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DOMINION ENERGY KEWAUNEE, INC.
KEWAUNEE POWER STATION
CORE OPERATING LIMITS REPORT CYCLE 31 REVISION 0

Pursuant to Kewaunee Power Station (KPS) Technical Specification 5.6.3.d, enclosed is a copy of the Kewaunee Power Station Core Operating Limits Report Cycle 31, Revision 0.

If you have questions or require additional information, please feel free to contact Mr. Jack Gadzala at 920-388-8604.

Very truly yours,

Michael J. Wilson
Director Safety and Licensing
Kewaunee Power Station

Commitments made by this letter: NONE

Enclosure
1. Kewaunee Power Station Core Operating Limits Report Cycle 31, Revision 0.

A001
NRR

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CORE OPERATING LIMITS REPORT

Kewaunee Unit 1 Cycle 31

Revision 0

February 2011

1.0 INTRODUCTION

This Core Operating Limits Report (COLR) for Kewaunee Unit 1 Cycle 31 has been prepared in accordance with the requirements of Kewaunee Technical Specification 5.6.3.

A cross reference between the COLR section and the KPS Technical Specifications affected by this report is given below:

COLR Section	KPS Technical Specification	Description
2.1	2.1.1	Reactor Core Safety Limit
2.2	3.1.1	Shutdown Margin
2.3	3.1.3	Moderator Temperature Coefficient (MTC)
2.4	3.1.5	Shutdown Bank Insertion Limits
2.5	3.1.6	Control Bank Insertion Limits
2.6	3.2.1	Heat Flux Hot Channel Factor ($F_Q(Z)$)
2.7	3.2.2	Nuclear Enthalpy Rise Hot Channel Factor ($F_{\Delta H}^N$)
2.8	3.2.3	AXIAL FLUX DIFFERENCE (AFD)
2.9	3.3.1 Function 6	Reactor Protection System Instrumentation: Overtemperature ΔT
2.10	3.3.1 Function 7	Reactor Protection System Instrumentation: Overpower ΔT
2.11	3.4.1	RCS Pressure, Temperature and Flow Departure from Nucleate Boiling (DNB) Limits
2.12	3.9.1	Boron Concentration (Refueling Operations)
Figure 1	2.1	Reactor Core Safety Limits Curve (1772 MWt)
Figure 2		DELETED (Required Shutdown Margin)
Figure 3		DELETED (Hot Channel Factor Normalized Operating Envelope (K(Z)))
Figure 4	3.1.6	Control Bank Insertion Limits
Figure 5		N(Z) Values (Top and Bottom 9% excluded)
Figure 6		DELETED (Penalty Factor, Fp, for $F_Q(Z)$)
Figure 7	3.2.3	AXIAL FLUX DIFFERENCE Envelope

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 5.6.3.

2.1 Reactor Core Safety Limits (TS 2.1.1)

The combination of rated power level, coolant pressure, and coolant temperature shall not exceed the limits shown in COLR Figure 1 (1772 MWt). 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 (TS 3.1.1)

Shutdown Margin shall be $\geq$ **1554 pcm.**

2.3 Moderator Temperature Coefficient (MTC) (TS 3.1.3)

2.3.1 When the reactor is critical and $\leq$ 60% of RATED THERMAL POWER, the moderator temperature coefficient shall be $\leq$ 5.0 pcm/°F. When the reactor is > 60% RATED THERMAL POWER, the moderator temperature coefficient shall be zero or negative.

a. The BOC/ARO-MTC shall be $\leq$ 5.0 pcm/°F (upper limit), when $\leq$60% RTP, and $\leq$ 0.0 pcm/°F when > 60% RTP.

b. The EOC/ARO/RTP-MTC shall be less negative than or equal to **XX** pcm/°F (lower limit).

MTC surveillance limits are:

i) The 300 ppm/ARO/RTP-MTC should be less negative than or equal to **XX pcm/°F**. If MTC is more negative, then repeat measurement once per 14 EFPD during the remainder of the fuel cycle. Note this surveillance does not need to be repeated if criterion ii, listed below, is satisfied.

ii) The 60 ppm/ARO/RTP-MTC should be less negative than or equal to **XX pcm/°F**.

MTC EOC limits will be provided following shutdown of Cycle 30.

2.4 <u>**Shutdown Bank Insertion Limits**</u> (TS 3.1.5)

The shutdown rods shall be fully withdrawn (224 steps) when the reactor is critical or approaching criticality.

2.5 <u>**Control Bank Insertion Limits**</u> (TS 3.1.6)

The control rod banks shall be limited in physical insertion as shown in **COLR Figure 4**.

2.6 <u>**Nuclear Heat Flux Hot Channel Factor ($F_Q(Z)$)**</u> (TS 3.2.1)

2.6.1 $F_Q^C(Z)$ Limits for Fuel

$$F_Q^N(Z) * 1.03 * 1.05 \le \frac{CFQ}{P} * K(Z) \qquad for\ P > 0.5 \qquad [422V+]$$

$$F_Q^N(Z) * 1.03 * 1.05 \le \frac{CFQ}{0.5} * K(Z) \qquad for\ P \le 0.5 \qquad [422V+]$$

Where:

P	is the fraction of full power at which the core is operating
K(Z)	is 1.0 for all core heights
Z	is the core height location for the FQ of interest
CFQ	**equals 2.50**
$F_Q^N(Z)$	is a measured FQ distribution obtained during the target flux determination

2.6.2 $F_Q^T(Z)$ Limits for Fuel

$$F_Q^N(Z) * 1.03 * 1.05 * N(Z) * F_P \le \frac{CFQ}{P} * K(Z) \qquad [422V+]$$

Where:

P	is the fraction of full power at which the core is operating
K(Z)	is 1.0 for all core heights
Z	is the core height location for the FQ of interest
CFQ	**equals 2.50**
F_p	is the penalty factor described in 2.6.3
N(Z)	is a cycle-specific non-equilibrium multiplier on $F_Q^N(Z)$ to account for power distribution transients during normal operation, provided in Figure 5.
$F_Q^N(Z)$	is a measured FQ distribution obtained during the target flux determination

The N(z) decks are generated for normal operation flux maps that are typically taken at full power, ARO. Additional N(z) decks may be generated, if necessary, consistent with the methodology described in Reference 1.

2.6.3 A penalty factor of 1.00 shall be used unless the Note criteria of TS SR 3.2.1.2 is met, at which time a penalty of 1.02 shall be used.

2.7 Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$) (TS 3.2.2)

$$F^N_{\Delta H} * 1.04 \le CFDH * [1 + PFDH * (1 - P)]$$ [422 V+]

Where:

P	is the fraction of full power at which the core is operating
CFDH	equals 1.70
PFDH	equals 0.3

2.8 AXIAL FLUX DIFFERENCE (AFD) (TS 3.2.3)

The AFD acceptable operation limits are provided in **COLR Figure 7**.

2.9 Overtemperature ΔT Setpoint (TS 3.3.1 Function 6)

$$\Delta T \le \Delta T_0 * \left[K_1 - K_2 * (T - T') * \frac{1 + \tau_1 s}{1 + \tau_2 s} + K_3 * (P - P') - f_1(\Delta I) \right]$$

ΔT_0 = Indicated ΔT at RATED THERMAL POWER, %

s = Laplace transform operator, sec^{-1}.

T = Average temperature, °F

T' ≤ **573.0 °F**

P = Pressurizer Pressure, psig

P' ≥ **2235 psig**

K_1 ≤ **1.195**

K_2 ≥ **0.015/°F**

K_3 ≥ **0.00072/psig**

τ_1 ≥ **30 seconds**

τ_2 ≤ **4 seconds**

$f_1(\Delta I)$ = 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 qt and qb are the percent power in the top and bottom halves of the core respectively and qt + qb is total core power in percent RATED THERMAL POWER, such that

(a) For qt - qb within **-15**, **+6** %, f(ΔI) = 0

(b) For each percent that the magnitude of qt - qb exceeds **+6%**, the ΔT trip setpoint shall be automatically reduced by an equivalent of **1.51%** of RATED THERMAL POWER.

(c) For each percent that the magnitude of qt - qb exceeds **-15%**, the ΔT trip setpoint shall be automatically reduced by an equivalent of **3.78%** of RATED THERMAL POWER.

2.10 **Overpower ΔT Setpoint** (TS 3.3.1 Function 7)

$$\Delta T \le \Delta T_0 * \left[K_4 - K_5 * \frac{\tau_3 s}{\tau_3 s + 1} * T - K_6 * (T - T') - f_2(\Delta I) \right]$$

ΔT_0	=	Indicated ΔT at RATED THERMAL POWER, %
s	=	Laplace transform operator, sec^{-1}.
T	=	Average temperature, °F
T'	≤	**573.0 °F**
K_4	≤	**1.095**
K_5	≥	**0.0275/°F** for increasing T
	≥	**0** for decreasing T
K_6	≥	**0.00103/°F** for T > T'
	≥	**0** for T < T'
τ_3	≥	**10 seconds**
$f_2(\Delta I)$	=	0 for all ΔI

2.11 **RCS Pressure, Temperature and Flow Departure from Nucleate Boiling (DNB) Limits** (TS 3.4.1)

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.

2.11.2 During steady state power operation, pressurizer pressure shall be ≥ **2217 psig** for control board indication or ≥ **2219 psig** for computer indication.

2.11.3 During steady state power operation, reactor coolant total flow rate shall be ≥ **186,000 gpm**.

2.12 **Boron Concentration (Refueling Operations)** (TS 3.9.1)

When there is fuel in the reactor, a minimum boron concentration of **2500** ppm and a shutdown margin of ≥ **5% Δk/k** shall be maintained in the Reactor Coolant System during reactor vessel head removal or while loading and unloading fuel from the reactor.

Figure 1
(TS 2.1.1)
Reactor Core Safety Limits Curve (1772 Mwt)
(Cores Containing 422V+ fuel)

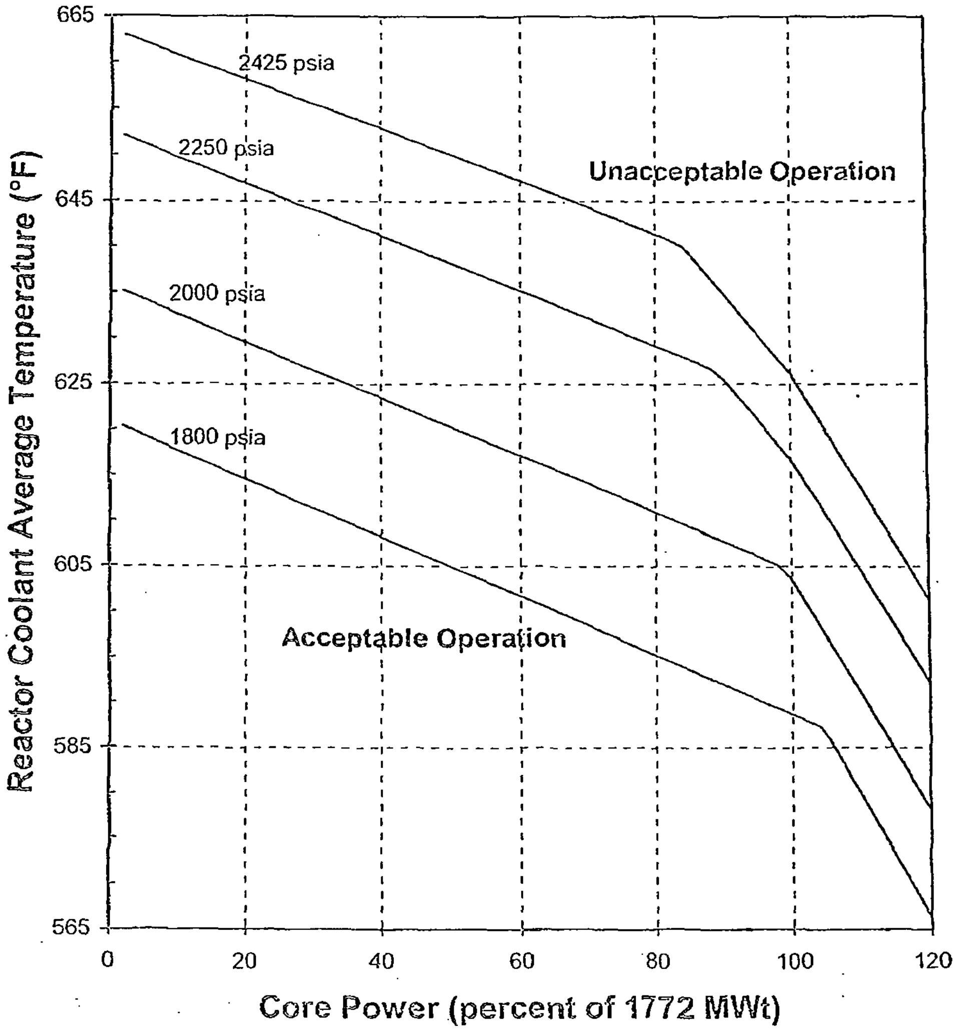


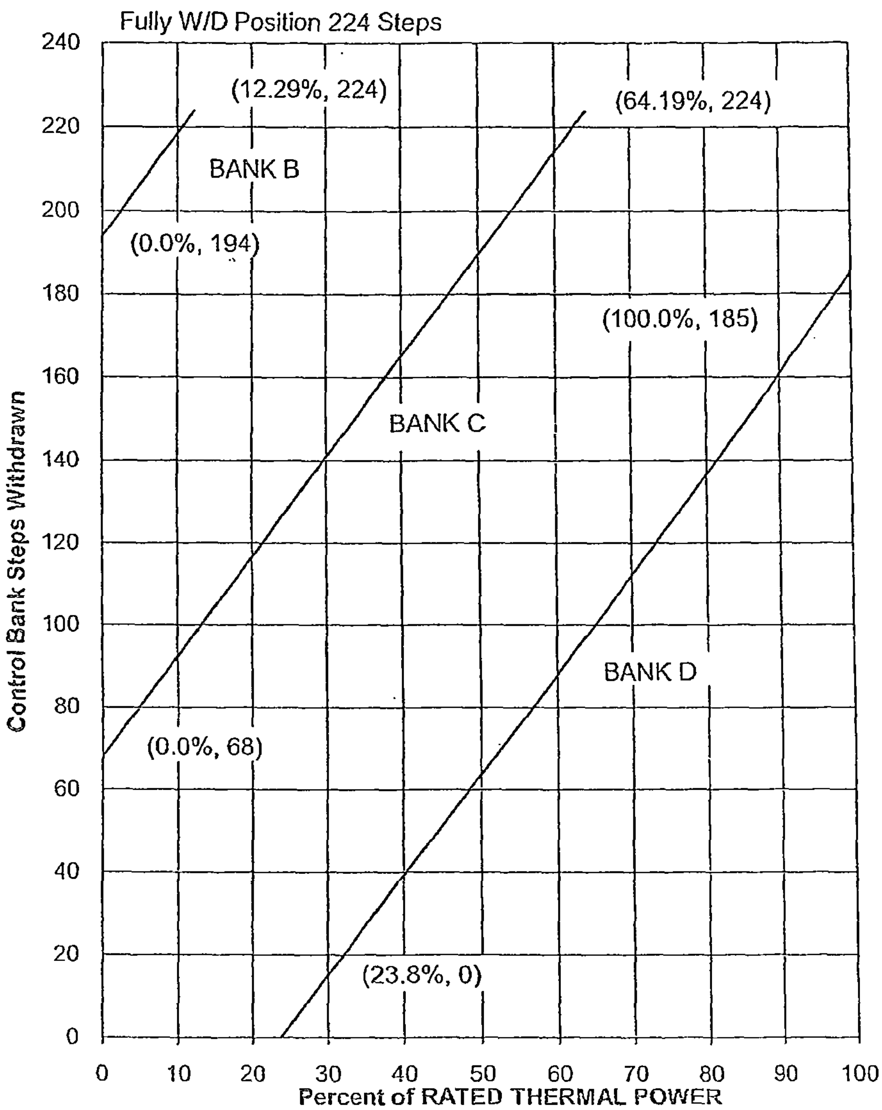
Figure 2
Required Shutdown Margin vs. Boron Concentration

DELETED

Figure 3
Hot Channel Factor Normalized Operating Envelope (K(Z))

DELETED

Figure 4
Control Bank Insertion Limits
(TS 3.1.6)



Note: The Rod Bank Insertion Limits are based on a control bank tip-to-tip distance of 126 steps.

Figure 5

N(Z) Values [1]

NODE	HEIGHT (FEET)	0 to 1000 MWD/MTU	1000 to 3000 MWD/MTU	3000 to 5000 MWD/MTU	5000 to 7000 MWD/MTU	7000 to 9000 MWD/MTU	9000 to XXXXX MWD/MTU	XXXXX to EOC MWD/MTU
Top								
6	11.0							
7	10.8							
8	10.6							
9	10.4							
10	10.2							
11	10.0							
12	9.8							
13	9.6							
14	9.4							
15	9.2							
16	9.0							
17	8.8							
18	8.6							
19	8.4							
20	8.2							
21	8.0							
22	7.8							
23	7.6							
24	7.4							
25	7.2							
26	7.0							
27	6.8							
28	6.6							
29	6.4							
30	6.2							
31	6.0							
32	5.8							
33	5.6							
34	5.4							
35	5.2							
36	5.0							
37	4.8							
38	4.6							
39	4.4							
40	4.2							
41	4.0							
42	3.8							
43	3.6							
44	3.4							
45	3.2							
46	3.0							
47	2.8							
48	2.6							
49	2.4							
50	2.2							

The N(z) data will be provided following shutdown of Cycle 30.

Cycle Specific N(Z) Data

Figure 5 (continued)
N(Z) Values [1]

NODE	HEIGHT (FEET)	0 to 1000 MWD/MTU	1000 to 3000 MWD/MTU	3000 to 5000 MWD/MTU	5000 to 7000 MWD/MTU	7000 to 9000 MWD/MTU	9000 to XXXXX MWD/MTU	XXXXX to EOC MWD/MTU
51	2.0							
52	1.8							
53	1.6							
54	1.4							
55	1.2							
56	1.0							
Bottom								

1) Excludes top and bottom 9%

These decks were generated for normal operation flux maps that are typically taken at full power ARO. Additional N(z) decks may be generated, if necessary, consistent with the methodology described in Reference 1.

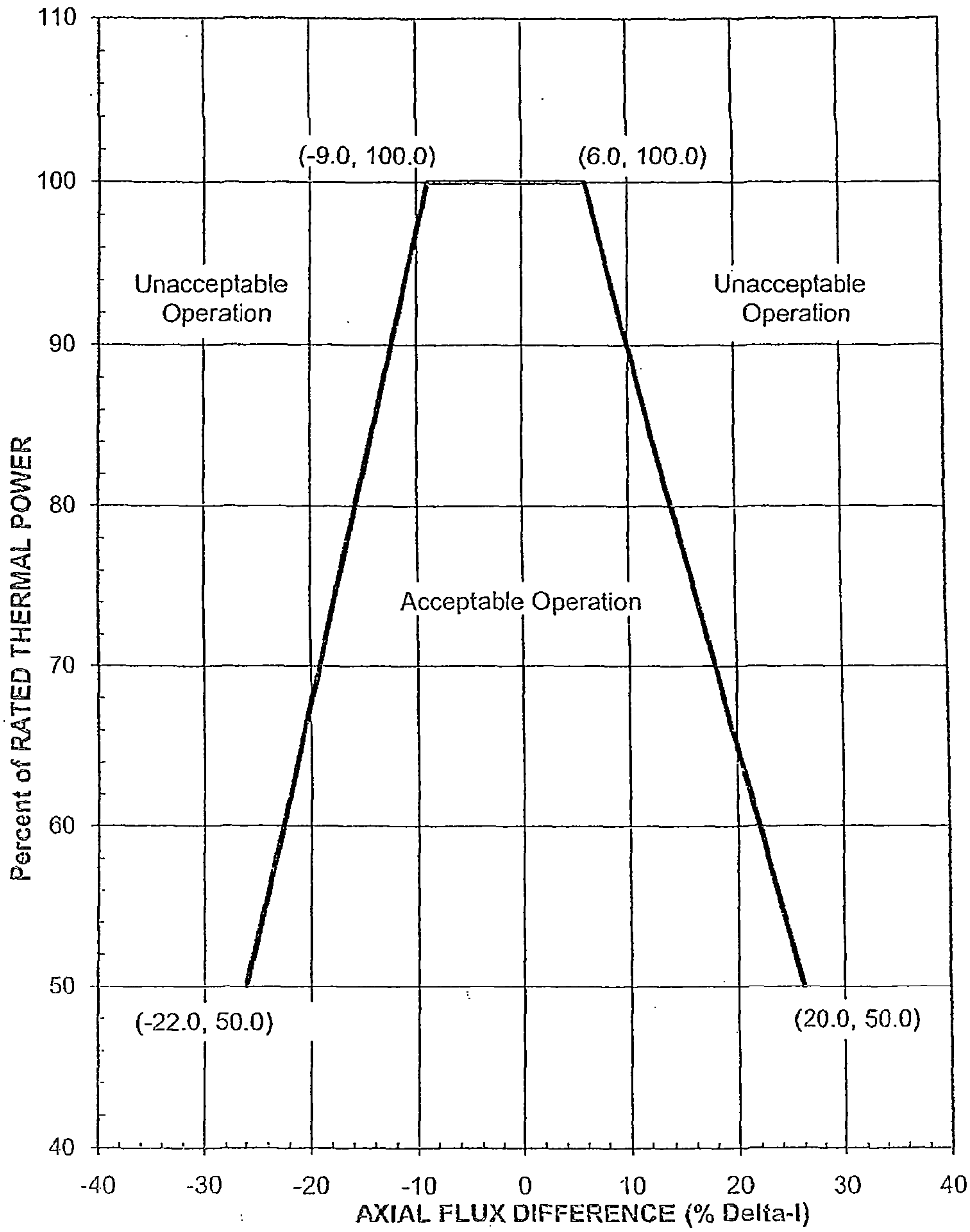
Figure 6
Penalty Factor, Fp, for $F_Q(Z)$

DELETED

Figure 7

AXIAL FLUX DIFFERENCE Target Band

(TS 3.2.3)



3.0 REFERENCES

1. Topical Report DOM-NAF-5-A, Revision 0.2-A, "Application of Dominion Nuclear Core Design and Safety Analysis Methods to the Kewaunee Power Station (KPS)," January 2011.

   Methodology for:
   TS 2.1.1 – Reactor Core Safety Limit;
   TS 3.1.1 – Shutdown Margin;
   TS 3.1.3 – Moderator Temperature Coefficient;
   TS 3.1.5 – Shutdown Bank Insertion Limits;
   TS 3.1.6 – Control Bank Insertion Limits;
   TS 3.2.1 – Heat Flux Hot Channel Factor ($F_Q(Z)$);
   TS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$);
   TS 3.2.3 – AXIAL FLUX DIFFERENCE (AFD);
   TS 3.4.1 – RCS Pressure, Temperature and Flow Departure from Nucleate Boiling (DNB) Limits;
   TS 3.9.1 –Boron Concentration (Refueling Operations)

2. Topical Report WPSRSEM-NP, Revision 3, "Kewaunee Nuclear Power Plant – Review for Kewaunee Reload Safety Evaluation Methods," September 10, 2001.

   Methodology for:
   TS 3.1.1 – Shutdown Margin

3. WCAP-12945-P-A (Proprietary), "Westinghouse Code Qualification Document for Best-Estimate Loss-of-Coolant Accident Analysis," Volume I, Revision 2, and Volume II-V, Revision 1, March 1998.

   Methodology for:
   TS 3.2.1 – Heat Flux Hot Channel Factor ($F_Q(Z)$)
   TS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$);

4. WCAP-10054-P-A, "Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code," August 1985.

   Methodology for:
   TS 3.2.1 – Heat Flux Hot Channel Factor ($F_Q(Z)$)

5. WCAP-10054-P-A, Addendum 2, Revision 1, "Addendum to the Westinghouse Small Break ECCS Evaluation Model Using the NOTRUMP Code: Safety Injection into the Broken Loop and the COSI Condensation Model," July 1997.

   Methodology for:
   TS 3.2.1 – Heat Flux Hot Channel Factor ($F_Q(Z)$)

6. WCAP-9272-P-A, "Westinghouse Reload Safety Evaluation Methodology," July 1985.

   Methodology for:
   TS 2.1.1 – Reactor Core Safety Limit;
   TS 3.1.3 – Moderator Temperature Coefficient;

7. WCAP-8745-P-A, "Design Bases for the Thermal Overtemperature ΔT and Thermal Overpower ΔT trip functions," September 1986.

   Methodology for:
   TS 3.3.1 Function 6 – Overtemperature ΔT Setpoint;
   TS 3.3.1 Function 7 – Overpower ΔT Setpoint

8. WCAP-14449-P-A, Revision 1, "Application of Best Estimate Large-Break LOCA Methodology to Westinghouse PWRs with Upper Plenum Injection," October 1999.

   Methodology for:
   TS 3.2.1 – Heat Flux Hot Channel Factor ($F_Q(Z)$)
   TS 3.2.2 – Nuclear Enthalpy Rise Hot Channel Factor ($F^N_{\Delta H}$);

9. WCAP-12610-P-A, "VANTAGE+ Fuel Assembly Reference Core Report," April 1995.

   Methodology for:
   TS 3.2.1 – Heat Flux Hot Channel Factor ($F_Q(Z)$)

10. CENP-397-P-A, Revision 1, "Improved Flow Measurement Accuracy Using Cross Flow Ultrasonic Flow Measurement Technology," May 2000.

    Methodology for:
    TS 3.3.1 Function 6 – Overtemperature ΔT Setpoint;
    TS 3.3.1 Function 7 – Overpower ΔT Setpoint