESS)	=	87.9	BTU / lbm	
COLD LEG ENTHALPY				+a,c
TEMPERATURE	=			
PRESSURE	=			
COLD LEG SPECIFIC VOLUME				
TEMPERATURE	=			
PRESSURE	=			

TABLE 5

CALORIMETRIC RCS FLOW MEASUREMENT UNCERTAINTY

Component	Instrument Uncertainty	Flow Uncertainty (% Flow)
		+a,c
FEEDWATER FLOW		
VENTURI		
THERMAL EXPANSION COEF.		
TEMPERATURE		
MATERIAL		
DENSITY		
TEMPERATURE		
PRESSURE		
DELTA P		
FEEDWATER ENTHALPY		
TEMPERATURE		
PRESSURE		
STEAM ENTHALPY		
PRESSURE		
MOISTURE		
NET PUMP HEAT ADDITION		
HOT LEG ENTHALPY		
TEMPERATURE		
STREAMING, RANDOM		
STREAMING, SYSTEMATIC		
PRESSURE		
COLD LEG ENTHALPY		
TEMPERATURE		
PRESSURE		
COLD LEG SPECIFIC VOLUME		
TEMPERATURE		
PRESSURE		

*, **, +, ++ Indicates Sets of Dependent Parameters

TABLE 5 (Continued)

CALORIMETRIC RCS FLOW MEASUREMENT UNCERTAINTY

Component		Flow Uncertainty
BIAS VALUES		
STEAM PRESSURE - ENTHALPY		[ ] +a,c
PRESSURIZER PRESSURE		
HOT LEG ENTHALPY		
COLD LEG ENTHALPY		
COLD LEG SPECIFIC VOLUME		
FLOW BIAS TOTAL VALUE		
2 LOOP UNCERTAINTY	(WITHOUT FLOW BIAS)	[ ] +a,c
	(FLOW BIAS)	

3.2 Loop RCS Flow Uncertainty (Using Plant Computer)

As noted earlier, the calorimetric RCS flow measurement is used as the reference for normalizing the loop RCS flow measurement from the cold leg elbow tap transmitters. Since the cold leg elbow tap transmitters feed the plant computer, it is a simple matter to perform a RCS flow surveillance. Table 6 notes the instrument uncertainties for determining flow by using the loop RCS flow channels and the plant computer, assuming two loop RCS flow channels are averaged per reactor coolant loop. The Δp transmitter uncertainties are converted to percent flow using the following conversion factor:

$$\% \text{ flow} = (\Delta p \text{ uncertainty})(1/2)(\text{Flow}_{max} / \text{Flow}_{nominal})^2$$

where Flow_{max} is the maximum value of the loop RCS flow channel. The loop RCS flow uncertainty is then combined with the calorimetric RCS flow measurement uncertainty. This combination of uncertainties results in the following total flow uncertainty:

# of loops	flow uncertainty (% flow)
2	±2.86 (random) +0.11 (bias)

The corresponding value used in RTDP is:

# of loops	standard deviation (% flow)
2	[ ]$^{+a,c}$

TABLE 6

LOOP RCS FLOW UNCERTAINTY
PLANT COMPUTER

INSTRUMENT UNCERTAINTIES
2 LOOP RCS FLOW CHANNELS AVERAGED PER REACTOR COOLANT LOOP
(F-411, -412, -413, -414, -415, -416)

		% d/p Span	% Flow
PMA	=		
PEA	=		
SRA	=		
SCA	=		
SMTE	=		
SPE	=		
STE	=		
SD	=		
BIAS	=		
RCA	=		
RMTE	=		
RTE	=		
RD	=		
A/D	=		
A/D_MTE	=		
A/D_TE	=		
A/D_D	=		
FLOW CALORIMETRIC	=		
FLOW CALORIMETRIC BIAS	=		
INSTRUMENT SPAN	=		

+a,c

SINGLE LOOP ELBOW TAP FLOW UNCERTAINTY = [ ] +a,c

2 LOOP RCS FLOW UNCERTAINTY
(RANDOM) = ±2.86% flow
(FLOW BIAS) = +0.11% flow

Note A: Module FM-411, -412, -413, -414, -415, -416 = 0.5% d/p span

* Zero values due to normalization to calorimetric RCS flow measurement

4. REACTOR POWER (Using Feedwater Venturis)

The plant is required to perform a primary/secondary side heat balance at least every 24 hours when power is above 15% RTP. This heat balance is used to verify that the plant is operating within the limits of the Operating License (1749 MWt-Core power) or 1757 MWt-NSSS power when using the feedwater venturis, and to adjust the Power Range Neutron Flux channels when the difference between the Power Range Neutron Flux channels and the heat balance is greater than allowed by the plant Technical Specifications. KNP also continuously calculates the reactor thermal output (RTO) to ensure that the power limit is not exceeded.

Assuming that the primary and secondary sides are in equilibrium; the core power is determined by summing the thermal output of the steam generators, correcting the total secondary power for Steam Generator blowdown (if not secured), subtracting the RCP heat addition, adding the primary side system losses, and dividing by the core Btu/hr at rated full power. The equation for this calculation is:

$$RP = \frac{\{ \Sigma_{i=1}^{N} [Q_{SG} - Q_P + (Q_L/N)]_i \}(100)}{H} \qquad \text{Eq. 8}$$

where;

RP	=	Core power (% RTP)
N	=	Number of primary side loops
Q_{SG}	=	Steam generator thermal output (BTU/hr) as defined in Eq. 6
Q_P	=	RCP heat addition (BTU/hr)
Q_L	=	Primary system net heat losses (BTU/hr)
H	=	Rated core power (BTU/hr).

For the purposes of this uncertainty analysis (and based on H noted above) it is assumed that the plant is at 100% RTP when the measurement is taken. Measurements performed at lower power levels will result in different uncertainty values. However, operation at lower power levels results in increased margin to DNB far in excess of any margin losses due to increased measurement uncertainty.

The feedwater flow is determined by multiple measurements from the feedwater flow venturis for each steam generator and equation 7.

where;

W_f	=	Feedwater loop flow (lb/hr)
K	=	Feedwater venturi flow coefficient
F_a	=	Feedwater venturi correction for thermal expansion
ρ_f	=	Feedwater density (lb/ft^3)
Δp	=	Feedwater venturi pressure drop (inches H_2O).

The feedwater venturi flow coefficient is the product of a number of constants including as-built dimensions of the venturi and calibration tests performed by the vendor. The thermal expansion correction is based on the coefficient of expansion of the venturi material and the difference between feedwater temperature and calibration temperature. Feedwater density is based on the measurement of feedwater temperature and steam pressure. The venturi pressure drop is obtained from the output of the differential pressure transmitter connected to the venturi.

The power measurement is thus based on the following plant measurements:

Steamline pressure (P_s)
Feedwater temperature (T_f)
Feedwater venturi differential pressure (Δp)
Steam generator blowdown flow (if not secured)

and on the following calculated values:

Feedwater pressure (P_f)
Feedwater venturi flow coefficient (K)
Feedwater venturi thermal expansion correction (F_a)
Feedwater density (ρ_f)
Feedwater enthalpy (h_f)
Steam enthalpy (h_s)
Moisture carryover (impacts h_s)
Primary system net heat losses (Q_L)
RCP heat addition (Q_p)

Secondary Side

The secondary side power calorimetric equations and effects are the same as those noted for the calorimetric RCS flow measurement (secondary side portion), Equation 6. The measurements and calculations are presented schematically on Figure 2.

For the measurement of feedwater flow, each feedwater venturi is calibrated by the vendor in a hydraulics laboratory under controlled conditions to an accuracy of [ ]$^{+a,c}$. The calibration data that substantiates this accuracy is provided to the plant by the vendor. An additional uncertainty factor of [ ]$^{+a,c}$ is included for installation effects, resulting in a conservative overall flow coefficient (K) uncertainty of [ ]$^{+a,c}$. Since the calculated steam generator thermal output is proportional to feedwater flow, the flow coefficient uncertainty is expressed as [ ]$^{+a,c}$. It should be noted that no allowance is made for feedwater venturi fouling. The effect of fouling results in an indicated power higher than actual, which is conservative.

The uncertainty applied to the feedwater venturi thermal expansion correction (F_a) is based on the uncertainties of the measured feedwater temperature and the coefficient of thermal expansion for the venturi material, 304 stainless steel. For this material, a change of ±1.0°F in the nominal feedwater temperature range changes F_a by [ ]$^{+a,c}$ and the steam generator thermal output by the same amount.

Based on data introduced into the ASME Code, the uncertainty in F_a for 304 stainless steel is ±5%. This results in an additional uncertainty of [ ]$^{+a,c}$ in power.

Using the NBS/NRC Steam Tables, it is possible to determine the sensitivities of various parameters to changes in feedwater temperature and pressure. Table 7 notes the instrument uncertainties for the hardware used to perform the measurements. Table 8 lists the various sensitivities. As can be seen on Table 8, feedwater temperature uncertainties have an impact on venturi F_a, feedwater density and feedwater enthalpy. Feedwater pressure uncertainties impact feedwater density and feedwater enthalpy.

Feedwater venturi Δp uncertainties are converted to % feedwater flow using the following conversion factor:

$$\% \text{ flow} = (\Delta p \text{ uncertainty})(1/2)(Flow_{max} / Flow_{nominal})^2$$

The feedwater flow transmitter span ($Flow_{max}$) is 117.5% of nominal flow.

Since it is necessary to make this determination daily, the plant computer is used for the calorimetric power measurement. As noted in Table 9, Westinghouse has determined the dependent sets in the calculation and the direction of interaction. This is the same as that performed for the calorimetric RCS flow measurement, but applicable only to power. The same was performed for the bias values. It should be noted that Westinghouse does not include any allowance for feedwater venturi fouling. The effect of fouling is to result in an indicated power higher than actual, which is conservative.

Using the power uncertainty values noted on Table 9, the 2 loop uncertainty (with bias values) equation is as follows:

[ ]$^{+a,c}$

Based on the number of loops and the instrument uncertainties for the four parameters, the uncertainty for the secondary side power calorimetric measurement using the feedwater flow venturis is:

# of loops	power uncertainty (% power)
2	[ ] +a,c

TABLE 7

POWER CALORIMETRIC INSTRUMENTATION UNCERTAINTIES

(% SPAN)

		FW Temp.	FW Pres.	FW ΔP	Steam Pres.
SRA	=				+a,c
SCA	=				
SMTE	=				
SPE	=				
STE	=				
SD	=				
BIAS	=				
RCA	=				
RMTE	=				
RTE	=				
RD	=				
RCA_A/D	=				
RMTE_A/D	=				
RTE_A/D	=				
RD_A/D	=				
CSA	=				
# OF INSTRUMENTS USED					
		1/Loop	not measured	1/Loop	2/Loop
		°F	psi	% Δp	psi
INST SPAN	=	200		117.5% flow	1400
INST UNC. (RANDOM)	=				+a,c
INST UNC. (BIAS)	=				
NOMINAL	=	435.3 °F	724 psia	100 % flow	624 psia

Feedwater temperature measurement is from channels 15043 and 15044.
Feedwater pressure measurement is not measured.
Feedwater flow measurement is from channels 23003, 23004, 23009, and 23011.
Steam pressure measurement is from channels 21094, 21095, 21096, 21097, 21098, and 21099.

TABLE 8

POWER CALORIMETRIC SENSITIVITIES

FEEDWATER FLOW			+a,c
F_a			
TEMPERATURE	=		
MATERIAL	=		
DENSITY			
TEMPERATURE	=		
PRESSURE	=		
DELTA P	=		
FEEDWATER ENTHALPY			
TEMPERATURE	=		
PRESSURE	=		
h_s	=	1203.3	BTU / lbm
h_f	=	414.0	BTU / lbm
Δh (SG)	=	789.3	BTU / lbm
STEAM ENTHALPY			+a,c
PRESSURE	=		
MOISTURE	=		

TABLE 9

SECONDARY SIDE POWER CALORIMETRIC MEASUREMENT UNCERTAINTY

+a,c

Component	Instrument Uncertainty	Power Uncertainty (% Power)
FEEDWATER FLOW		
VENTURI		
THERMAL EXPANSION COEFFICIENT		
TEMPERATURE		
MATERIAL		
DENSITY		
TEMPERATURE		
PRESSURE		
DELTA P		
FEEDWATER ENTHALPY		
TEMPERATURE		
PRESSURE		
STEAM ENTHALPY		
PRESSURE		
MOISTURE		
NET PUMP HEAT ADDITION		
BIAS VALUES		
FEEDWATER DELTA P		
STEAM PRESSURE - ENTHALPY		
POWER BIAS TOTAL VALUE		
SINGLE LOOP UNCERTAINTY (WITHOUT BIAS)		
2 LOOP UNCERTAINTY (RANDOM)		
(BIAS VALUE)		

*, **, INDICATES SETS OF DEPENDENT PARAMETERS

IV. RESULTS/CONCLUSIONS

The preceding sections provide the methodology to account for pressure, temperature, power and RCS flow uncertainties for the RTDP analysis. The uncertainty calculations have been performed for Kewaunee with the plant specific instrumentation and calibration procedures. The following table summarizes the results and the uncertainties that are used in the Kewaunee safety analysis.

Parameter	Calculated Uncertainty	Uncertainty Used in Safety Analysis
Pressurizer Pressure	[ ]+a,c	±50.0 psi (random) 15.0 psi (bias)
Tavg		±6.0°F (random) -1.1°F (bias)
Power (feedwater venturis)		±2.0% power (random) -0.32% power (bias) (at 1757 MWt-NSSS power)
RCS Flow (plant computer) (calorimetric measurement)	 ±2.86% flow (random) +0.11% flow (bias) [ ]+a,c	 ±4.3% flow (random) +0.11% flow (bias) (at 1757 MWt-NSSS power)

REFERENCES

1. WCAP-11397-P-A, "Revised Thermal Design Procedure", April 1989.
2. Westinghouse letter NS-CE-1583, C. Eicheldinger to J. F. Stolz, NRC, dated 10/25/77.
3. Westinghouse letter NS-PLC-5111, T. M. Anderson to E. Case, NRC, dated 5/30/78.
4. Westinghouse letter NS-TMA-1837, T. M. Anderson to S. Varga, NRC, dated 6/23/78.
5. Westinghouse letter NS-EPR-2577, E. P. Rahe Jr. to C. H. Berlinger, NRC, dated 3/31/82.
6. Westinghouse Letter NS-TMA-1835, T. M. Anderson to E. Case, NRC, dated 6/22/78.
7. NRC letter, S. A. Varga to J. Dolan, Indiana and Michigan Electric Company, dated 2/12/81.
8. NUREG-0717 Supplement No. 4, Safety Evaluation Report related to the operation of Virgil C. Summer Nuclear Station Unit No. 1, Docket 50-395, August 1982.
9. Regulatory Guide 1.105 Rev. 2, "Instrument Setpoints for Safety-Related Systems", dated 2/86.
10. NUREG/CR-3659 (PNL-4973), "A Mathematical Model for Assessing the Uncertainties of Instrumentation Measurements for Power and Flow of PWR Reactors", 2/85.
11. ANSI/ANS Standard 58.4-1979, "Criteria for Technical Specifications for Nuclear Power Stations".
12. ISA Standard S67.04, 1994, "Setpoints for Nuclear Safety-Related Instrumentation Used in Nuclear Power Plants".
13. Tuley, C. R., Williams T. P., "The Significance of Verifying the SAMA PMC 20.1-1973 Defined Reference Accuracy for the Westinghouse Setpoint Methodology", Instrumentation, Controls, and Automation in the Power Industry, June 1992, Vol.35, pp. 497-508.
14. Instrument Society of America Standard S51.1-1979, Reaffirmed 1993, "Process Instrumentation Terminology".

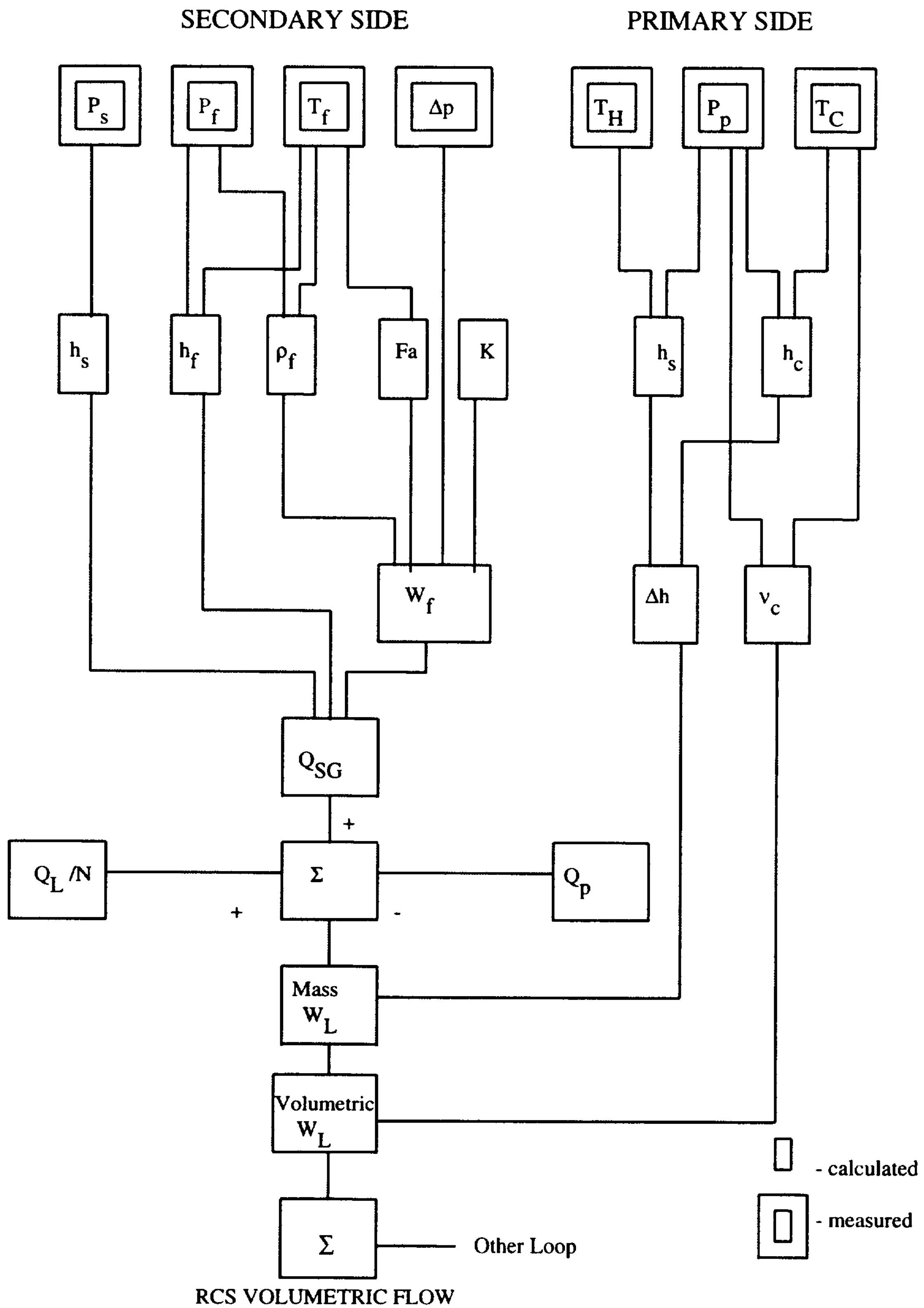

Figure 1
Calorimetric RCS Flow Measurement (Using Venturi on Feedwater Bypass Loop)

SECONDARY SIDE

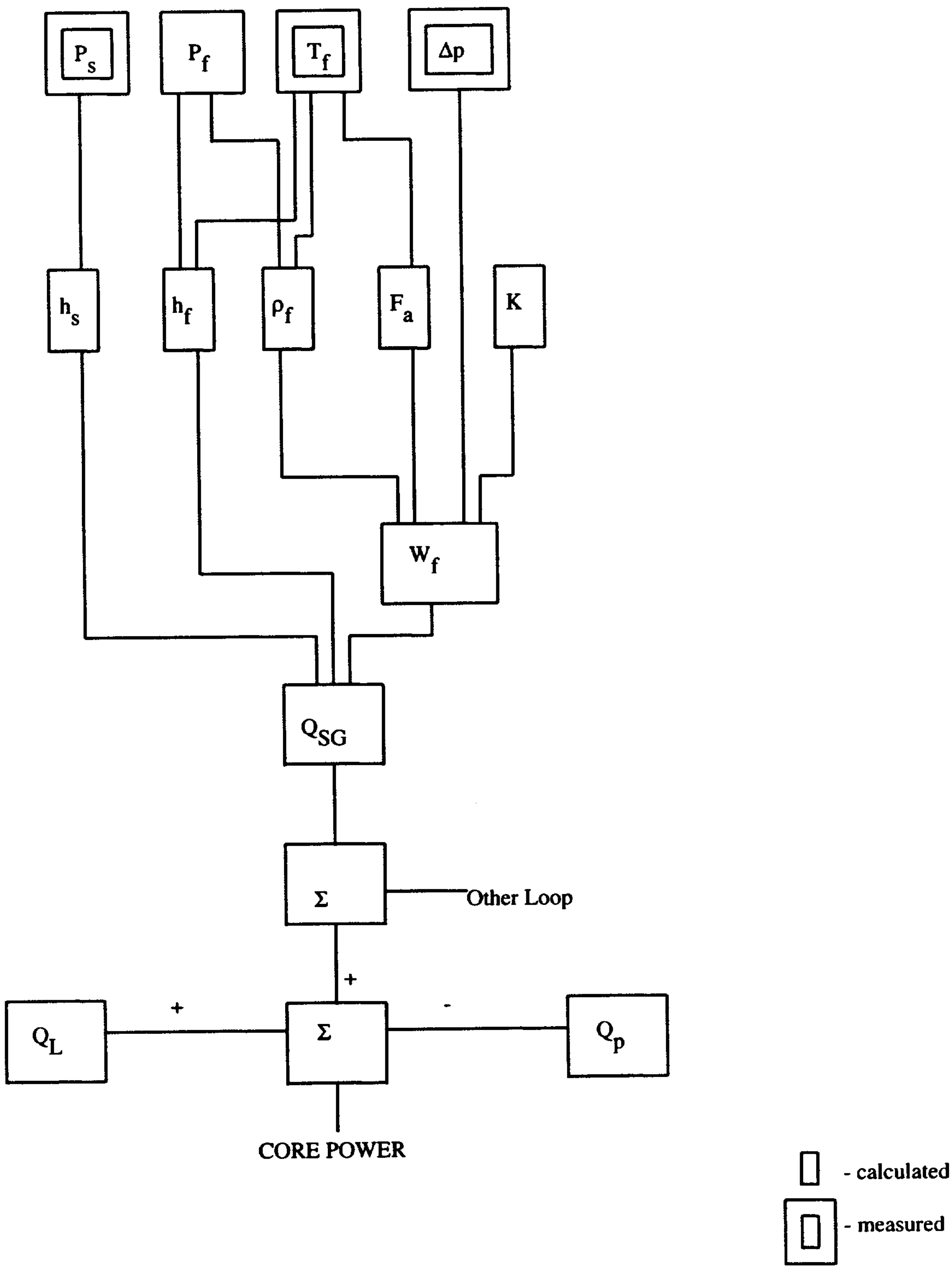

Figure 2
Calorimetric Power Measurement (Using Feedwater Venturis)

ATTACHMENT 8

Letter from M. E. Warner (NMC)

To

Document Control Desk (NRC)

Dated

July 26, 2002

License Amendment Request 187

Westinghouse Authorization Letter , CAW-02-1540 with accompanying affidavit, Proprietary Information Notice, and Copyright Notice

Westinghouse Electric Company
Nuclear Services
P.O. Box 355
Pittsburgh, Pennsylvania 15230-0355
USA

Document Control Desk
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Direct tel: (412) 374-5282
Direct fax: (412) 374-4011
e-mail: Sepp1ha@westinghouse.com

Attention: Mr. Samuel J. Collins

Our ref: CAW-02-1540

July 22, 2002

APPLICATION FOR WITHHOLDING PROPRIETARY INFORMATION FROM PUBLIC DISCLOSURE

Subject: WCAP-15591, "Westinghouse Revised Thermal Design Procedure Instrument Uncertainty Methodology – Kewaunee Nuclear Plant (Power Uprate to 1757 MWt-NSSS Power with Feedwater Venturis and 54F Replacement Steam Generators)", July 2002 (Proprietary)

Dear Mr. Collins:

The proprietary information for which withholding is being requested in the above-referenced report is further identified in Affidavit CAW-02-1540 signed by the owner of the proprietary information, Westinghouse Electric Company LLC. The affidavit, which accompanies this letter, sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10 CFR Section 2.790 of the Commission's regulations.

Accordingly, this letter authorizes the utilization of the accompanying Affidavit by the Nuclear Management Company LLC (NMC).

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-02-1540 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Enclosures

Cc: G. Shukla/NRR

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

ss

COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared H. A. Sepp, who, being by me duly sworn according to law, deposes and says that he is authorized to execute this Affidavit on behalf of Westinghouse Electric Company LLC ("Westinghouse"), and that the averments of fact set forth in this Affidavit are true and correct to the best of his knowledge, information, and belief:

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 22ND day
of July, 2002

Notary Public

LORRAINE M. PIPLICA
COMMONWEALTH OF PENNSYLVANIA
NOTARY PUBLIC

Notarial Seal
Lorraine M. Piplica, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Dec. 14, 2003
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory and Licensing Engineering, in Nuclear Services, Westinghouse Electric Company LLC ("Westinghouse"), and as such, I have been specifically delegated the function of reviewing the proprietary information sought to be withheld from public disclosure in connection with nuclear power plant licensing and rule making proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse Electric Company LLC.

(2) I am making this Affidavit in conformance with the provisions of 10CFR Section 2.790 of the Commission's regulations and in conjunction with the Westinghouse application for withholding accompanying this Affidavit.

(3) I have personal knowledge of the criteria and procedures utilized by the Westinghouse Electric Company LLC in designating information as a trade secret, privileged or as confidential commercial or financial information.

(4) Pursuant to the provisions of paragraph (b)(4) of Section 2.790 of the Commission's regulations, the following is furnished for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld.

(i) The information sought to be withheld from public disclosure is owned and has been held in confidence by Westinghouse.

(ii) The information is of a type customarily held in confidence by Westinghouse and not customarily disclosed to the public. Westinghouse has a rational basis for determining the types of information customarily held in confidence by it and, in that connection, utilizes a system to determine when and whether to hold certain types of information in confidence. The application of that system and the substance of that system constitutes Westinghouse policy and provides the rational basis required.

Under that system, information is held in confidence if it falls in one or more of several types, the release of which might result in the loss of an existing or potential competitive advantage, as follows:

(a) The information reveals the distinguishing aspects of a process (or component, structure, tool, method, etc.) where prevention of its use by any of Westinghouse's competitors without license from Westinghouse constitutes a competitive economic advantage over other companies.

(b) It consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), the application of which data secures a competitive economic advantage, e.g., by optimization or improved marketability.

(c) Its use by a competitor would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing a similar product.

(d) It reveals cost or price information, production capacities, budget levels, or commercial strategies of Westinghouse, its customers or suppliers.

(e) It reveals aspects of past, present, or future Westinghouse or customer funded development plans and programs of potential commercial value to Westinghouse.

(f) It contains patentable ideas, for which patent protection may be desirable.

There are sound policy reasons behind the Westinghouse system which include the following:

(a) The use of such information by Westinghouse gives Westinghouse a competitive advantage over its competitors. It is, therefore, withheld from disclosure to protect the Westinghouse competitive position.

(b) It is information which is marketable in many ways. The extent to which such information is available to competitors diminishes the Westinghouse ability to sell products and services involving the use of the information.

(c) Use by our competitor would put Westinghouse at a competitive disadvantage by reducing his expenditure of resources at our expense.

(d) Each component of proprietary information pertinent to a particular competitive advantage is potentially as valuable as the total competitive advantage. If competitors acquire components of proprietary information, any one component may be the key to the entire puzzle, thereby depriving Westinghouse of a competitive advantage.

(e) Unrestricted disclosure would jeopardize the position of prominence of Westinghouse in the world market, and thereby give a market advantage to the competition of those countries.

(f) The Westinghouse capacity to invest corporate assets in research and development depends upon the success in obtaining and maintaining a competitive advantage.

(iii) The information is being transmitted to the Commission in confidence and, under the provisions of 10CFR Section 2.790, it is to be received in confidence by the Commission.

(iv) The information sought to be protected is not available in public sources or available information has not been previously employed in the same original manner or method to the best of our knowledge and belief.

(v) The proprietary information sought to be withheld in this submittal is that which is appropriately marked in the letter dated July 22, 2002, "WCAP-15591, "Westinghouse Revised Thermal Design Procedure Instrument Uncertainty Methodology – Kewaunee Nuclear Plant (Power Uprate to 1757 MWt-NSSS Power with Feedwater Venturis and 54F Replacement Steam Generators)", July 2002 (Proprietary), being transmitted by the Nuclear Management Company LLC (NMC) letter and Application for Withholding Proprietary Information from Public Disclosure, to the Document Control Desk, Attention Mr. Samuel J. Collins. The proprietary information as submitted for use by Westinghouse Electric Company LLC for Kewaunee Nuclear Plant is expected to be applicable for other licensees in confirming post-LOCA long term core cooling capabilities.

This information is part of that which will enable Westinghouse to:

(a) Provide documentation of the analysis and methods for determining operating parameter uncertainties.

(b) Calculate information which is used in thermal analysis of the nuclear fuel.

(c) Assist the customer in obtaining NRC approval.

Further this information has substantial commercial value as follows:

(a) Westinghouse plans to sell the use of similar information to its customers for purposes of meeting NRC requirements for licensing documentation.

(b) Westinghouse can sell support and defense of the technology to its customers in the licensing process.

Public disclosure of this proprietary information is likely to cause substantial harm to the competitive position of Westinghouse because it would enhance the ability of competitors to provide similar calculations and licensing defense services for commercial power reactors without commensurate expenses. Also, public disclosure of the information would enable others to use the information to meet NRC requirements for licensing documentation without purchasing the right to use the information.

The development of the technology described in part by the information is the result of applying the results of many years of experience in an intensive Westinghouse effort and the expenditure of a considerable sum of money.

In order for competitors of Westinghouse to duplicate this information, similar technical programs would have to be performed and a significant manpower effort, having the requisite talent and experience, would have to be expended.

Further the deponent sayeth not.

PROPRIETARY INFORMATION NOTICE

Transmitted herewith are proprietary and/or non-proprietary versions of documents furnished to the NRC in connection with requests for generic and/or plant-specific review and approval.

In order to conform to the requirements of 10 CFR 2.790 of the Commission's regulations concerning the protection of proprietary information so submitted to the NRC, the information which is proprietary in the proprietary versions is contained within brackets, and where the proprietary information has been deleted in the non-proprietary versions, only the brackets remain (the information that was contained within the brackets in the proprietary versions having been deleted). The justification for claiming the information so designated as proprietary is indicated in both versions by means of lower case letters (a) through (f) contained within parentheses located as a superscript immediately following the brackets enclosing each item of information being identified as proprietary or in the margin opposite such information. These lower case letters refer to the types of information Westinghouse customarily holds in confidence identified in Sections (4)(ii)(a) through (4)(ii)(f) of the affidavit accompanying this transmittal pursuant to 10 CFR 2.790(b)(1).

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ATTACHMENT 9

Letter from M. E. Warner (NMC)

To

Document Control Desk (NRC)

Dated

July 26, 2002

License Amendment Request 187

Revised Core Operating Limit Report Pages

TRM 2.1

Kewaunee Nuclear Power Plant

CORE OPERATING LIMITS REPORT (COLR)

CYCLE ~~25~~26

REVISION 1~~0~~

1.0 CORE OPERATING LIMITS REPORT

This Core Operating Limits Report (COLR) for Kewaunee Nuclear Power Plant (KNPP) has been prepared in accordance with the requirements of Technical Specification (TS) 6.9.4.

A cross-reference between the COLR sections and the KNPP Technical Specifications affected by this report is given below:

COLR Section	KNPP TS	Description
2.1	2.1	Reactor Core Safety Limits
2.2	3.10.a	Shutdown Margin
2.3	3.1.f.3 3.1.f.4	Moderator Temperature Coefficient
2.4	3.10.d.1	Shutdown Bank Insertion Limit
2.5	3.10.d.2	Control Bank Insertion Limits
2.6	3.10.b.1.A 3.10.b.4 3.10.b.5.C.i	Heat Flux Hot Channel Factor ($F_Q(Z)$)
2.7	3.10.b.1.B	Nuclear Enthalpy Rise Hot Channel Factor ($F^N H$)
2.8	3.10.b.9 3.10.b.11.A	Axial Flux Difference (AFD)
2.9	2.3.a.3.A	Overtemperature ΔT Setpoint
2.10	2.3.a.3.B	Overpower ΔT Setpoint
2.11	3.10.k 3.10.l 3.10.m.1	RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits
2.12	3.8.a.5	Refueling Boron Concentration
Figure 1		Reactor Core Safety Limits
Figure 2		Required Shutdown Margin
Figure 3		K(Z) Normalized Operating Envelope
Figure 4		Control Bank Insertion Limits
Figure 5a		V(Z) as a Function of Core HeightRAOC Summary of W(Z) at 150 MWD/MTU
Figure 5b		RAOC Summary of W(Z) at 6000 MWD/MTU
Figure 5c		RAOC Summary of W(Z) at 9000 MWD/MTU
Figure 5d		RAOC Summary of W(Z) at 16000 MWD/MTU
Figure 6		Axial Flux Difference (Typical)

2.0 Operating Limits

The cycle-specific parameter limits for the specifications listed in Section 1.0 are presented in the following subsections. These limits have been developed using the NRC approved methodologies specified in Technical Specification 6.9.a.4

2.1 Reactor Core Safety Limits

The combination of rated power level, coolant pressure, and coolant temperature shall not exceed the limits shown in COLR Figure 1. The safety limit is exceeded if the point defined by the combination of Reactor Coolant System average temperature and power level is at any time above the appropriate pressure line

2.2 Shutdown Margin

2.2.1 When the reactor is subcritical prior to reactor startup, the SHUTDOWN margin shall be at least that shown in COLR Figure 2.

2.3 Moderator Temperature Coefficient

2.3.1 When the reactor is critical and ≤ 60% RATED POWER, the moderator temperature coefficient shall be ≤ 5.0 pcm/°F, except during LOW POWER PHYSICS TESTING. When the reactor is > 60% RATED POWER, the moderator temperature coefficient shall be zero or negative.

2.3.2 The reactor will have a moderator temperature coefficient no less negative than -8 pcm/°F for 95% of the cycle time at full power.

2.4 Shutdown Bank Insertion Limit

2.4.1 The shutdown rods shall be fully withdrawn when the reactor is critical or approaching criticality

2.5 Control Bank Insertion Limit

2.5.1 The control banks shall be limited in physical insertion; insertion limits are shown in COLR Figure 4

2.6 Nuclear Heat Flux Hot Channel Factor ($F_Q^N(Z)$)

2.6.1 $F_Q^N(Z)$ Limits for FRA-ANP Fuel

$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.35)/P \times K(Z)$ for $P > 0.5$	[FRA-ANP Hvy]
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (4.70) \times K(Z)$ for $P \leq 0.5$	[FRA-ANP Hvy]
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.28)/P \times K(Z)$ for $P > 0.5$	[FRA-ANP Std]
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (4.56) \times K(Z)$ for $P \leq 0.5$	[FRA-ANP Std]
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (2.50)/P \times K(Z)$ for $P > 0.5$	[422 V+]
$F_Q^N(Z) \times 1.03 \times 1.05 \leq (5.00) \times K(Z)$ for $P \leq 0.5$	[422 V+]

where:

- P is the fraction of full power at which the core is OPERATING
- K(Z) is the function given in Figure 3
- Z is the core height location for the F_Q of interest

2.6.2 The measured $F_Q^{EQ}(Z)$ hot channel factors under equilibrium conditions shall satisfy the following relationship for the central axial 80% of the core for FRA-ANP fuel:

$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times VW(Z) \leq (2.35)/P \times K(Z)$	[FRA-ANP Hvy]
$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times VW(Z) \leq (2.28)/P \times K(Z)$	[FRA-ANP Std]
$F_Q^{EQ}(Z) \times 1.03 \times 1.05 \times W(Z) \leq (2.5)/P \times K(Z)$	[422 V +]

where:

- P is the fraction of full power at which the core is OPERATING
- VW(Z) is defined in COLR Figure 5
- $F_Q^{EQ}(Z)$ is a measured F_Q distribution obtained during the target flux determination

2.6.3 The penalty factor for TS 3.10.b.5.C.i shall be 2%.

2.7 Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}^{N}$)

2.7.1 $F_{\Delta H}^{N}$ Limits for FRA-ANP Fuel

$F_{\Delta H}^{N} \times 1.04 \leq 1.70\ [1 + 0.23(1-P)]$	422 V + and [422 V+ and FRA-ANP Hvy]
$F_{\Delta H}^{N} \times 1.04 \leq 1.55\ [1 + 0.23(1-P)]$	[FRA-ANP Std]

where:

P is the fraction of full power at which the core is OPERATING

2.8 Axial Flux Difference (AFD)

2.8.1 The indicated axial flux target band shall be the area maintained within ± 5% about the target flux difference.

2.8.2 The envelope is an area whose outer limits are described by -10% and +10% from the target axial flux difference at 90% rated power and increasing by -1% and +1% from the target axial flux difference for each 2.7% decrease in rated power < 90% and > 50%.The Aaxial Flux Difference (AFD) acceptable operation limits are provided in Figure 6.

2.9 Overtemperature ΔT Setpoint

Overtemperature ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED POWER, % RATED POWER
T	=	reference Average temperature at RATED POWER, °F
T'	≤=	567.3573.0 °F
P	=	Pressurizer Pressure, psig
P'	=	2235 psig
K_1	=	1.111.20
K_2	=	0.00900.015/°F
K_3	=	0.0005660.00072/psig
τ_1	=	30 seconds
τ_2	=	4 seconds
f(ΔI)	=	An even function of the indicated difference between top and bottom detectors of the power range nuclear ion chambers. Selected gains are based on measured instrument response during plant startup tests, where q_t and q_b are the percent power in the top and bottom halves of the core respectively, and $q_t + q_b$ is total core power in percent of RATED POWER, such that

(a) For $q_t - q_b$ within -1222, +9 12 %, f(ΔI) = 0

(b) For each percent that the magnitude of $q_t - q_b$ exceeds +9 12 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 2.50.96 % of RATED POWER.

(c) For each percent that the magnitude of $q_t - q_b$ exceed -12 22 % the ΔT trip setpoint shall be automatically reduced by an equivalent of 1.50.86 % of RATED POWER.

2.10 Overpower ΔT Setpoint

Overpower ΔT setpoint parameter values:

ΔT_0	=	Indicated ΔT at RATED POWER, % RATED POWER
T	=	reference Average temperature at RATED POWER, °F
T'	≤=	567.3573.0 °F
K_4	=	1.101.095
K_5	=	0.02750.0275/°F for increasing T; 0 for decreasing T
K_6	=	0.0020.00103/°F for T > T' ; 0 for T < T'
τ_3	=	10 seconds
f(ΔI)	=	Same as in 2.90 for all ΔI

2.11 RCS Pressure, Temperature, and Flow Departure from Nucleate Boiling (DNB) Limits

2.11.1 During steady state power operation, Tavg shall be < 576.7°F for control board indication or < 576.5°F for computer indication > 2217 psig for control board indication > 2219 psig for computer indication< 568.8°F.

2.11.2 During steady state power operation, Pressurizer Pressure shall be > 2217 psig for control board indication or > 2219 psig for computer indication < 576.7°F for control board indication < 576.5°F for computer indication

≥ 2205 psig

2.11.3 During steady state power operation, reactor coolant total flow rate shall be ≥ 93,000186,000 gpm per loop.

2.12 Refueling Boron Concentration

2.12.1 When there is fuel in the reactor, a minimum boron concentration of 2200 2250 ppm shall be maintained in the Reactor Coolant System during reactor vessel head removal or while loading and unloading fuel from the reactor.

Figure 1

Reactor Core Safety Limits Curve

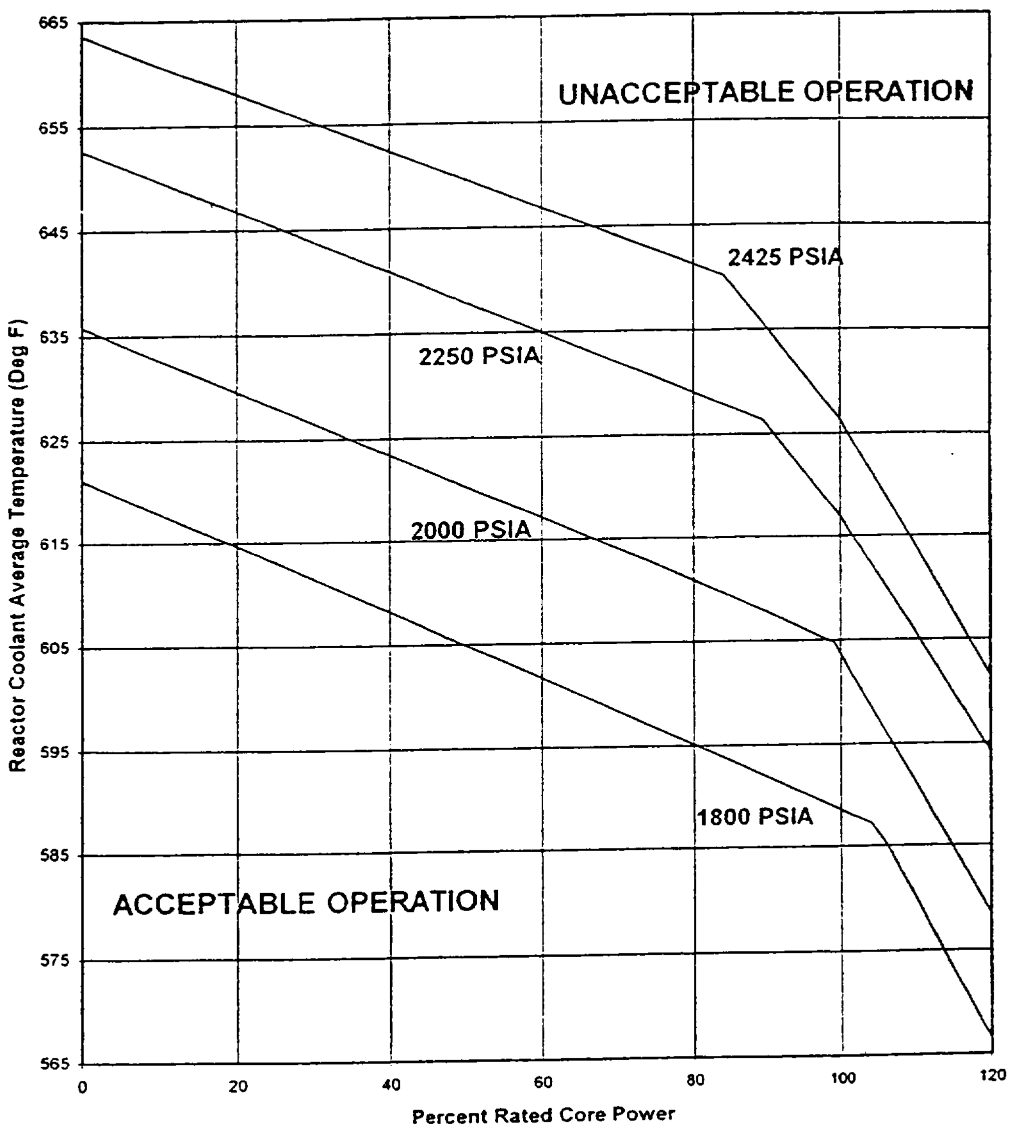


Figure 2

Required Shutdown Reactivity vs Boron Concentration

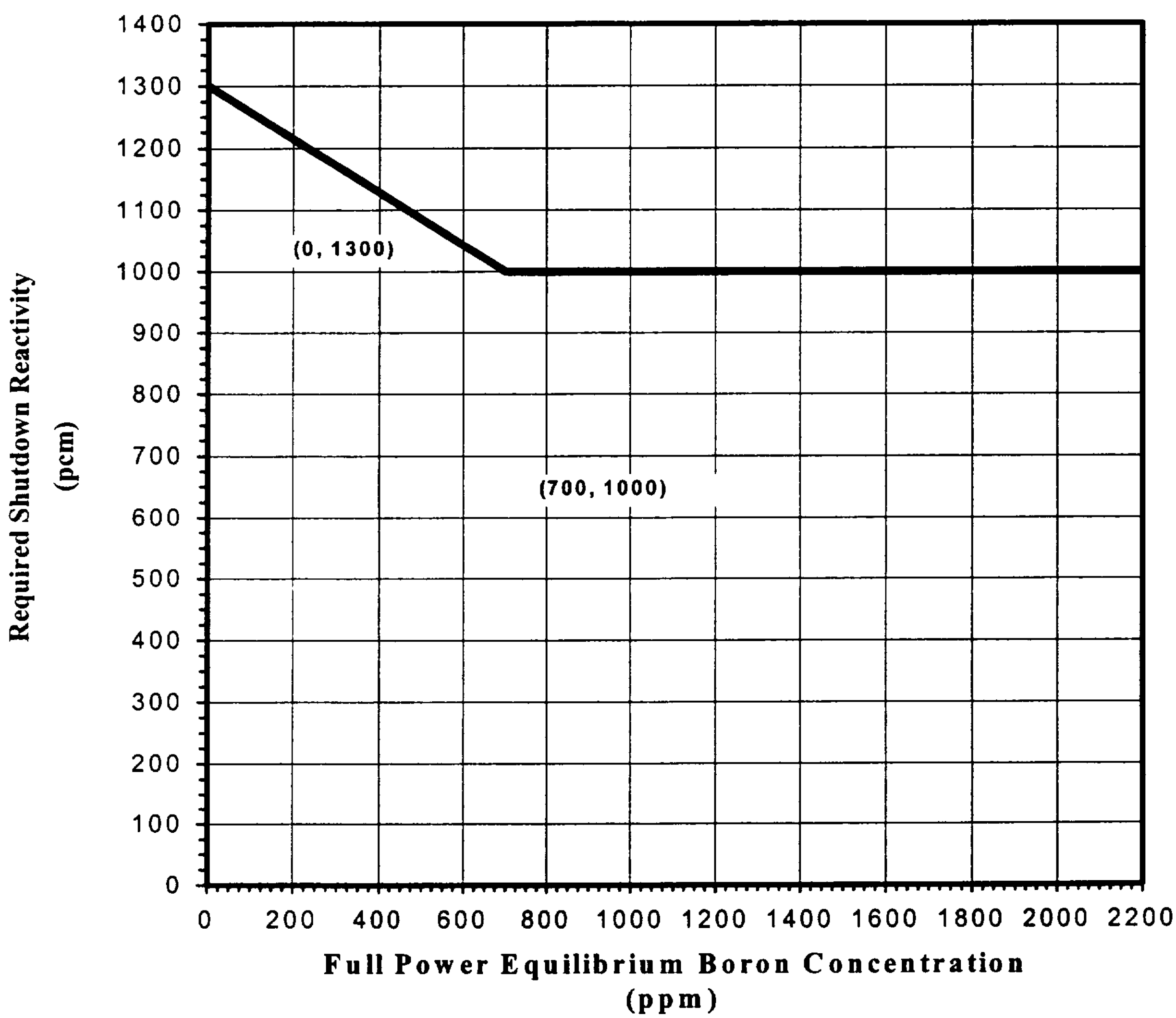


Figure 3

Hot Channel Factor Normalized Operating Envelope

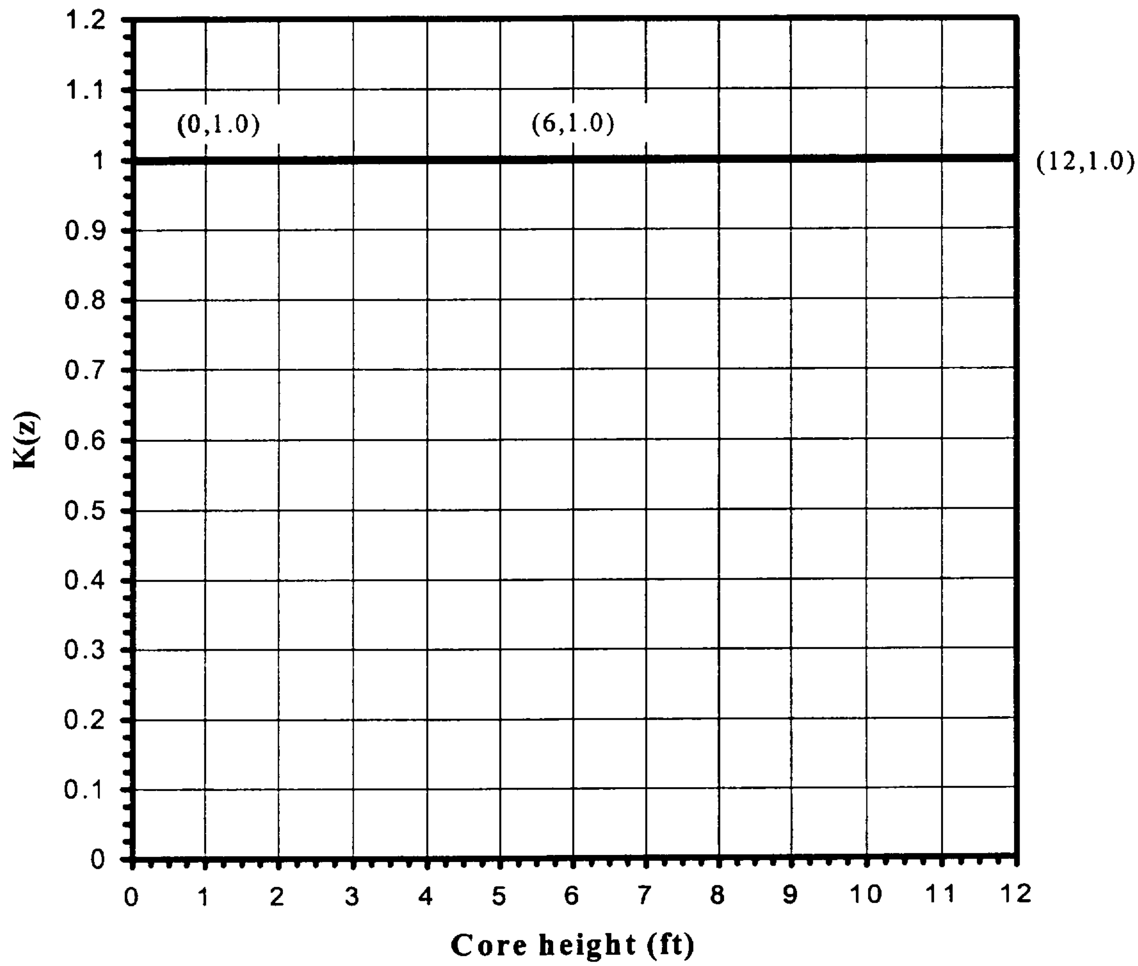


Figure 4

Control Bank Insertion Limits

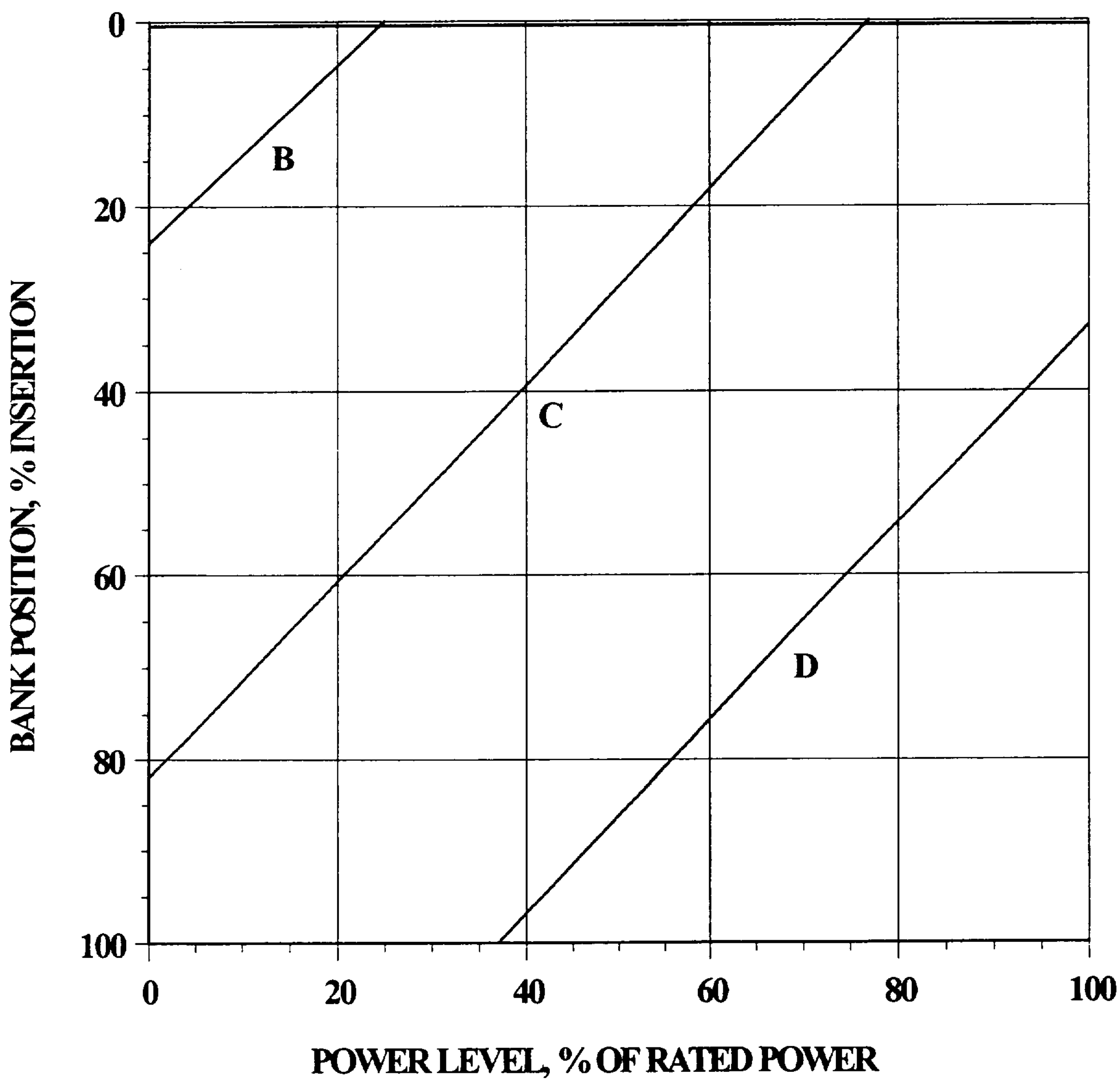
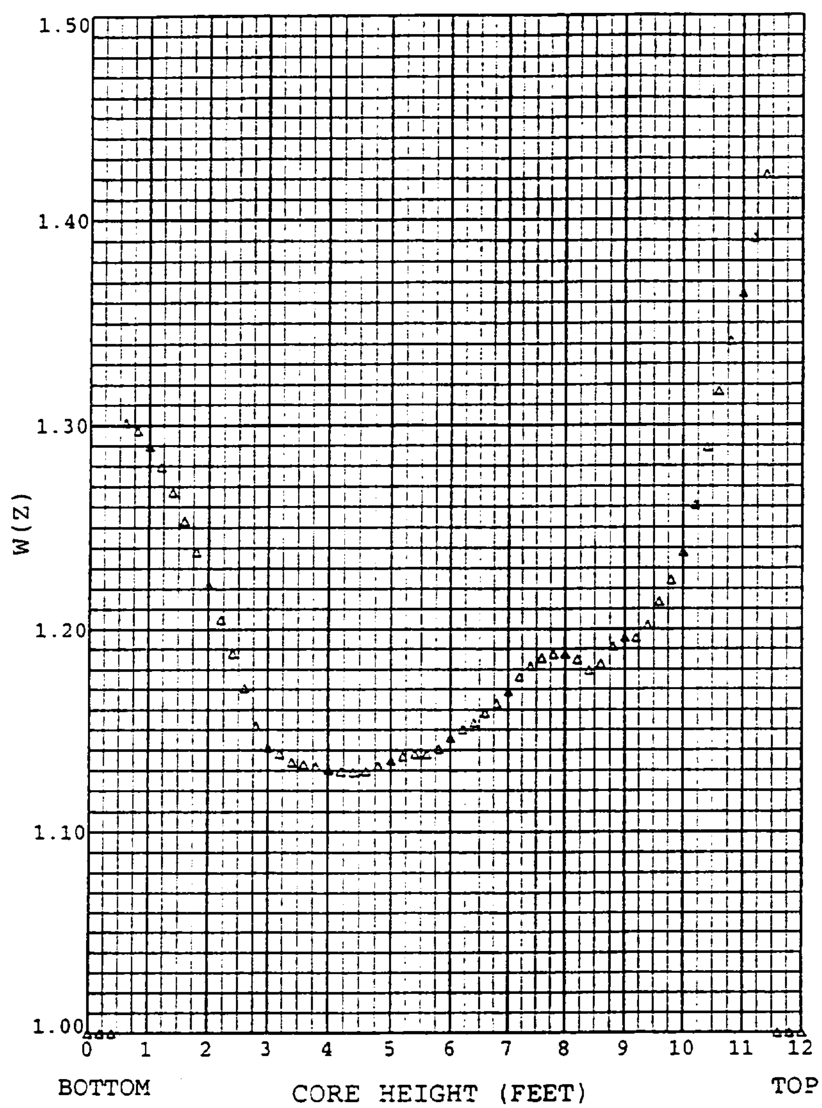


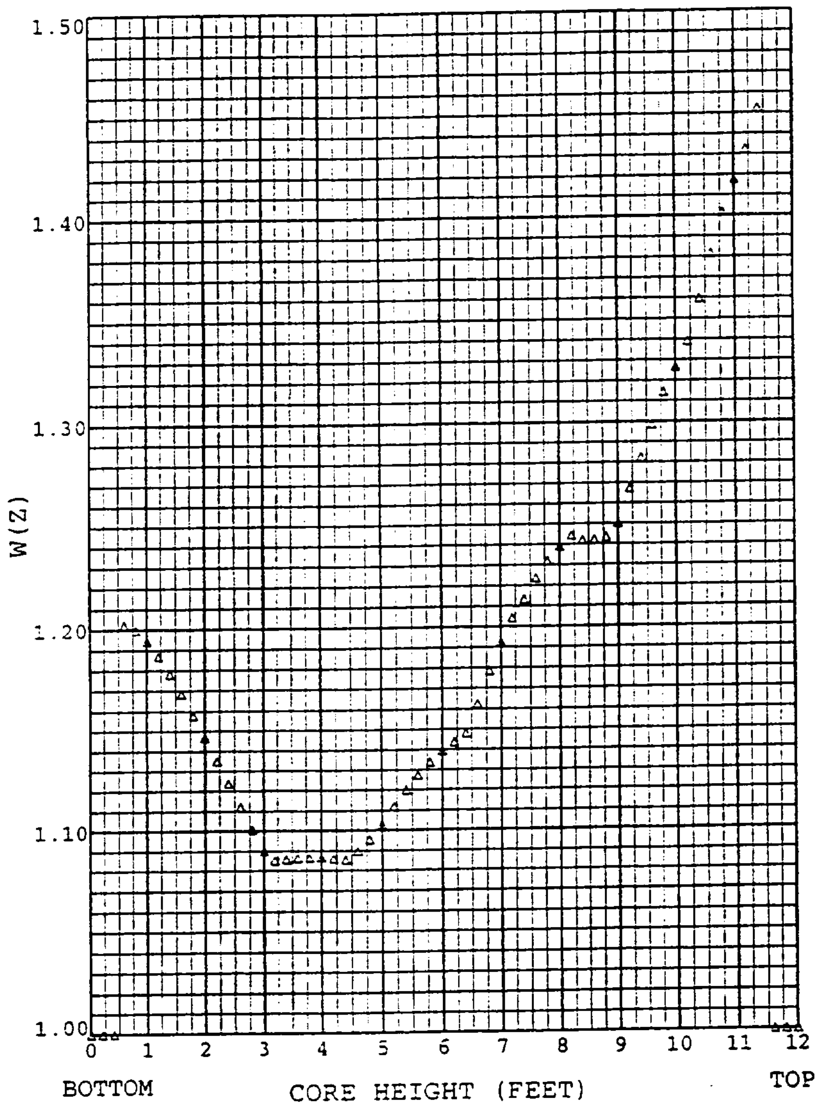
Figure 5a



Height (feet)	Max. W(Z)
0.0000	1.0000
0.2000	1.0000
0.4000	1.0000
0.6000	1.3014
0.8000	1.2974
1.0000	1.2897
1.2000	1.2794
1.4000	1.2671
1.6000	1.2532
1.8000	1.2380
2.0000	1.2219
2.2000	1.2050
2.4000	1.1878
2.6000	1.1707
2.8000	1.1519
3.0000	1.1413
3.2000	1.1382
3.4000	1.1341
3.6000	1.1331
3.8000	1.1320
4.0000	1.1304
4.2000	1.1295
4.4000	1.1292
4.6000	1.1298
4.8000	1.1322
5.0000	1.1350
5.2000	1.1369
5.4000	1.1380
5.6000	1.1380
5.8000	1.1406
6.0000	1.1460
6.2000	1.1501
6.4000	1.1534
6.6000	1.1583
6.8000	1.1631
7.0000	1.1689
7.2000	1.1763
7.4000	1.1818
7.6000	1.1856
7.8000	1.1874
8.0000	1.1875
8.2000	1.1849
8.4000	1.1796
8.6000	1.1828
8.8000	1.1913
9.0000	1.1958
9.2000	1.1956
9.4000	1.2021
9.6000	1.2135
9.8000	1.2243
10.0000	1.2378
10.2000	1.2607
10.4000	1.2891
10.6000	1.3168
10.8000	1.3414
11.0000	1.3646
11.2000	1.3912
11.4000	1.4219
11.6000	1.0000
11.8000	1.0000
12.0000	1.0000

Figure 5a
RAOC Summary of W(Z) at 150 MWD/MTU With HFP AFD Band of -12/+8 %
(Top 5% and Bottom 5% Excluded)

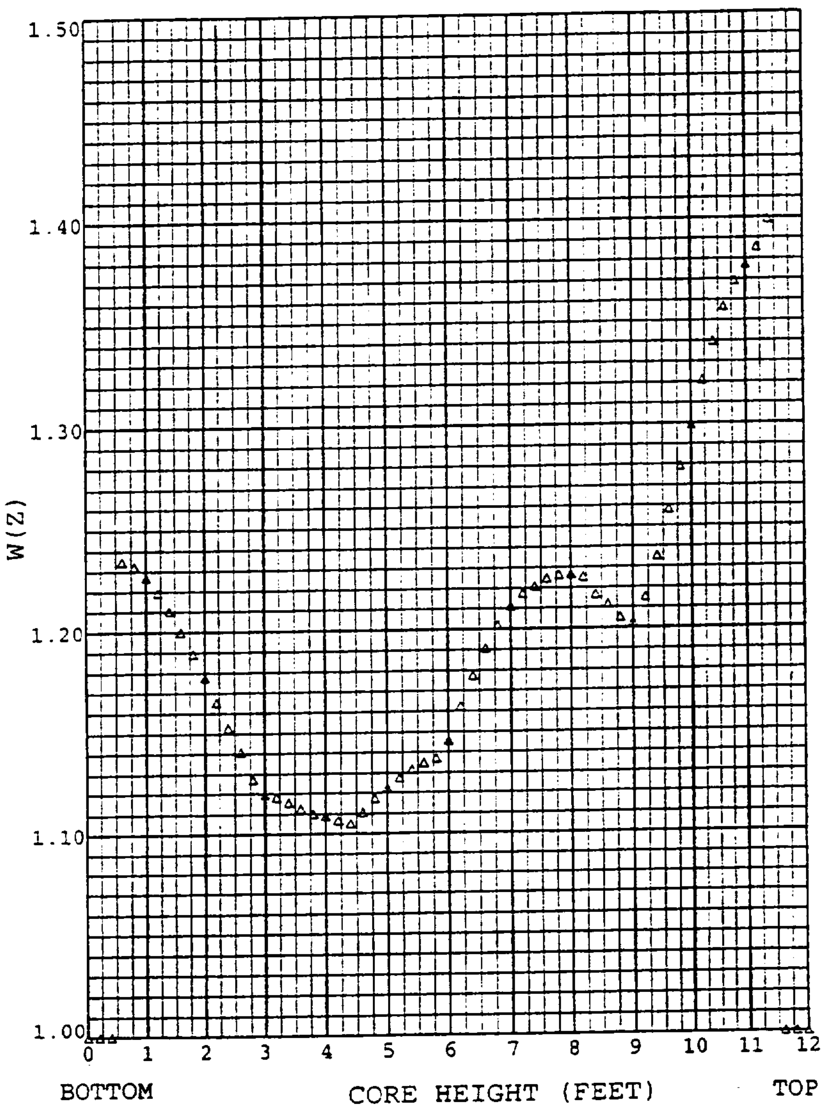
Figure 5b



Height (feet)	Max. W(Z)
0.0000	1.0000
0.2000	1.0000
0.4000	1.0000
0.6000	1.2024
0.8000	1.1997
1.0000	1.1944
1.2000	1.1870
1.4000	1.1782
1.6000	1.1684
1.8000	1.1578
2.0000	1.1466
2.2000	1.1351
2.4000	1.1236
2.6000	1.1120
2.8000	1.1006
3.0000	1.0900
3.2000	1.0851
3.4000	1.0856
3.6000	1.0862
3.8000	1.0863
4.0000	1.0865
4.2000	1.0858
4.4000	1.0853
4.6000	1.0897
4.8000	1.0956
5.0000	1.1030
5.2000	1.1120
5.4000	1.1200
5.6000	1.1273
5.8000	1.1338
6.0000	1.1394
6.2000	1.1435
6.4000	1.1479
6.6000	1.1623
6.8000	1.1787
7.0000	1.1925
7.2000	1.2042
7.4000	1.2132
7.6000	1.2236
7.8000	1.2319
8.0000	1.2390
8.2000	1.2444
8.4000	1.2419
8.6000	1.2422
8.8000	1.2434
9.0000	1.2503
9.2000	1.2672
9.4000	1.2823
9.6000	1.2986
9.8000	1.3143
10.0000	1.3268
10.2000	1.3391
10.4000	1.3596
10.6000	1.3816
10.8000	1.4015
11.0000	1.4179
11.2000	1.4325
11.4000	1.4523
11.6000	1.0000
11.8000	1.0000
12.0000	1.0000

Figure 5b
RAOC Summary of W(Z) at 6000 MWD/MTU With HFP AFD Band of -12/+8 %
(Top 5% and Bottom 5% Excluded)

Figure 5c

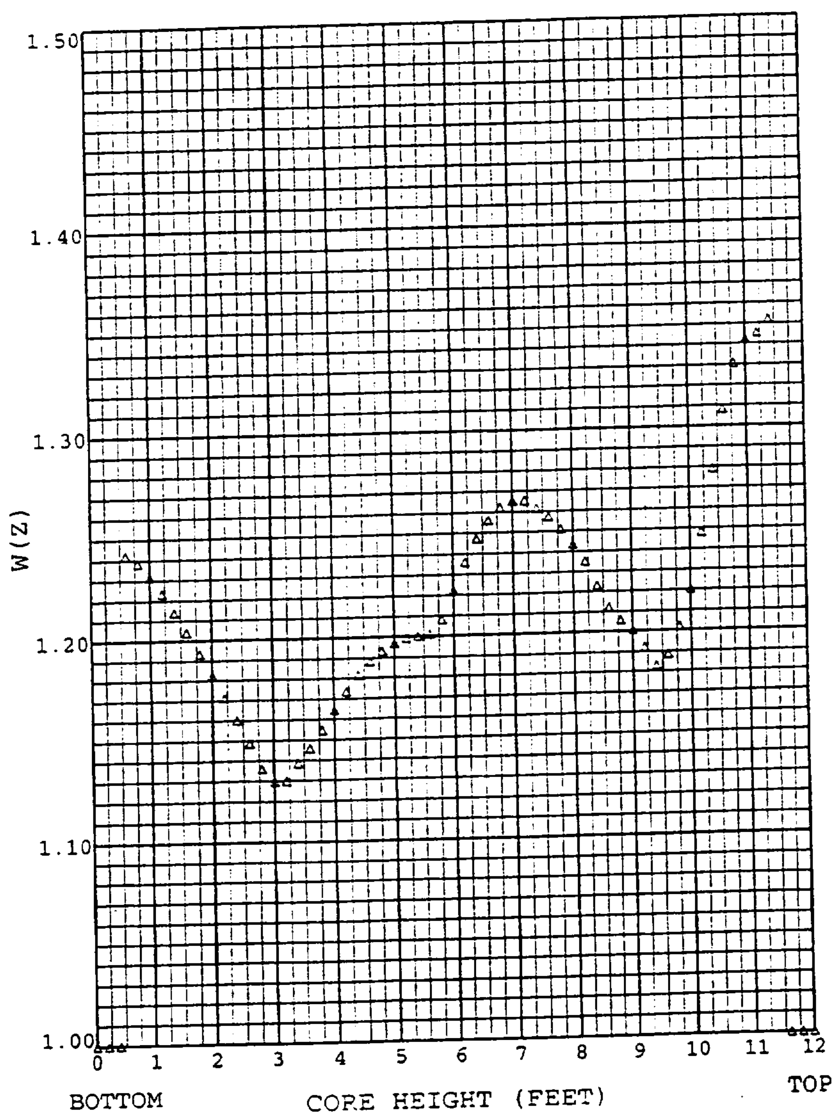


Height (feet)	Max. W(Z)
0.0000	1.0000
0.2000	1.0000
0.4000	1.0000
0.6000	1.2348
0.8000	1.2324
1.0000	1.2269
1.2000	1.2193
1.4000	1.2103
1.6000	1.2001
1.8000	1.1891
2.0000	1.1775
2.2000	1.1653
2.4000	1.1530
2.6000	1.1408
2.8000	1.1272
3.0000	1.1197
3.2000	1.1182
3.4000	1.1156
3.6000	1.1125
3.8000	1.1101
4.0000	1.1088
4.2000	1.1068
4.4000	1.1051
4.6000	1.1107
4.8000	1.1174
5.0000	1.1226
5.2000	1.1275
5.4000	1.1315
5.6000	1.1347
5.8000	1.1369
6.0000	1.1457
6.2000	1.1624
6.4000	1.1774
6.6000	1.1907
6.8000	1.2020
7.0000	1.2111
7.2000	1.2174
7.4000	1.2209
7.6000	1.2248
7.8000	1.2264
8.0000	1.2267
8.2000	1.2253
8.4000	1.2167
8.6000	1.2117
8.8000	1.2052
9.0000	1.2027
9.2000	1.2151
9.4000	1.2353
9.6000	1.2582
9.8000	1.2792
10.0000	1.2993
10.2000	1.3210
10.4000	1.3400
10.6000	1.3568
10.8000	1.3693
11.0000	1.3773
11.2000	1.3857
11.4000	1.3992
11.6000	1.0000
11.8000	1.0000
12.0000	1.0000

Figure 5c

RAOC Summary of W(Z) at 9000 MWD/MTU With HFP AFD Band of -12/+8 %
(Top 5% and Bottom 5% Excluded)

Figure 5d



Height (feet)	Max. W(Z)
0.0000	1.0000
0.2000	1.0000
0.4000	1.0000
0.6000	1.2420
0.8000	1.2383
1.0000	1.2317
1.2000	1.2234
1.4000	1.2140
1.6000	1.2039
1.8000	1.1934
2.0000	1.1826
2.2000	1.1714
2.4000	1.1601
2.6000	1.1487
2.8000	1.1358
3.0000	1.1298
3.2000	1.1299
3.4000	1.1384
3.6000	1.1458
3.8000	1.1546
4.0000	1.1645
4.2000	1.1736
4.4000	1.1815
4.6000	1.1881
4.8000	1.1933
5.0000	1.1971
5.2000	1.1994
5.4000	1.2002
5.6000	1.2010
5.8000	1.2081
6.0000	1.2224
6.2000	1.2360
6.4000	1.2473
6.6000	1.2562
6.8000	1.2624
7.0000	1.2656
7.2000	1.2655
7.4000	1.2617
7.6000	1.2574
7.8000	1.2511
8.0000	1.2435
8.2000	1.2349
8.4000	1.2231
8.6000	1.2124
8.8000	1.2058
9.0000	1.2008
9.2000	1.1924
9.4000	1.1830
9.6000	1.1885
9.8000	1.2022
10.0000	1.2204
10.2000	1.2480
10.4000	1.2791
10.6000	1.3083
10.8000	1.3308
11.0000	1.3423
11.2000	1.3453
11.4000	1.3520
11.6000	1.0000
11.8000	1.0000
12.0000	1.0000

Figure 5d

RAOC Summary of W(Z) at 16000 MWD/MTU With HFP AFD Band of -12/+8 %

(Top 5% and Bottom 5% Excluded)

Figure 6

Axial Flux Difference (Typical)