ENCLOSURE 2

WCAP-15092 Revision 2,

Turkey Point Units 3 and 4

WOG Reactor Vessel 60-Year Evaluation

Minigroup Heatup and Cooldown

Limit Curves for Normal Operation,

Westinghouse Electric Company LLC,

February 2000.

WCAP-15092
Revision 2

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Turkey Point Units 3 and 4 WOG Reactor Vessel 60-Year Evaluation Minigroup Heatup and Cooldown Limit Curves for Normal Operation

Westinghouse Electric Company LLC

WESTINGHOUSE NON-PROPRIETARY CLASS 3

WCAP-15092, Revision 2

Turkey Point Units 3 and 4
WOG Reactor Vessel 60-Year Evaluation Minigroup
Heatup and Cooldown Limit Curves
For Normal Operation

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February, 2000

Prepared by the Westinghouse Electric Company
for the WOG Reactor Vessel 60-Year Evaluation Minigroup

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PREFACE

This report has been technically reviewed and verified by: ______________________
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RECORD OF REVISION

Revision 1:

- Updated all pressure-temperature curves using the 1996 App. G to Section XI of the ASME Code, K_{Ic} from Code Case N-640 and the removal of the flange requirement per WCAP-15315. All calculations for adjusted reference temperature remain unchanged from Revision 0.
- Text has been updated to support the use of the '96 App. G, K_{Ic} and elimination of the flange notch.

Revision 2:

- Revised fluence values for the lower shell forging have been provided by FP&L and incorporated into this revision. All appropriate text and tables have been updated to reflect the new fluence values. No changes were required to be made to the PT Curves in Figures 9-1 to 9-4 and data points in Tables 9-1 to 9-4.

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1.0 INTRODUCTION

Heatup and cooldown limit curves are calculated using the adjusted RT_{NDT} (reference nil-ductility temperature) corresponding to the limiting beltline region material of the reactor vessel. The adjusted RT_{NDT} of the limiting material in the core region of the reactor vessel is determined by using the unirradiated reactor vessel material fracture toughness properties, estimating the radiation-induced ΔRT_{NDT}, and adding a margin. The unirradiated RT_{NDT} is designated as the higher of either the drop weight nil-ductility transition temperature (NDTT) or the temperature at which the material exhibits at least 50 ft-lb of impact energy and 35-mil lateral expansion (normal to the major working direction) minus 60°F.

RT_{NDT} increases as the material is exposed to fast-neutron radiation. Therefore, to find the most limiting RT_{NDT} at any time period in the reactor's life, ΔRT_{NDT} due to the radiation exposure associated with that time period must be added to the unirradiated RT_{NDT} (IRT_{NDT}). The extent of the shift in RT_{NDT} is enhanced by certain chemical elements (such as copper and nickel) present in reactor vessel steels. The Nuclear Regulatory Commission (NRC) has published a method for predicting radiation embrittlement in Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials"[1]. Regulatory Guide 1.99, Revision 2, is used for the calculation of Adjusted Reference Temperature (ART) values (IRT_{NDT} + ΔRT_{NDT} + margins for uncertainties) at the 1/4T and 3/4T locations, where T is the thickness of the vessel at the beltline region measured from the clad/base metal interface. The most limiting ART values are used in the generation of heatup and cooldown pressure-temperature limit curves for normal operation.

2.0 PURPOSE

Turkey Point Units 3 and 4 has contracted Westinghouse to generate new heatup and cooldown curves for the current end of license and for license renewal. The Turkey Point Units 3 and 4 heatup and cooldown curves were generated without margins for instrumentation errors and include a hydrostatic leak test limit curve from 2485 to 2000 psig. These curves do not include pressure-temperature limits for the vessel flange regions as originally required of by 10 CFR Part 50, Appendix G[2]. Per WCAP-15315, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation For Operating PWR and BWR Plants" , the flange limits are no longer necessary.

The purpose of this report is to present the calculations and the development of Turkey Point Units 3 and 4 heatup and cooldown curves for the current end of license and license renewal. This report documents the calculated adjusted reference temperature (ART) values following the methods of Regulatory Guide 1.99, Revision 2[1], for all the beltline materials and the development of the heatup and cooldown pressure-temperature limit curves for normal operation.

3.0 CRITERIA FOR ALLOWABLE PRESSURE-TEMPERATURE RELATIONSHIPS

3.1 Overall Approach

Appendix G to 10 CFR Part 50, "Fracture Toughness Requirements"[2] specifies fracture toughness requirements for ferritic materials of pressure-retaining components of the reactor coolant pressure boundary of light water nuclear power reactors to provide adequate margins of safety during any condition of normal operation, including anticipated operational occurrences and system hydrostatic tests, to which the pressure boundary may be subjected over its service lifetime. The ASME Boiler and Pressure Vessel Code forms the basis for these requirements. Section XI, Division 1, "Rules for Inservice Inspection of Nuclear Power Plant Components", Appendix G[3], contains the conservative methods of analysis.

Appendix G was recently revised to incorporate the most recent elastic solutions for K_I due to pressure and radial thermal gradients. The new solutions are based on finite element analyses for inside surface flaws performed at Oak Ridge National Laboratories and sponsored by the NRC, and work published for outside surface flaws. These solutions provide results that are very similar to those obtained by using solutions previously developed by Raju and Newman.

This revision now provides consistent computational methods for pressure and thermal K_I for thermal gradients through the vessel wall at any time during the transient. Consistent with the original version of Appendix G, no contribution for crack face pressure is included in the K_I due to pressure, and cladding effects are neglected. The ASME approach for calculating the allowable limit curves for various heatup and cooldown rates specifies that the total stress intensity factor, K_I, for the combined thermal and pressure stresses at any time during heatup or cooldown cannot be greater than the reference stress intensity factor, K_{Ic}, for the metal temperature at that time. K_{Ic} is obtained from the reference fracture toughness curve, defined in Code Case N-640 of the ASME Appendix G to Section XI[3 & 8]. The K_{Ic} curve is given by the following equation:

$$K_{Ic} = 33.2 + 20.734 * e^{[0.02(T - RT_{NDT})]}$$

where,

K_{Ic} = reference stress intensity factor as a function of the metal temperature T and the metal reference nil-ductility temperature RT_{NDT}

This K_{Ic} curve is based on the lower bound of static critical K_I values measured as a function of temperature on specimens of SA-533 Grade B Class1, SA-508-1, SA-508-2, SA-508-3 steel.
Using these most recent elastic solutions in the low temperature region will provide some relief to restrictions associated with reactor operation at relatively low temperatures. The pressure-temperature curves for Turkey Point Units 3 and 4 will be developed using the current ASME Section XI, Appendix G methodology (which includes 1996 Code Case N-588 circumferential flaw methodology) and the Code Case N-640 K_{Ic} methodology. The reason for using these methodologies is that the limiting beltline material for both vessels is the circumferential weld seam and the circumferential flaw methodology (Code Case N-588) provides enough relief at the lower end of the pressure-temperature curves to cause the forging material to become limiting at lower temperatures.

3.2 Methodology for Pressure-Temperature Limit Curve Development

The governing equation for the heatup-cooldown analysis is defined in Appendix G of the ASME Code as follows:

$$C^* K_{Im} + K_{It} < K_{Ic}$$

where,

K_{Im} = stress intensity factor caused by membrane (pressure) stress

K_{It} = stress intensity factor caused by the thermal gradients

K_{Ic} = function of temperature relative to the RT_{NDT} of the material

C = 2.0 for Level A and Level B service limits

C = 1.5 for hydrostatic and leak test conditions during which the reactor core is not critical

The following revisions were made to ASME Section XI, Appendix G:

G-2214.1 Membrane Tension:

$$K_{Im} = M_m x(pR_i / t)$$

where:

M_m for an inside axial surface flaw is given by:

M_m = 1.85 for $\sqrt{t}\ 0 < 2$,

M_m = $0.926\sqrt{t}\ 0$ for $2 \le \sqrt{t} \le 3.464$,

M_m = 3.21 for $\sqrt{t}\ 0 > 3.464$

M_m for an outside axial surface flaw is given by:

M_m = 1.77 for $\sqrt{t}\ 0 < 2$,

M_m = $0.893\sqrt{t}\ 0$ for $2 \le \sqrt{t} \le 3.464$,

M_m = 3.09 for $\sqrt{t}\ 0 > 3.464$

and p = internal pressure, R_i = vessel inner radius, and t = vessel wall thickness.

M_m for an inside circumferential surface defect is given by:

M_m = 0.89 for $\sqrt{t} < 2$

M_m = $0.443\sqrt{t}$ for $2 \le \sqrt{t} \le 3.464$

M_m = 1.53 for $\sqrt{t} > 3.464$

M_m for an outside circumferential surface defect is given by:

M_m = 0.89 for $\sqrt{t} < 2$

M_m = $0.443\sqrt{t}$ for $2 \le \sqrt{t} \le 3.464$

M_m = 1.53 for $\sqrt{t} > 3.464$

and p = internal pressure, R_i = vessel inner radius, and t = vessel wall thickness.

G-2214.3 Radial Thermal Gradient:

The maximum K_I produced by radial thermal gradient for the postulated inside surface defect of G-2120 is $K_{It} = 0.953x10^{-3}$ x CR x $t^{2.5}$, where CR is the cooldown rate in °F/hr., or for a postulated outside surface defect, $K_{It} = 0.753x10^{-3}$ x HU x $t^{2.5}$, where HU is the heatup rate in °F/hr.

The through-wall temperature difference associated with the maximum thermal K_I can be determined from Fig. G-2214-1. The temperature at any radial distance from the vessel surface can be determined from Fig. G-2214-2 for the maximum thermal K_I.

(a) The maximum thermal K_I relationship and the temperature relationship in Fig. G-2214-1 are applicable only for the conditions given in G-2214.3(a)(1) and (2).

(b) Alternatively, the K_I for radial thermal gradient can be calculated for any thermal stress distribution and at any specified time during cooldown for a ¼-thickness inside surface defect using the relationship:

$$K_{It} = (1.0359\,C_0 + 0.6322\,C_1 + 0.4753\,C_2 + 0.3855\,C_3) * \sqrt{\pi a}$$

or similarly, K_{IT} during heatup for a ¼-thickness outside surface defect using the relationship:

$$K_{It} = (1.043\,C_0 + 0.630\,C_1 + 0.481\,C_2 + 0.401\,C_3) * \sqrt{\pi a}$$

where the coefficients C_0, C_1, C_2 and C_3 are determined from the thermal stress distribution at any specified time during the heatup or cooldown using the form:

$$\sigma(x) = C_0 + C_1(x/a) + C_2(x/a)^2 + C_3(x/a)^3$$

and x is a variable that represents the radial distance from the appropriate (i.e., inside or outside) surface to any point on the crack front and a is the maximum crack depth.

At any time during the heatup or cooldown transient, K_{Ic} is determined by the metal temperature at the tip of a postulated flaw at the 1/4T and 3/4T location, the appropriate value for RT_{NDT}, and the reference fracture toughness curve. The thermal stresses resulting from the temperature gradients through the vessel wall are calculated and then the corresponding (thermal) stress intensity factors, K_{It}, for the reference flaw are computed. From Equation 2, the pressure stress intensity factors are obtained and, from these, the allowable pressures are calculated.

For the calculation of the allowable pressure versus coolant temperature during cooldown, the reference flaw of Appendix G to the ASME Code is assumed to exist at the inside of the vessel wall. During cooldown, the controlling location of the flaw is always at the inside of the wall because the thermal gradients produce tensile stresses at the inside, which increase with increasing cooldown rates. Allowable pressure-temperature relations are generated for both steady-state and finite cooldown rate situations. From these relations, composite limit curves are constructed for each cooldown rate of interest.

The use of the composite curve in the cooldown analysis is necessary because control of the cooldown procedure is based on the measurement of reactor coolant temperature, whereas the limiting pressure is actually dependent on the material temperature at the tip of the assumed flaw. During cooldown, the 1/4T vessel location is at a higher temperature than the fluid adjacent to the vessel inner diameter. This condition, of course, is not true for the steady-state situation. It follows that, at any given reactor coolant temperature, the ΔT (temperature) developed during cooldown results in a higher value of K_{Ic} at the 1/4T location for finite cooldown rates than for steady-state operation. Furthermore, if conditions exist so that the increase in K_{Ic} exceeds K_{It}, the calculated allowable pressure during cooldown will be greater than the steady-state value.

The above procedures are needed because there is no direct control on temperature at the 1/4T location and, therefore, allowable pressures may unknowingly be violated if the rate of cooling is decreased at various intervals along a cooldown ramp. The use of the composite curve eliminates this problem and ensures conservative operation of the system for the entire cooldown period.

Three separate calculations are required to determine the limit curves for finite heatup rates. As is done in the cooldown analysis, allowable pressure-temperature relationships are developed for steady-state conditions as well as finite heatup rate conditions assuming the presence of a 1/4T defect at the inside of the wall. The heatup results in compressive stresses at the inside surface that alleviate the tensile stresses produced by internal pressure. The metal temperature at the crack tip lags the coolant temperature; therefore, the K_{Ic} for the 1/4T crack during heatup is lower than the K_{Ic} for the 1/4T crack during steady-state conditions at the same coolant temperature. During heatup, especially at the end of the transient, conditions may exist so that the effects of compressive thermal stresses and lower K_{Ic} values do not offset each other, and the pressure-temperature curve based on steady-state conditions no longer represents a lower bound of all similar curves for finite heatup rates when the 1/4T flaw is considered. Therefore, both cases have to be analyzed in order to ensure that at any coolant temperature the lower value of the allowable pressure calculated for steady-state and finite heatup rates is obtained.

The second portion of the heatup analysis concerns the calculation of the pressure-temperature limitations for the case in which a 1/4T flaw located at the 1/4T location from the outside surface is assumed. Unlike the situation at the vessel inside surface, the thermal gradients established at the outside surface during heatup produce stresses which are tensile in nature and therefore tend to reinforce any pressure stresses present. These thermal stresses are dependent on both the rate of heatup and the time (or coolant temperature) along the heatup ramp. Since the thermal stresses at the outside are tensile and increase with increasing heatup rates, each heatup rate must be analyzed on an individual basis.

Following the generation of pressure-temperature curves for both the steady-state and finite heatup rate situations, the final limit curves are produced by constructing a composite curve based on a point-by-point comparison of the steady-state and finite heatup rate data. At any given temperature, the allowable pressure is taken to be the lesser of the three values taken from the curves under consideration. The use of the composite curve is necessary to set conservative heatup limitations because it is possible for conditions to exist wherein, over the course of the heatup ramp, the controlling condition switches from the inside to the outside, and the pressure limit must at all times be based on analysis of the most critical criterion.

3.3 Flange Requirements

10 CFR Part 50, Appendix G addresses the metal temperature of the closure head flange and vessel flange regions. This rule states that the metal temperature of the closure flange regions must exceed the material unirradiated RT_{NDT} by at least 120°F for normal operation when the pressure exceeds 20 percent of the preservice hydrostatic test pressure (3107 psi), which is 621 psig for Turkey Point Units 3 and 4. However, per WCAP-15315, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation For Operating PWR and BWR Plants"[9], this requirement is no longer necessary when using the methodology of Code Case N-640[8]. Hence, Turkey Point Units 3 and 4 heatup and cooldown limit curves will be generated without flange requirements included.

4.0 CHEMISTRY FACTOR DETERMINATION

4.1 Chemistry Factor Methodology:

The calculations of chemistry factor (CF) values for the Turkey Point Units 3 and 4 reactor vessel beltline materials are performed in accordance with Regulatory Guide 1.99, Revision 2 as follows:

The CF is based on the Cu and Ni weight % of the material or it is based on the results of surveillance capsule test data. When the weight percent of copper and nickel is used to determine the CF, the CF is obtained from either Table 1 or Table 2 of Regulatory Guide 1.99, Revision 2.

When surveillance capsule data is used to determine the CF, the CF is determined as follows:

$$CF = \frac{\sum_{i=1}^{n} [A_i x\, fi^{(0.28-0.1\log fi)}]}{\sum_{i=1}^{n} [f_i^{(0.28-0.1\log fi)}]^2}$$

Where:	n	=	The Number of Surveillance Data Points
	A_i	=	The Measured Value of ΔRT_{NDT}
	f_i	=	Fluence for each Surveillance Data Point

When the surveillance weld copper and nickel content differs from that of the vessel weld, the measured values of ΔRT_{NDT} are adjusted by multiplying them by the ratio of the chemistry factor for the vessel weld to that for the surveillance weld based on the copper and nickel content of the materials. The Ratio Procedure is documented in Regulatory Guide 1.99 Revision 2 Position 2.1, and shown below.

4.1.1 Application of the Ratio Procedure:

The Turkey Point Units 3 and 4 intermediate/lower shell circumferential weld seams, and the surveillance program weld metal were all fabricated with weld wire Heat #71249 and Linde 80 flux. The surveillance weld data is not credible. Note: The surveillance weld has a higher Cu than the best estimate , therefore for conservatism, the ratio procedure will not be applied to calculating the chemistry factor for the weld.

4.1.2 Temperature Effects on Surveillance Data:

Studies have shown that for temperatures near 550°F, a 1°F decrease in irradiation temperature will result in approximately 1°F increase in ΔRT_{NDT}. Thus, for plants that use surveillance data from other reactor vessels that operate at a different temperature or when the capsule is at a different temperature than the plant, then this difference must be considered.

The temperature adjustment is as follows:

Temp. Adjusted ΔRT_{NDT} = ΔRT_{NDT} Measured + ($T_{capsule}$ - T_{plant})

The Turkey Points Units 3 and 4 capsules are located in the reactor between the thermal shield and the vessel wall and are positioned opposite the center of the core. The test capsules are in guide tubes attached to the thermal shield. The location of the specimens with respect to the reactor vessel beltline provides assurance that the reactor vessel wall and the specimens experience equivalent operating conditions and the temperatures will not differ by more than 25°F. Since both plants are operated at the same temperature, no temperature adjustment was made. However, one weld surveillance capsule data point is from the B&WOG A-5 Capsule at Davis-Besse. The Tcold for Davis-Besse is 9°F higher than the Turkey Point (555°F vs. 546°F) and a 9°F correction was made.

Following in Table 4-1 are best estimate chemistry values for all the beltline materials along with the chemistry factors (CF) as determined per Regulatory Guide 1.99, Revision 2, Position 1 or 2

TABLE 4-1

Reactor Vessel Beltline Material Copper and Nickel Content and Calculated CF

Material Description	wt. % Cu[(a)]	wt. % Ni[(a)]	CF
Turkey Point Unit 3			
Intermediate Shell Forging (Heat # 123P461VA1)	0.06	0.70	14.55°F
Int/Lower Shell Circ. Weld (Heat # 71249)	0.23	0.59	167.55°F
Lower Shell Forging (Heat # 123S266VA1)	0.08	0.67	42.7°F
Turkey Point Unit 4			
Intermediate Shell Forging (Heat # 123P481VA1)	0.05	0.68	31°F
Int/Lower Shell Circ. Weld (Heat # 71249)	0.23	0.59	167.55°F
Lower Shell Forging (Heat # 122S180VA1)	0.06	0.74	5.35°F

NOTES:

(a) These values were determined by FP&L and listed in Reference 4.

Tables 4-2 and 4-3 provide the calculation of the CF values for the surveillance materials per Regulatory Guide 1.99, Revision 2, Position 2.1. The ratio procedure of Regulatory Guide 1.99, Revision 2, Position 2.1 will not be applied to the weld metal (ie. Ratio = 1.0) because the surveillance weld has higher copper concentration than the best estimate chemistry.

TABLE 4-2

Calculation of Chemistry Factors using Turkey Point Unit 3 Surveillance Capsule Data

Material	Capsule	Fluence[(a,b)]	FF	ΔRT_{NDT}[(b)]	FF * ΔRT_{NDT}[(c)]	FF^2
Inter. Shell Forging 123P461VA1	S	1.72×10^{19}	1.149	13°F	14.94	1.32
	T	0.74×10^{19}	0.9155	18°F	16.48	0.838
				SUM:	31.42	2.158
	Chemistry Factor = 14.55[(c)]					
Lower Shell Forging 123S266VA1	V	1.53×10^{19}	1.1176	55°F	61.47	1.249
	S	1.72×10^{19}	1.149	42°F	48.27	1.32
				SUM:	109.74	2.57
	Chemistry Factor = 42.7[(c)]					
Weld Metal SA1101 and SA1094 Heat #71249	Davis Besse	2.57×10^{19}	1.2530	225°F	281.93	1.570
	V3	1.539×10^{19}	1.1176	179°F	200.05	1.249
	T3	0.740×10^{19}	0.9155	166°F	151.97	0.8381
	T4	0.708×10^{19}	0.9031	211°F	190.55	0.8156
				SUM:	824.52	4.473
	Chemistry Factor = 184.3[(c)]					

(a) Fluence values are in units of n/cm^2, E > 1.0 MeV.

(b) Data obtained from FP&L in Reference 4.

(c) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

TABLE 4-3						
Calculation of Chemistry Factors using Turkey Point Unit 4 Surveillance Capsule Data						
Material	Capsule	Fluence[a,b]	FF	ΔRT_{NDT}[b]	FF * ΔRT_{NDT}[d]	FF^2
Inter. Shell	S	1.43 x 10^{19}	N/A	35°F	N/A	N/A
123P481VA1				SUM:	N/A	N/A
	Chemistry Factor = N/A					
Lower Shell	S	1.43 x 10^{19}	1.099	0°F	0	1.208
Forging	T	0.708 x 10^{19}	0.903	12°F	10.84	0.815
122S180VA1				SUM:	10.84	2.023
	Chemistry Factor = 5.35[d]					
Weld Metal	Davis Besse	2.57 x 10^{19}	1.2530	225F	281.93	1.570
SA1101 and	T4	0.708 x 10^{19}	0.9031	179°F	200.05	0.8156
SA1094	V3	1.53 x 10^{19}	1.1176	166°F	151.97	1.249
Heat #71249[c]	T3	0.74 x 10^{19}	0.9155	211°F	190.55	0.8381
				SUM:	824.52	4.473
	Chemistry Factor = 184.3 [d]					

(a) Fluence values are in units of n/cm^2, E > 1.0 MeV.

(b) Data obtained from FP&L in Reference 4.

(c) Surveillance weldments SA1101 (Unit 3) and SA1094 (Unit 4) were both fabricated using weld metal Heat #71249 and Linde 80 flux (Lot #8445 for SA1101 and Lot #8457 for SA1094).

(d) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

4.2 Surveillance Program Credibility Evaluation:

Regulatory Guide 1.99, Revision 2, describes general procedures acceptable to the NRC staff for calculating the effects of neutron radiation embrittlement of the low-alloy steels currently used for light-water-cooled reactor vessels. Position C.2 of Regulatory Guide 1.99, Revision 2, describes the methodology for calculating the adjusted reference temperature and Charpy upper-shelf energy of reactor vessel beltline materials using surveillance capsule data. The methods of Position C.2 can only be applied when two or more credible surveillance data sets become available from the reactor in question.

To date, there have been three surveillance capsules removed from the Turkey Point Unit 3 reactor vessel and two from the Turkey Point Unit 4 reactor vessel. This capsule data must be shown to be credible. In accordance with the discussion of Regulatory Guide 1.99, Revision 2, there are five requirements that must be met for the surveillance data to be judged credible.

The purpose of this evaluation is to document the information provided by FP&L in regard to the Turkey Point Units 3 and 4 reactor vessel surveillance data for each of the credibility requirements of Regulatory Guide 1.99, Revision 2.

Criterion 1: ***Materials in the capsules should be those judged most likely to be controlling with regard to radiation embrittlement.***

The beltline region of the reactor vessel is defined in Appendix G to 10 CFR Part 50, "Fracture Toughness Requirements", December 19, 1995 to be:

"the reactor vessel (shell material including welds, heat affected zones, and plates or forgings) that directly surrounds the effective height of the active core and adjacent regions of the reactor vessel that are predicted to experience sufficient neutron radiation damage to be considered in the selection of the most limiting material with regard to radiation damage."

The forging materials and weld metal contained in the capsules are representative of all of the materials in the Turkey Point Units 3 and 4 reactor vessel beltline regions (Ref. 6 & 11). Therefore, the criteria is met.

Criterion 2: ***Scatter in the plots of Charpy energy versus temperature for the irradiated and unirradiated conditions should be small enough to permit the determination of the 30 ft-lb temperature and upper shelf energy, unambiguously.***

The shift values used for this evaluation are the h-Tan shifts for surveillance data from the E-900 Database.[4] Therefore, this criteria is met.

Criterion 3: ***When there are two or more sets of surveillance data from one reactor, the scatter of ΔRT_{NDT} values about a best-fit line drawn as described in Regulatory Position 2.1 normally should be less than 28°F for welds and 17°F for base metal. Even if the fluence range is large (two or more orders of magnitude), the scatter should not exceed twice those values. Even if the data fail this criterion for use in shift calculations, they may be credible for determining decrease in upper shelf energy if the upper shelf can be clearly determined, following the definition given in ASTM E185-82.***

The least squares method, as described in Regulatory Position 2.1, will be utilized in determining a best-fit line for this data to determine if this criteria is met.

TABLE 4-4

Calculation of Chemistry Factors using Turkey Point Unit 3 Surveillance Capsule Data

Material	Capsule	Fluence[a,b]	FF	ΔRT_{NDT}[b]	FF * ΔRT_{NDT}[d]	FF^2
Intermediate Shell	S	1.72×10^{19}	1.149	13°F	14.94	1.32
Forging 123P461VA1	T	0.74×10^{19}	0.9155	18°F	16.48	0.838
				SUM:	31.42	2.158
	Chemistry Factor = 14.55[d]					
Lower Shell	V	1.53×10^{19}	1.1176	55°F	61.47	1.249
Forging 123S266VA1	S	1.72×10^{19}	1.149	42°F	48.27	1.32
				SUM:	109.74	2.57
	Chemistry Factor = 42.7[d]					
Surveillance Program	Davis Besse	2.57×10^{19}	1.2530	225F	281.93	1.570
Weld Metal SA1101	V3	1.539×10^{19}	1.1176	179°F	200.05	1.249
and SA1094	T3	0.740×10^{19}	0.9155	166°F	151.97	0.8381
Heat #71249[c]	T4	0.708×10^{19}	0.9031	211°F	190.55	0.8156
				SUM:	824.52	4.473
	Chemistry Factor = 184.3[d]					

(a) Fluence values are in units of n/cm^2, E > 1.0 MeV.

(b) Data obtained from FP&L in Reference 4.

(c) Surveillance program weldments SA1101 (Unit 3) and SA1094 (Unit 4) were both fabricated using weld metal Heat #71249 and Linde 80 flux (Lot #8445 for SA1101 and Lot #8457 for SA1094).

(d) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

TABLE 4-5						
Turkey Point Unit 3 Surveillance Capsule Data Scatter about the Best-Fit Line						
Material	CF (°F)	FF	Measured ΔRT_{NDT} (30 ft-lb) (°F)	Best Fit[a] ΔRT_{NDT} (°F)	Scatter of ΔRT_{NDT} (°F)	<17°F <28°F
Intermediate Shell	14.55	1.1492	13	16.73	-3.7	yes
Forging 123P461VA1	14.55	0.9155	18	13.3	4.7	yes
Lower Shell	42.7	1.1176	55	47.73	7.3	yes
Forging 123S266VA1	42.7	1.1492	42	49.07	-7.1	yes
Surveillance Program	184.3	1.2530	225	230.98	-5.98	yes
Weld Metal SA1101	184.3	1.1176	179	206.01	-27.01	yes
and SA1094	184.3	0.916	166	168.76	-2.76	yes
	184.3	0.9031	211	166.46	44.54	no

(a) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

The scatter of ΔRT_{NDT} values about a best-fit line drawn, as described in Regulatory Position 2.1, should be less than 17°F for base metal. As shown above, the scatter of all data points is less than 17°F of the best-fit line. Therefore, the surveillance forging material data provided by FP&L is considered credible and was used to determine the Adjusted Reference Temperatures (ARTs).

The scatter of ΔRT_{NDT} values about a best-fit line drawn, as described in Regulatory Position 2.1, should be less than 28°F for weld metal. As shown above, the scatter for one out of four points is greater than 28°F. Therefore, the surveillance weld metal data provided by FP&L is not considered to be credible and was not used to determine the Adjusted Reference Temperatures (ARTs). The ART for the weld metal was determined using the table contained in Regulatory Guide 1.99, Revision 2.

TABLE 4-6						
Calculation of Chemistry Factors using Turkey Point Unit 4 Surveillance Capsule Data						
Material	Capsule	Fluence(a,b)	FF	ΔRT_{NDT}(b)	FF * ΔRT_{NDT}(d)	FF^2
Intermediate Shell Forging 123P481VA1	S	1.43×10^{19}	N/A	35°F	N/A	N/A
				SUM:	N/A	N/A
	Chemistry Factor = 31					
Lower Shell Forging 122S180VA1	S	1.43×10^{19}	1.099	0°F	0	1.208
	T	0.708×10^{19}	0.903	12°F	10.84	0.815
	SUM:				10.84	2.0239
	Chemistry Factor = 5.35(d)					
Surveillance Program Weld Metal SA1094 and SA1101 Heat #71249(c)	Davis Besse	2.57×10^{19}	1.2530	225°F	281.93	1.570
	T4	0.708×10^{19}	0.9031	179°F	200.05	0.8156
	V3	1.53×10^{19}	1.1176	166°F	151.97	1.249
	T3	0.74×10^{19}	0.9155	211°F	190.55	0.8381
				SUM:	824.52	4.473
	Chemistry Factor = 184.3(d)					

(a) Fluence values are in units of n/cm^2, E > 1.0 MeV.

(b) Data obtained from FP&L in Reference 4.

(c) Surveillance program weldments SA1101 (Unit 3) and SA1094 (Unit 4) were both fabricated using weld metal Heat #71249 and Linde 80 flux (Lot #8445 for SA1101 and Lot #8457 for SA1094).

(d) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

TABLE 4-7 Turkey Point Unit 4 Surveillance Capsule Data Scatter about the Best-Fit Line						
Material	CF (°F)	FF	Measured ΔRT_{NDT} (30 ft-lb) (°F)	Best Fit[a] ΔRT_{NDT} (°F)	Scatter of ΔRT_{NDT} (°F)	<17°F <28°F
Intermediate Shell Forging 123P481VA1	N/A	N/A	35	N/A	N/A	N/A
Lower Shell	5.35	1.099	10	5.89	4.11	yes
Forging 122S180VA1	5.35	0.9031	5	4.84	0.16	yes
Surveillance Program	184.3	1.2530	225	230.98	-5.98	yes
Weld Metal SA1094	184.3	1.1176	179	206.01	-27.01	yes
and SA1101	184.3	0.916	166	168.76	-2.76	yes
	184.3	0.9031	211	166.46	44.42	no

(a) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

The scatter of ΔRT_{NDT} values about a best-fit line drawn, as described in Regulatory Position 2.1, should be less than 17°F for base metal. As shown above, the scatter of all data points for the lower shell forging 122S180VA1 is less than 17°F of the best-fit line. Therefore, the surveillance forging material data for lower shell forging 122S180VA1 provided by FP&L is considered credible and was used to determine the Adjusted Reference Temperatures (ARTs). There is only one set of surveillance capsule data for intermediate shell forging 123P481VA1, and the requirement is at least two. Therefore, the tables of Regulatory Guide 1.99, Revision 2, was used to determine the CF.

The scatter of ΔRT_{NDT} values about a best-fit line drawn, as described in Regulatory Position 2.1, should be less than 28°F for weld metal. As shown above, the scatter for one out of four points is greater than 28°F. Therefore, the surveillance weld metal data provided by FP&L is not considered to be credible and was not used to determine the Adjusted Reference Temperatures (ARTs). The ART for the weld metal was determined using the table contained in Regulatory Guide 1.99, Revision 2.

Criterion 4: ***The irradiation temperature of the Charpy specimens in the capsule should match the vessel wall temperature at the cladding/base metal interface within +/- 25°F.***

The temperature at the surveillance capsule locations is within 25°F of the vessel wall temperature at the cladding/base metal interface during normal reactor operation. Therefore, this criteria is met.

Criterion 5: ***The surveillance data for the correlation monitor material in the capsule should fall within the scatter band of the data base for that material.***

There is no new correlation monitor material data.

4.2.1 Application of the Credibility Criteria:

According to information provided by FP&L in Reference 4:

The Turkey Point Unit 3 surveillance data for intermediate shell forging 123P461VA1 and lower shell forging 123S266VA1 is deemed credible in accordance with the credibility criteria of Regulatory Guide 1.99, Revision 2. The surveillance data for Turkey Point Unit 3 surveillance weld material SA1101 is deemed not credible.

The Turkey Point Unit 4 surveillance data for lower shell forging 122S180VA1 is deemed credible in accordance with the credibility criteria of Regulatory Guide 1.99, Revision 2. The surveillance data for Turkey Point Unit 4 intermediate shell forging 123P481VA1 and surveillance weld material SA1094 are deemed not credible.

4.2.2 σ_Δ and How it was Determined:

Per Regulatory Guide 1.99, Revision, 2 Position 1.1, the values of σ_Δ are referred to as "28°F for welds and 17°F for base metal, except that σ_Δ need not exceed 0.50 times the mean value of ΔRT_{NDT}." The "mean value of ΔRT_{NDT}" is defined in Regulatory Guide 1.99, Revision 2, by Equation 2. The chemistry factor in Regulatory Guide 1.99, Revision 2, Equation 2 is calculated from Tables 1 and 2 or Position 2.1 of Regulatory Guide 1.99, Revision 2. When Position 2.1 is used, σ_Δ may be cut in half (i.e., 8.5°F and 14°F).

17°F and 28°F were used for forging 123P481VA1 and welds, respectively. Since the surveillance data is credible for the forging materials, a σ_Δ of 8.5°F was used for all Turkey Point Units 3 and 4 forging materials.

5.0 UNIRRADIATED PROPERTIES

5.1 Initial RT_{NDT} of Beltline Materials

Table 5-1 contains a description of the beltline materials and their initial RT_{NDT} values.

TABLE 5-1

Reactor Vessel Material Initial RT_{NDT}

Material Description	Heat #	Flux Type	Flux Lot	Initial RT_{NDT} (a)
Turkey Point Unit 3				
Closure Head Flange	- -	N/A	N/A	44°F
Vessel Flange	- -	N/A	N/A	-23°F
Inter. Shell Forging	123P461VA1	N/A	N/A	40°F
Lower Shell Forging	123S266VA1	N/A	N/A	30°F
Int/Lower Shell Circ. Weld	71249	Linde 80	8445	10°F
Turkey Point Unit 4				
Closure Head Flange	- -	N/A	N/A	-4°F
Vessel Flange	- -	N/A	N/A	-1°F
Inter. Shell Forging	123P481VA1	N/A	N/A	50°F
Lower Shell Forging	122S180VA1	N/A	N/A	40°F
Int/Lower Shell Circ. Weld	71249	Linde 80	8445	10°F

NOTES:
(a) The Initial RT_{NDT} values were obtained from FP&L in Reference 4 and are measured values.

5.2 Determination of σ_I :

Since the initial RT_{NDT} values are measured values, the Turkey Point Unit 3 and Turkey Point Unit 4 σ_I values are 0°F.

5.3 Bolt-up Temperature:

The minimum bolt-up temperature requirements for the Turkey Point Unit 3 and Unit 4 reactor pressure vessels are according to Paragraph G-2222 of the ASME Boiler and Pressure Vessel (B&PV) Code, Section XI, Appendix G, the reactor vessel may be bolted up and pressurized to 20 percent of the initial hydrostatic test pressure at the initial RT_{NDT} of the material stressed by the bolt-up. Therefore, since the most limiting initial RT_{NDT} value is 44°F (Unit 3 closure head flange), the reactor vessel can be bolted up at 44°F. The limiting initial RT_{NDT} for the Unit 4 reactor vessel is only -1°F. However, FP&L has specified minimum bolt-up temperatures of 71°F for Turkey Point Unit 3 and 70°F Turkey Point Unit 4 reactor vessels[4].

6.0 REACTOR VESSEL GEOMETRIC & SYSTEM PARAMETERS

6.1 Reactor Vessel Physical Dimensions and Operating Conditions:

The following are the Turkey Point Units 3 and 4 reactor vessel physical dimensions and operating conditions:

Reactor vessel inner diameter (to clad)	= 155.5 inches
Clad thickness	= 0.156 inches
Reactor Vessel Beltline Thickness	= 7.75 inches
Pre-Service System Hydrostatic Pressure	= 3107 psig
Capacity Factor (Future Cycles)	= 90%

System and Component Operating Conditions/Dimensions:

Design Pressure	= 2485 psig
Operating Pressure	= 2235 psig

7.0 FLUENCE FACTOR DETERMINATION

7.1 Peak Clad Base Metal Interface Fluence for each Beltline Material:

Contained in Table 7-1 are the reactor vessel clad/base metal interface fluences. These values were obtained from FP&L in Reference 4.

TABLE 7-1		
Best-Estimate Fluence (10^{19} n/cm^2, E > 1.0 MeV) at the Pressure Vessel Clad/Base Metal Interface for the Turkey Point Units 3 and 4 Reactor Vessels		
Material	EFPY	Fluence
Turkey Point Unit 3		
Intermediate Shell Forging (Ht. # 123P461VA1)	32	5.0[(a)]
Lower Shell Forging (Ht. # 123S266VA1)	32	4.0
Int/Lower Shell Circ. Weld (Ht. # 71249)	32	3.0
Intermediate Shell Forging (Ht. # 123P461VA1)	48	7.0[(a)]
Lower Shell Forging (Ht. # 123S266VA1)	48	6.0
Int/Lower Shell Circ. Weld (Ht. # 71249)	48	4.5
Turkey Point Unit 4		
Intermediate Shell Forging (Ht. # 123P481VA1)	32	5.0[(a)]
Lower Shell Forging (Ht. # 122S180VA1)	32	4.0
Int/Lower Shell Circ. Weld (Ht. # 71249)	32	3.0
Intermediate Shell Forging (Ht. # 123P481VA1)	48	7.0[(a)]
Lower Shell Forging (Ht. # 122S180VA1)	48	6.0
Int/Lower Shell Circ. Weld (Ht. # 71249)	48	4.5

Note:
(a) These values are conservative based on revised values given in Reference 10.

Per FP&L the current end of license (EOL) EFPY is <32 EFPY and the EOL license renewal EFPY is 48

EFPY.

Thus, the EFPY values used to generate pressure/temperature curves and the calculated fluence values are:

Current EOL = 32 EFPY
Renewal EOL = 48 EFPY

Turkey Point Units 3 and 4 each have only one beltline weld (i.e., the circumferential weld between the intermediate and lower shell forgings). These beltline circumferential welds for Turkey Point Units 3 and 4 reactor vessels were fabricated with the same weld wire and flux. A portion of the circumferential welds will receive the peak vessel fluence at the core centerline. Only this peak vessel fluence will be used for the ART calculations for the welds. As for the intermediate and lower shell forgings, the applicable peak vessel fluences will be used for the ART calculations.

7.2 1/4T & 3/4T Thickness Fluence for each Beltline Material:

The neutron fluence at the 1/4T & 3/4T depth in the vessel wall was calculated per Regulatory Guide 1.99, Revision 2, as follows:

$$f = f_{surf} * e^{\{-0.24\,(x)\}},\ 10^{19}\ n/cm^2\ (E > 1.0\ MeV)$$

where: f_{surf} = Vessel inner wall surface fluence, 10^{19} n/cm^2 (E > 1.0 MeV) (See Table 7-1)
x = is the depth into the vessel wall from the inner surface, inches
(0.25 * 7.75 inches or 0.75 * 7.75 inches)

Contained in Table 7-2 is a summary of the fluence values used to calculate the Turkey Point Units 3 and 4 ART values used to develop the pressure-temperature curves for normal operation.

TABLE 7-2				
Summary of Fluence Values Used to Calculate the Turkey Point Units 3 and 4 ART Values				
Material	EFPY	Peak Clad/Base Metal Fluence (E > 1.0 MeV)	1/4T Fluence (E > 1.0 MeV)	3/4T Fluence (E > 1.0 MeV)
Turkey Point Unit 3				
Intermediate Shell Forging (Ht. # 123P461VA1)	32	5.0×10^{19} n/cm^2	3.11×10^{19} n/cm^2	1.20×10^{19} n/cm^2
Lower Shell Forging (Ht. # 123S266VA1)	32	4.0×10^{19} n/cm^2	2.49×10^{19} n/cm^2	9.64×10^{18} n/cm^2
Int/Lower Shell Circ. Weld (Ht. # 71249)	32	3.0×10^{19} n/cm^2	1.87×10^{19} n/cm^2	7.23×10^{18} n/cm^2
Intermediate Shell Forging (Ht. # 123P461VA1)	48	7.0×10^{19} n/cm^2	4.36×10^{19} n/cm^2	1.69×10^{19} n/cm^2
Lower Shell Forging (Ht. # 123S266VA1)	48	6.0×10^{19} n/cm^2	3.73×10^{19} n/cm^2	1.45×10^{19} n/cm^2
Int/Lower Shell Circ. Weld (Ht. # 71249)	48	4.5×10^{19} n/cm^2	2.80×10^{19} n/cm^2	1.08×10^{19} n/cm^2
Turkey Point Unit 4				
Intermediate Shell Forging (Ht. # 123P481VA1)	32	5.0×10^{19} n/cm^2	3.11×10^{19} n/cm^2	1.20×10^{19} n/cm^2
Lower Shell Forging (Ht. # 122S180VA1)	32	4.0×10^{19} n/cm^2	2.49×10^{19} n/cm^2	9.64×10^{18} n/cm^2
Int/Lower Shell Circ. Weld (Ht. # 71249)	32	3.0×10^{19} n/cm^2	1.87×10^{19} n/cm^2	7.23×10^{18} n/cm^2
Intermediate Shell Forging (Ht. # 123P481VA1)	48	7.0×10^{19} n/cm^2	4.36×10^{19} n/cm^2	1.69×10^{19} n/cm^2
Lower Shell Forging (Ht. # 122S180VA1)	48	6.0×10^{19} n/cm^2	3.73×10^{19} n/cm^2	1.45×10^{19} n/cm^2
Int/Lower Shell Circ. Weld (Ht. # 71249)	48	4.5×10^{19} n/cm^2	2.80×10^{19} n/cm^2	1.08×10^{19} n/cm^2

7.3 Fluence Factors:

The fluence factors were calculated per Regulatory Guide 1.99, Revision 2, using the following equation.

FF = fluence factor = $f^{(0.28 - 0.1 \log (f))}$

where: f = Vessel inner wall surface fluence, 1/4 T fluence or 3/4T fluence, [10^{19} n/cm^2 (E > 1.0 MeV) $\div$ 10^{19} n/cm^2 (E > 1.0 MeV)]

Contained in Table 7-3 is a summary of the calculated fluence factors for 32 and 48 EFPY.

TABLE 7-3					
Summary of Fluence Factors Used to Calculate the Turkey Point Units 3 and 4 ART Values					
Material	EFPY	1/4T Fluence (E > 1.0 MeV)	Fluence Factor	3/4T Fluence (E > 1.0 MeV)	Fluence Factor
Turkey Point Unit 3					
Inter. Shell Forging (Ht. #123P461VA1)	32	3.11×10^{19} n/cm^2	1.30	1.20×10^{19} n/cm^2	1.05
Lower Shell Forging (Ht. #123S266VA1)	32	2.49×10^{19} n/cm^2	1.25	9.64×10^{18} n/cm^2	0.99
Int/Lower Shell Circ. Weld	32	1.87×10^{19} n/cm^2	1.17	7.23×10^{18} n/cm^2	0.91
Inter. Shell Forging (Ht. #123P461VA1)	48	4.36×10^{19} n/cm^2	1.37	1.69×10^{19} n/cm^2	1.14
Lower Shell Forging (Ht. #123S266VA1)	48	3.73×10^{19} n/cm^2	1.34	1.45×10^{19} n/cm^2	1.10
Int/Lower Shell Circ. Weld	48	2.80×10^{19} n/cm^2	1.27	1.08×10^{19} n/cm^2	1.02
Turkey Point Unit 4					
Inter. Shell Forging (Ht. #123P481VA1)	32	3.11×10^{19} n/cm^2	1.30	1.20×10^{19} n/cm^2	1.05
Lower Shell Forging (Ht. #122S180VA1)	32	2.49×10^{19} n/cm^2	1.25	9.64×10^{18} n/cm^2	0.99
Int/Lower Shell Circ. Weld	32	1.87×10^{19} n/cm^2	1.17	7.23×10^{18} n/cm^2	0.91
Inter. Shell Forging (Ht. #123P481VA1)	48	4.36×10^{19} n/cm^2	1.37	1.69×10^{19} n/cm^2	1.14
Lower Shell Forging (Ht. #122S180VA1)	48	3.73×10^{19} n/cm^2	1.34	1.45×10^{19} n/cm^2	1.10
Int/Lower Shell Circ. Weld	48	2.80×10^{19} n/cm^2	1.27	1.08×10^{19} n/cm^2	1.02

8.0 CALCULATION OF ADJUSTED REFERENCE TEMPERATURE

8.1 Methodology:

From Regulatory Guide 1.99, Revision 2, the adjusted reference temperature (ART) for each material in the beltline region is given by the following expression:

$$ART = Initial\ RT_{NDT} + \Delta\ RT_{NDT} + Margin$$

Initial RT_{NDT} is the reference temperature for the unirradiated material as defined in paragraph NB-2331 of Section III of the ASME Boiler and Pressure Vessel Code[7]. If measured values of initial RT_{NDT} for the material in question are not available, generic mean values for that class of material may be used if there are sufficient test results to establish a mean and standard deviation for the class.

ΔRT_{NDT} is the mean value of the adjustment in reference temperature caused by irradiation and should be calculated as follows:

$$\Delta\ RT_{NDT} = CF * f^{(0.28-0.10\log f)}$$

To calculate ΔRT_{NDT} at any depth (e.g., at 1/4T or 3/4T), the following formula must first be used to attenuate the fluence at the specific depth. $F = F_{surf}^{(-.24x)}$

The resultant fluence is then placed in the equation above to calculate the ΔRT_{NDT} at the specific depth. The calculated CF and FF values are given in Tables 4-1 and 7-3 of this report.

When there are "two or more credible surveillance data sets"[1] available, Regulatory Guide 1.99 Revision 2, Position 2.1, states "To calculate the Margin in this case, use Equation 4; the values given there for σ_Δ may be cut in half". Equation 4 from Regulatory Guide 1.99 Revision 2, is as follows:

$$M = 2\sqrt{\sigma_I^2 + \sigma_\Delta^2}$$

The values of σ_Δ are referred to as "28°F for welds and 17°F for base metals."

Standard Deviation for Initial RT_{NDT} Margin Term, σ_I: If the initial RT_{NDT} values are measured values, then σ_I is taken to be 0°F, otherwise use 17°F.

Standard Deviation for ΔRT_{NDT} Margin Term, σ_Δ: Per Regulatory Guide 1.99 Revision 2, Position 1.1, the values of σ_Δ are referred to as "28°F for welds and 17°F for base metal, except that σ_Δ need not exceed 0.50 times the mean value of ΔRT_{NDT}." The "mean value of ΔRT_{NDT}" is defined in Regulatory Guide 1.99 Revision 2, by Equation 2. The chemistry factor in Regulatory Guide 1.99, Revision 2, Equation 2 is calculated from Tables 1 and 2 of Regulatory Guide 1.99 Revision 2.

Per Regulatory Guide 1.99, Revision 2, Position 2.1, when there is credible surveillance data, σ_Δ is taken to be the lesser of ½ΔRT_{NDT} or 14°F (28°F/2) for welds, or 8.5°F (17°F/2) for base metal. ΔRT_{NDT} again is defined herein by Equation 4, while utilizing a "Best-Fit Chemistry Factor" calculated in accordance with Position 2.1 of Regulatory Guide 1.99, Revision 2.

Since σ_I is taken to be zero when a heat-specific measured value of initial RT_{NDT} are available (as they are in this case), the total margin term, based on Equation 4 of Regulatory Guide 1.99, Revision 2, is as follows:

Position 1.1: Lesser of ΔRT_{NDT} or 56°F for Welds
Lesser of ΔRT_{NDT} or 34°F for Base Metal

Position 2.1: Lesser of ΔRT_{NDT} or 28°F for Welds
Lesser of ΔRT_{NDT} or 17°F for Base Metal

8.2 Adjusted Reference Temperature (ART) Calculations:

The ART calculations along with the actual margin terms used for Turkey Point are listed in Tables 8-1 through 8-4.

TABLE 8-1							
Calculation of the ART Values for Turkey Point Units 3 and 4 for the 1/4T Location and 32 EFPY							
Material	RG 1.99 R2 Method	CF	FF	ΔRT_{NDT}[(a)]	Margin	IRT_{NDT}	ART
Turkey Point Unit 3							
Intermediate Shell Forging (Ht. # 123P461VA1)	Position 2.1	14.55°F	1.30	18.9°F	17°F	40°F	75.9°F
Lower Shell Forging (Ht. # 123S266VA1)	Position 2.1	42.7°F	1.25	53.2°F	17°F	30°F	100.2°F
Int/Lower Shell Circ. Weld (Ht. # 71249)	Position 1.1	167.55°F	1.17	196.2°F	56°F	10°F	**262.2°F**
Turkey Point Unit 4							
Intermediate Shell Forging (Ht. # 123P481VA1)	Position 2.1	31°F	1.30	40.28°F	34°F	50°F	124.3°F
Lower Shell Forging (Ht. # 122S180VA1)	Position 2.1	5.35°F	1.25	6.66°F	17°F	40°F	63.7°F
Int/Lower Shell Circ. Weld (Ht. # 71249)	Position 1.1	167.55°F	1.17	196.2°F	56°F	10°F	**262.2°F**

(a) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

TABLE 8-2							
Calculation of the ART Values for Turkey Point Units 3 and 4 for the 3/4T Location and 32 EFPY							
Material	RG 1.99 R2 Method	CF	FF	ΔRT_{NDT}(a)	Margin	IRT_{NDT}	ART
Turkey Point Unit 3							
Intermediate Shell Forging (Ht. # 123P461VA1)	Position 2.1	14.55°F	1.05	15.3°F	17°F	40°F	72.3°F
Lower Shell Forging (Ht. # 123S266VA1)	Position 2.1	42.7°F	0.99	42.3°F	17°F	30°F	89.3°F
Int/Lower Shell Circ. Weld (Ht. # 71249)	Position 1.1	167.55°F	0.91	152.3°F	56°F	10°F	**218.3°F**
Turkey Point Unit 4							
Intermediate Shell Forging (Ht. # 123P481VA1)	Position 2.1	31°F	1.05	32.55°F	34°F	50°F	116.6°F
Lower Shell Forging (Ht. # 122S180VA1)	Position 2.1	5.35°F	0.99	5.3°F	17°F	40°F	64.3°F
Int/Lower Shell Circ. Weld (Ht. # 71249)	Position 1.1	167.55°F	0.91	152.3°F	56°F	10°F	**218.3°F**

(a) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

TABLE 8-3							
Calculation of the ART Values for Turkey Point Units 3 and 4 for the 1/4T Location and 48 EFPY							
Material	RG 1.99 R2 Method	CF	FF	ΔRT_{NDT}[(a)]	Margin	IRT_{NDT}	ART
Turkey Point Unit 3							
Intermediate Shell Forging (Ht. # 123P461VA1)	Position 1.1	14.55°F	1.37	20.0°F	17°F	40°F	77.0°F
Lower Shell Forging (Ht. # 123S266VA1)	Position 2.1	42.7°F	1.34	57.3°F	17°F	30°F	104.3°F
Int/Lower Shell Circ. Weld (Ht. # 71249)	Position 1.1	167.55°F	1.27	212.5°F	56°F	10°F	**279.5°F**
Turkey Point Unit 4							
Inter. Shell Forging (Ht. # 123P481VA1)	Position 1.1	31°F	1.37	42.6°F	34°F	50°F	126.5°F
Lower Shell Forging (Ht. # 122S180VA1)	Position 2.1	5.35°F	1.34	7.2°F	17°F	40°F	64.2°F
Int/Lower Shell Circ. Weld (Ht. # 71249)	Position 1.1	167.55°F	1.27	212.5°F	56°F	10°F	**279.5°F**

(a) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

TABLE 8-4

Calculation of the ART Values for Turkey Point Units 3 and 4 for the 3/4T Location and 48 EFPY

Material	RG 1.99 R2 Method	CF	FF	ΔRT_{NDT} (a)	Margin	IRT_{NDT}	ART
Turkey Point Unit 3							
Intermediate Shell Forging (Ht. # 123P461VA1)	Position 1.1	14.55°F	1.14	16.6°F	17°F	40°F	73.6°F
Lower Shell Forging (Ht. # 123S266VA1)	Position 2.1	42.7°F	1.10	47.1°F	17°F	30°F	94.1°F
Int/Lower Shell Circ. Weld (Ht. # 71249)	Position 1.1	167.55°F	1.02	171.3°F	56°F	10°F	**237.3°F**
Turkey Point Unit 4							
Intermediate Shell Forging (Ht. # 123P481VA1)	Position 1.1	31°F	1.14	35.5°F	34°F	50°F	119.3°F
Lower Shell Forging (Ht. # 122S180VA1)	Position 2.1	5.35°F	1.10	5.9°F	17°F	40°F	62.9°F
Int/Lower Shell Circ. Weld (Ht. # 71249)	Position 1.1	167.55°F	1.02	171.3°F	56°F	10°F	**237.3°F**

(a) The values shown are the rounded results from the FP&L spreadsheet calculations with up to eight significant digits. The values may vary slightly from results calculated using the listings in the table.

Contained in Tables 8-5 and 8-6 is a summary of the limiting ART values used in the generation of the Turkey Point Units 3 and 4 reactor vessel heatup and cooldown curves.

TABLE 8-5		
Summary of the Limiting Circumferential Weld Seam ART Values to be Used in the Generation of the Turkey Point Reactor Vessel Heatup and Cooldown Curves		
EFPY	1/4 T Limiting ART	3/4 Limiting ART
32	262°F	218°F
48	280°F	237°F

TABLE 8-6		
Summary of the Limiting Forging ART Values to be Used in the Generation of the Turkey Point Reactor Vessel Heatup and Cooldown Curves		
EFPY	1/4 T Limiting ART	3/4 Limiting ART
32	124°F	117°F
48	127°F	119°F

9.0 HEATUP AND COOLDOWN PRESSURE-TEMPERATURE LIMIT CURVES

9.1 Introduction and Methodology:

Pressure-temperature limit curves for normal heatup and cooldown of the primary reactor coolant system have been calculated for the pressure and temperature in the reactor vessel beltline region using the methods discussed in Sections 3 and 8 of this report.

Figure 9-1 presents the heatup curves without margins for possible instrumentation errors for heatup rates of 60 and 100°F/hr. This curve is applicable to 32 EFPY (current end of license). Figure 9-2 presents the cooldown curves without margins for possible instrumentation errors for cooldown rates of 0, 20, 40, 60, and 100°F/hr. These curves are also applicable to 32 EFPY (current end of license). Figure 9-3 presents the heatup curves without margins for possible instrumentation errors for heatup rates of 60 and 100°F/hr. These curves are applicable to 48 EFPY (end of license renewal). Figure 9-4 presents the cooldown curves without margins for possible instrumentation errors for cooldown rates of 0, 20, 40, 60, and 100°F/hr. These curves are also applicable to 48 EFPY (end of license renewal). Allowable combinations of temperature and pressure for specific temperature change rates are below and to the right of the limit lines shown in Figures 9-1 through 9-4. This is in addition to other criteria which must be met before the reactor is made critical, as discussed in the following paragraphs.

The reactor must not be made critical until pressure-temperature combinations are to the right of the criticality limit line shown in Figures 9-1 and 9-3. The straight-line portion of the criticality limit is at the minimum permissible temperature for the 2485 psig inservice hydrostatic test as required by Appendix G to 10 CFR Part 50. The governing equation for the hydrostatic test is defined in Appendix G to Section XI of the ASME Code[3] as follows:

$$1.5\, K_{Im} < K_{Ic}$$

where,

K_{Im} is the stress intensity factor covered by membrane (pressure) stress,
$K_{Ic} = 33.2 + 20.734\, e^{[0.02\,(T - RT_{NDT})]}$,
T is the minimum permissible metal temperature, and
RT_{NDT} is the metal reference nil-ductility temperature

The criticality limit curve specifies pressure-temperature limits for core operation to provide additional margin during actual power production as specified in Reference 2. The pressure-temperature limits for core operation (except for low power physics tests) are that the reactor vessel must be at a temperature equal to or higher than the minimum temperature required for the inservice hydrostatic test, and at least 40°F higher than the minimum permissible temperature in the corresponding pressure-temperature curve for heatup and cooldown calculated as described in Section 3 of this report. The vertical line drawn from these points on the pressure-temperature curve, intersecting a curve 40°F higher than the pressure-temperature limit curve, constitutes the limit for core operation for the reactor vessel.

Figures 9-1 through 9-4 define all of the above limits for ensuring prevention of nonductile failure for the Turkey Point Units 3 and 4 reactor vessels. The data points for the heatup and cooldown pressure-temperature limit curves shown in Figures 9-1 through 9-4 are presented in Tables 9-1 through 9-4.

MATERIAL PROPERTY BASIS

LIMITING MATERIAL: Intermediate/Lower Shell Circumferential Weld Seams (Ht. # 71249)

LIMITING ART VALUES AT 32 EFPY: 1/4T, 262°F

3/4T, 218°F

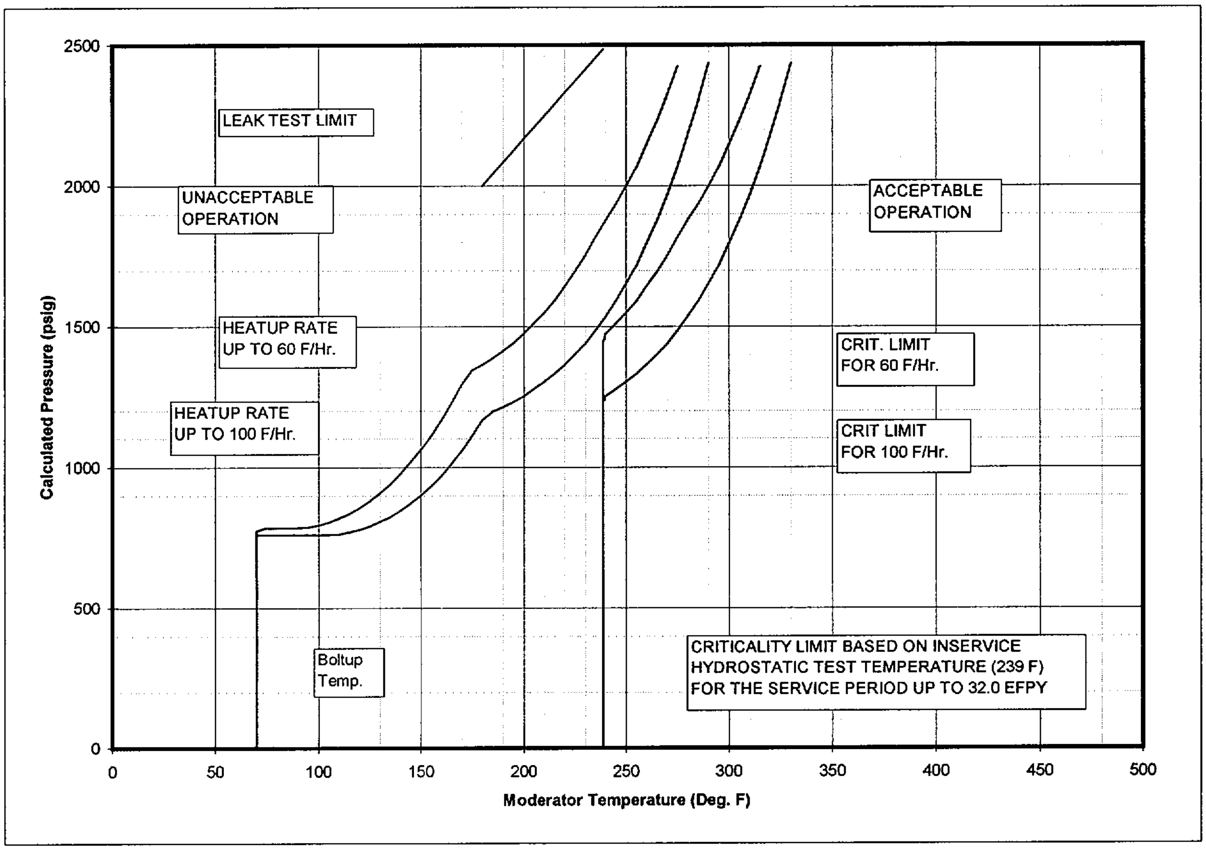

FIGURE 9-1 Turkey Point Units 3 and 4 Reactor Coolant System Heatup Limitations (Heatup Rate of 60 and 100°F/hr) Applicable for 32 EFPY (Without Margins for Instrumentation Errors)

MATERIAL PROPERTY BASIS

LIMITING MATERIAL: Intermediate/Lower Shell Circumferential Weld Seams (Ht. # 71249)

LIMITING ART VALUES AT 32 EFPY: 1/4T, 262°F

3/4T, 218°F

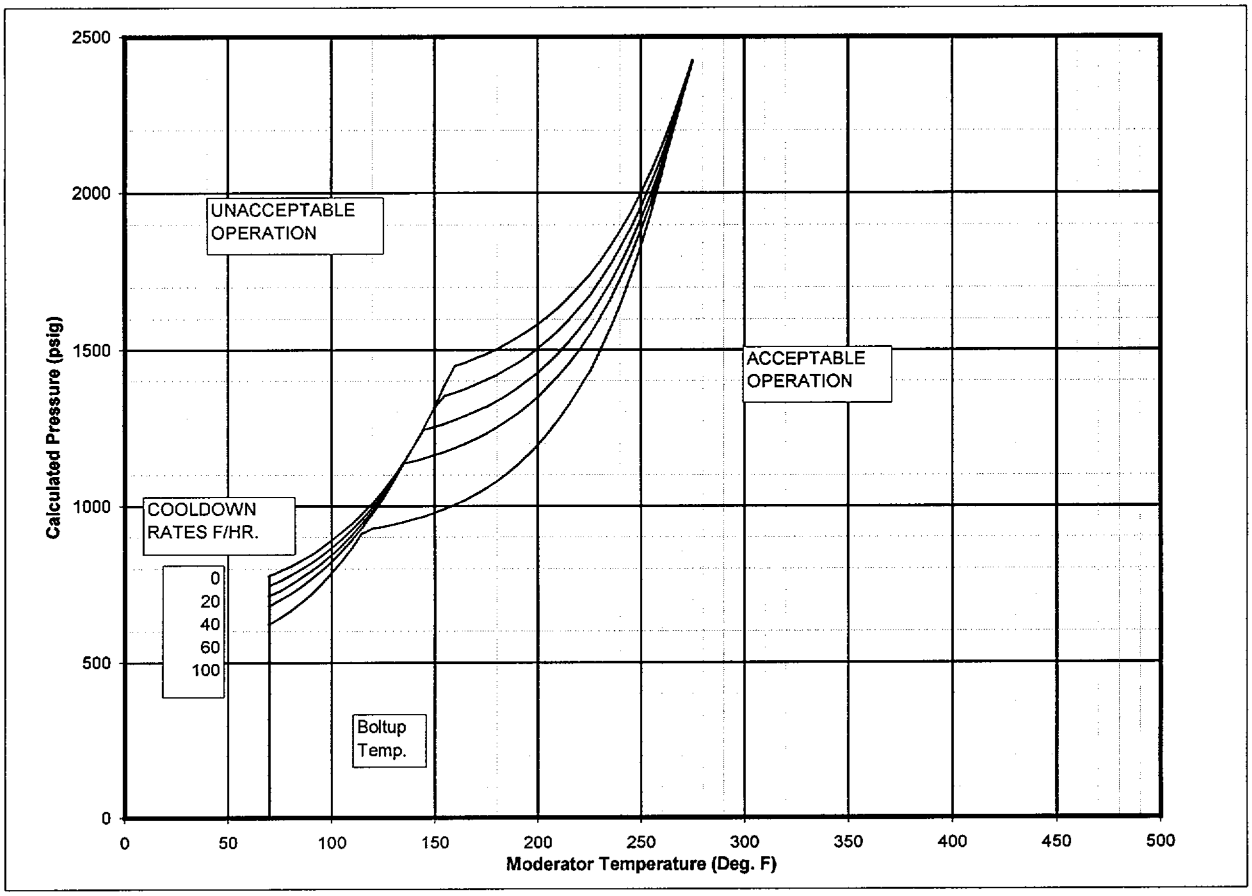

FIGURE 9-2 Turkey Point Units 3 and 4 Reactor Coolant System Cooldown Limitations (Cooldown Rates of 0, 20, 40, 60 and 100°F/hr) Applicable for 32 EFPY (Without Margins for Instrumentation Errors)

MATERIAL PROPERTY BASIS

LIMITING MATERIAL: Intermediate/Lower Shell Circumferential Weld Seams (Ht. # 71249)
LIMITING ART VALUES AT 48 EFPY: 1/4T, 280°F
3/4T, 237°F

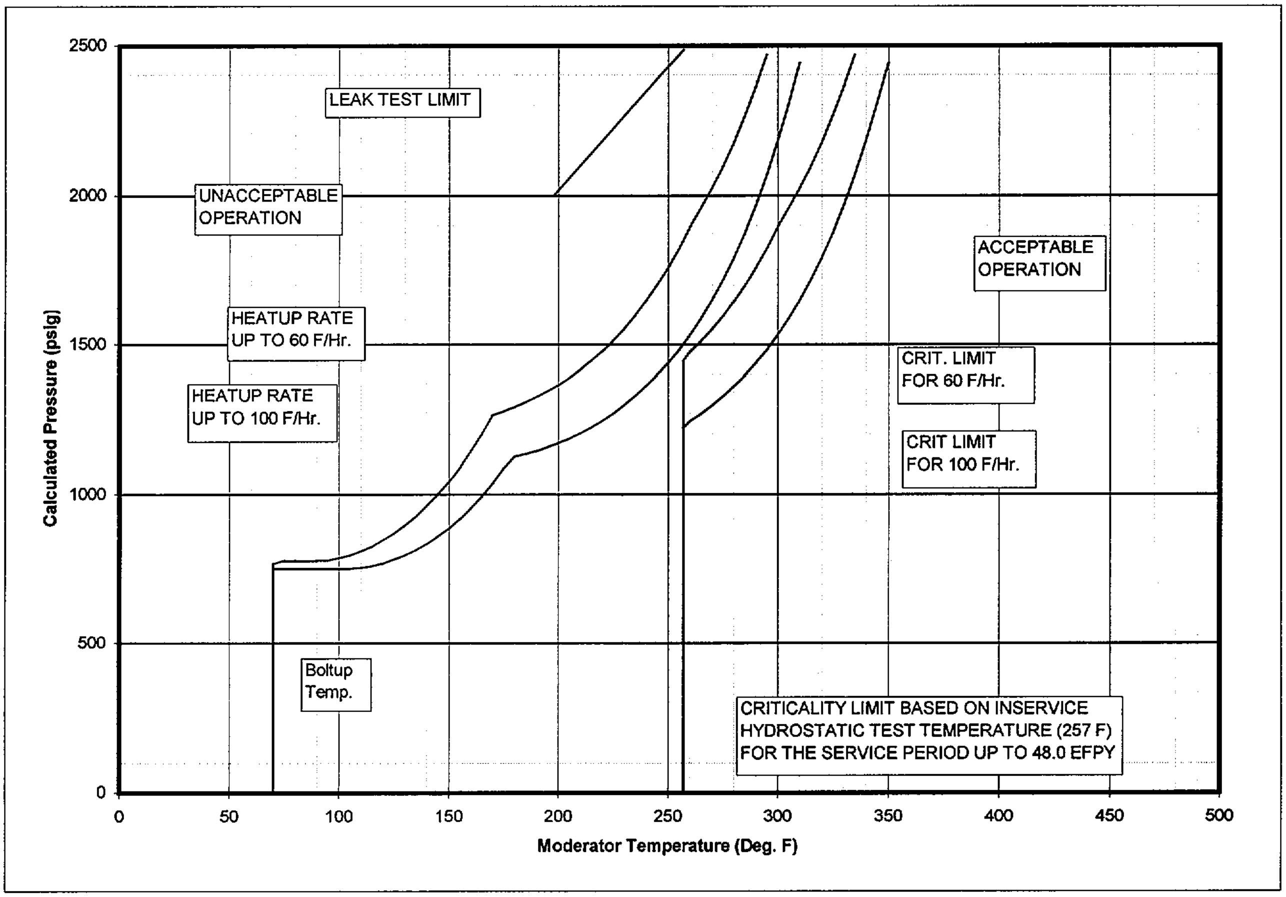

FIGURE 9-3 Turkey Point Units 3 and 4 Reactor Coolant System Heatup Limitations (Heatup Rate of

60 and 100°F/hr) Applicable for 48 EFPY (Without Margins for Instrumentation Errors)

MATERIAL PROPERTY BASIS

LIMITING MATERIAL: Intermediate/Lower Shell Circumferential Weld Seams (Ht. # 71249)

LIMITING ART VALUES AT 48 EFPY: 1/4T, 280°F

3/4T, 237°F

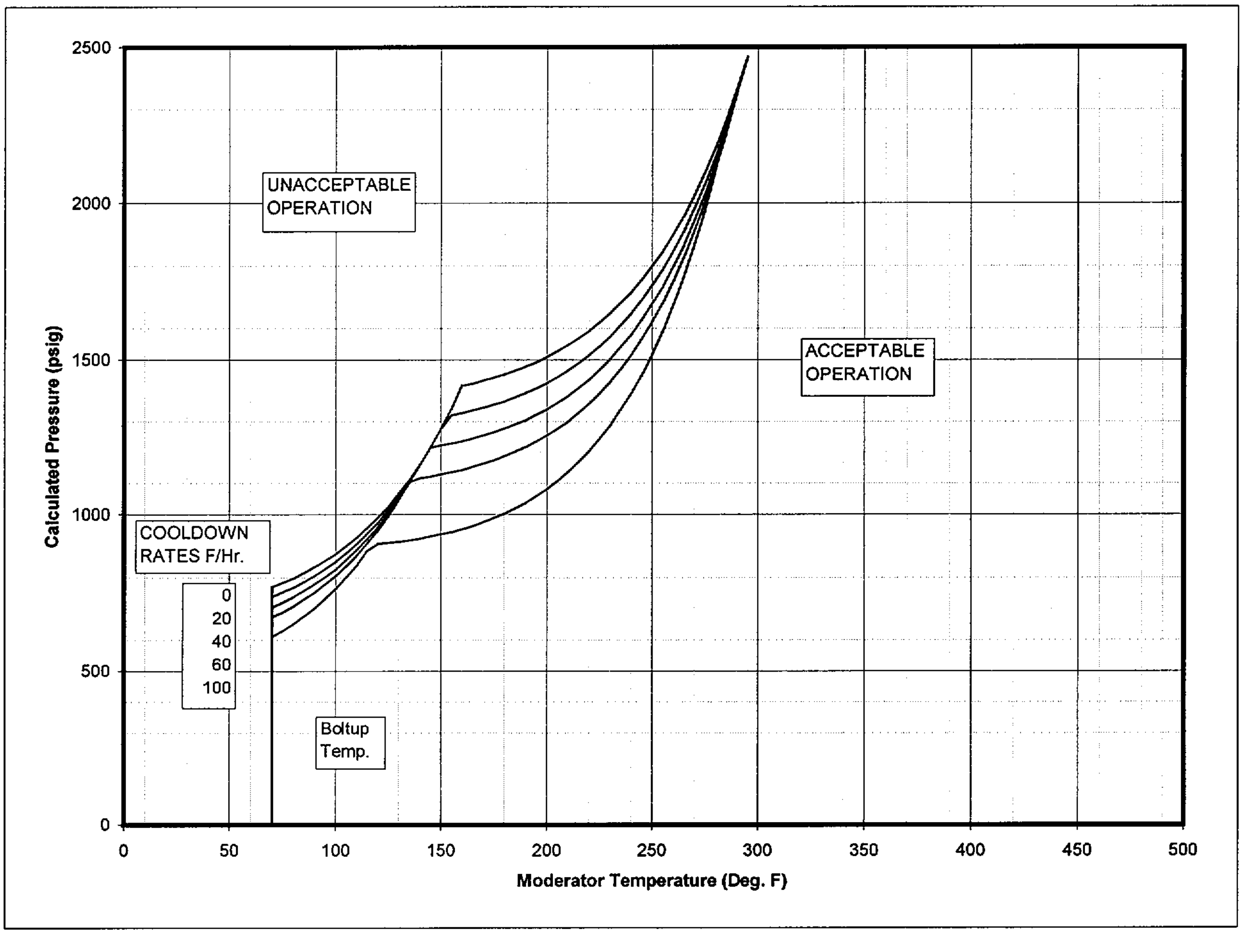

FIGURE 9-4 Turkey Point Units 3 and 4 Reactor Coolant System Cooldown Limitations (Cooldown Rates of 0, 20, 40, 60 and 100°F/hr) Applicable for 48 EFPY (Without Margins for Instrumentation Errors)

TABLE 9-1
Turkey Point Units 3 and 4 Reactor Vessel Heatup Curve Data Points for 32 EFPY
Without Margins for Instrumentation Errors

60 Heatup		60 Critical Limit		100 Heatup		100 Critical Limit		Leak Test Limit	
T	P	T	P	T	P	T	P	T	P
70	0	239	0	70	0	239	0	180	2000
70	776	239	1355	70	761	239	1133	239	2485
75	786	239	1291	75	761	239	1133		
80	786	239	1269	80	761	239	1133		
85	786	239	1254	85	761	239	1133		
90	786	239	1243	90	761	239	1133		
95	788	239	1235	95	761	239	1133		
100	794	239	1231	100	761	239	1133		
105	805	239	1229	105	761	239	1133		
110	819	239	1230	110	764	239	1133		
115	836	239	1232	115	770	239	1133		
120	857	239	1236	120	779	239	1133		
125	881	239	1241	125	791	239	1133		
130	909	239	1248	130	807	239	1133		
135	941	239	1257	135	825	239	1133		
140	976	239	1267	140	847	239	1135		
145	1016	239	1279	145	872	239	1139		
150	1060	239	1292	150	900	239	1144		
155	1110	239	1307	155	933	239	1151		
160	1165	239	1324	160	970	239	1159		
165	1226	239	1343	165	1011	239	1170		
170	1293	239	1364	170	1057	239	1182		
175	1343	239	1387	175	1109	239	1196		
180	1364	239	1413	180	1166	239	1212		
185	1387	239	1442	185	1196	239	1231		
190	1413	240	1474	190	1212	240	1251		
195	1442	245	1509	195	1231	245	1275		
200	1474	250	1549	200	1251	250	1301		
205	1509	255	1592	205	1275	255	1330		
210	1549	260	1640	210	1301	260	1363		
215	1592	265	1693	215	1330	265	1399		
220	1640	270	1752	220	1363	270	1440		
225	1693	275	1816	225	1399	275	1485		
230	1752	280	1877	230	1440	280	1534		
235	1816	285	1934	235	1485	285	1589		
240	1877	290	1997	240	1534	290	1650		

245	1934	295	2066	245	1589	295	1717	

TABLE 9-1 - Continued

Turkey Point Units 3 and 4 Reactor Vessel Heatup Curve Data Points for 32 EFPY

Without Margins for Instrumentation Errors

60 Heatup		60 Critical Limit		100 Heatup		100 Critical Limit		
T	P	T	P	T	P	T	P	
250	1997	300	2142	250	1650	300	1792	
255	2066	305	2227	255	1717	305	1874	
260	2142	310	2320	260	1792	310	1965	
265	2227	315	2423	265	1874	315	2065	
270	2320			270	1965	320	2176	
275	2423			275	2065	325	2298	
				280	2176	330	2433	
				285	2298			
				290	2433			

TABLE 9-2

Turkey Point Units 3 and 4 Reactor Vessel Cooldown Curve Data Points for 32 EFPY Without Margins for Instrumentation Errors

Steady State		20F		40F		60F		100F	
T	P	T	P	T	P	T	P	T	P
70	0	70	0	70	0	70	0	70	0
70	776	70	745	70	713	70	682	70	621
75	791	75	760	75	730	75	700	75	641
80	806	80	777	80	748	80	719	80	664
85	824	85	796	85	768	85	741	85	689
90	843	90	816	90	790	90	765	90	717
95	864	95	839	95	815	95	791	95	749
100	888	100	865	100	842	100	821	100	783
105	914	105	893	105	872	105	854	105	822
110	943	110	924	110	906	110	890	110	865
115	975	115	958	115	943	115	930	115	912
120	1010	120	996	120	984	120	975	120	928
125	1049	125	1038	125	1029	125	1024	125	934
130	1092	130	1084	130	1080	130	1078	130	941
135	1139	135	1136	135	1135	135	1136	135	948
140	1191	140	1191	140	1191	140	1143	140	957
145	1249	145	1249	145	1242	145	1152	145	966
150	1313	150	1313	150	1252	150	1162	150	977
155	1384	155	1350	155	1262	155	1172	155	990
160	1448	160	1361	160	1273	160	1184	160	1003
165	1459	165	1373	165	1286	165	1198	165	1019
170	1472	170	1386	170	1300	170	1213	170	1036
175	1486	175	1401	175	1316	175	1230	175	1056
180	1501	180	1418	180	1333	180	1249	180	1077
185	1518	185	1436	185	1353	185	1269	185	1102
190	1537	190	1456	190	1374	190	1293	190	1129
195	1558	195	1478	195	1398	195	1318	195	1159
200	1581	200	1503	200	1425	200	1347	200	1193
205	1606	205	1530	205	1454	205	1379	205	1231
210	1634	210	1560	210	1487	210	1414	210	1272

TABLE 9-2 - Continued

Turkey Point Units 3 and 4 Reactor Vessel Cooldown Curve Data Points for 32 EFPY

Without Margins for Instrumentation Errors

Steady State		20F		40F		60F		100F	
T	P	T	P	T	P	T	P	T	P
215	1665	215	1594	215	1523	215	1454	215	1319
220	1700	220	1631	220	1563	220	1497	220	1371
225	1738	225	1672	225	1608	225	1545	225	1428
230	1780	230	1717	230	1657	230	1599	230	1492
235	1826	235	1768	235	1711	235	1658	235	1563
240	1877	240	1823	240	1772	240	1724	240	1642
245	1934	245	1885	245	1839	245	1797	245	1729
250	1997	250	1953	250	1913	250	1878	250	1826
255	2066	255	2028	255	1995	255	1967	255	1933
260	2142	260	2111	260	2085	260	2066	260	2052
265	2227	265	2203	265	2186	265	2176	265	2184
270	2320	270	2305	270	2297	270	2298		
275	2423	275	2417	275	2420				

TABLE 9-3

Turkey Point Units 3 and 4 Reactor Vessel Heatup Curve Data Points for 48 EFPY Without Margins for Instrumentation Errors

60 Heatup		60 Critical Limit		100 Heatup		100 Critical Limit		Leak Test Limit	
T	P	T	P	T	P	T	P	T	P
70	0	257	0	70	0	257	0	198	2000
70	768	257	1350	70	753	257	1102	257	2485
75	779	257	1276	75	753	257	1102		
80	779	257	1254	80	753	257	1102		
85	779	257	1238	85	753	257	1102		
90	779	257	1225	90	753	257	1102		
95	781	257	1217	95	753	257	1102		
100	786	257	1211	100	753	257	1102		
105	796	257	1207	105	753	257	1102		
110	809	257	1205	110	756	257	1102		
115	826	257	1205	115	761	257	1102		
120	846	257	1207	120	770	257	1102		
125	869	257	1210	125	781	257	1102		
130	896	257	1214	130	796	257	1102		
135	926	257	1219	135	813	257	1102		
140	960	257	1225	140	834	257	1102		
145	998	257	1232	145	858	257	1103		
150	1041	257	1241	150	885	257	1105		
155	1088	257	1251	155	916	257	1108		
160	1141	257	1262	160	952	257	1112		
165	1200	257	1274	165	991	257	1118		
170	1262	257	1288	170	1036	257	1125		
175	1274	257	1304	175	1085	257	1134		
180	1288	257	1321	180	1125	257	1144		
185	1304	257	1341	185	1134	257	1156		
190	1321	257	1362	190	1144	257	1169		
195	1341	257	1386	195	1156	257	1184		
200	1362	257	1413	200	1169	257	1202		
205	1386	257	1442	205	1184	257	1221		
210	1413	260	1475	210	1202	260	1243		
215	1442	265	1511	215	1221	265	1267		
220	1475	270	1550	220	1243	270	1294		
225	1511	275	1594	225	1267	275	1324		
230	1550	280	1643	230	1294	280	1357		
235	1594	285	1697	235	1324	285	1394		
240	1643	290	1756	240	1357	290	1435		

245	1697	295	1822	245	1394	295	1481	

TABLE 9-3 - Continued

Turkey Point Units 3 and 4 Reactor Vessel Heatup Curve Data Points for 48 EFPY Without Margins for Instrumentation Errors

60 Heatup		60 Critical Limit		100 Heatup		100 Critical Limit		
T	P	T	P	T	P	T	P	
250	1756	300	1895	250	1435	300	1531	
255	1822	305	1958	255	1481	305	1587	
260	1895	310	2023	260	1531	310	1648	
265	1958	315	2095	265	1587	315	1716	
270	2023	320	2175	270	1648	320	1791	
275	2095	325	2263	275	1716	325	1875	
280	2175	330	2360	280	1791	330	1966	
285	2263	335	2468	285	1875	335	2068	
290	2360			290	1966	340	2179	
295	2468			295	2068	345	2303	
				300	2179	350	2439	
				305	2303			
				310	2439			

TABLE 9-4
Turkey Point Units 3 and 4 Reactor Vessel Cooldown Curve Data Points for 48 EFPY
Without Margins for Instrumentation Errors

Steady State		20F		40F		60F		100F	
T	P	T	P	T	P	T	P	T	P
70	0	70	0	70	0	70	0	70	0
70	768	70	736	70	704	70	672	70	609
75	782	75	751	75	719	75	689	75	628
80	797	80	766	80	737	80	707	80	649
85	813	85	784	85	755	85	727	85	673
90	831	90	804	90	776	90	750	90	700
95	851	95	825	95	800	95	775	95	729
100	874	100	849	100	825	100	803	100	762
105	898	105	875	105	854	105	834	105	798
110	925	110	905	110	885	110	868	110	838
115	955	115	937	115	920	115	905	115	883
120	988	120	973	120	959	120	947	120	906
125	1025	125	1012	125	1002	125	994	125	910
130	1065	130	1056	130	1049	130	1045	130	914
135	1110	135	1104	135	1101	135	1102	135	918
140	1159	140	1158	140	1159	140	1115	140	923
145	1214	145	1214	145	1214	145	1121	145	929
150	1274	150	1274	150	1220	150	1127	150	936
155	1341	155	1318	155	1227	155	1134	155	944
160	1414	160	1325	160	1235	160	1142	160	953
165	1423	165	1334	165	1243	165	1151	165	964
170	1431	170	1343	170	1253	170	1162	170	975
175	1441	175	1353	175	1264	175	1173	175	988
180	1452	180	1364	180	1276	180	1186	180	1002
185	1464	185	1377	185	1289	185	1200	185	1019
190	1477	190	1391	190	1304	190	1216	190	1037
195	1492	195	1406	195	1320	195	1233	195	1058
200	1508	200	1423	200	1338	200	1253	200	1080
205	1525	205	1442	205	1359	205	1275	205	1106
210	1545	210	1463	210	1381	210	1299	210	1135
215	1567	215	1487	215	1406	215	1326	215	1166
220	1591	220	1512	220	1434	220	1356	220	1202
225	1617	225	1541	225	1465	225	1389	225	1241

TABLE 9-4 - Continued
Turkey Point Units 3 and 4 Reactor Vessel Cooldown Curve Data Points for 48 EFPY
Without Margins for Instrumentation Errors

Steady State		20F		40F		60F		100F	
T	P	T	P	T	P	T	P	T	P
230	1646	230	1572	230	1499	230	1426	230	1285
235	1679	235	1607	235	1537	235	1467	235	1334
240	1715	240	1646	240	1578	240	1513	240	1388
245	1754	245	1689	245	1625	245	1563	245	1448
250	1798	250	1736	250	1676	250	1619	250	1515
255	1846	255	1788	255	1733	255	1681	255	1590
260	1899	260	1846	260	1796	260	1750	260	1672
265	1958	265	1910	265	1866	265	1826	265	1764
270	2023	270	1981	270	1943	270	1910	270	1865
275	2095	275	2059	275	2029	275	2004	275	1978
280	2175	280	2146	280	2123	280	2107	280	2102
285	2263	285	2242	285	2228	285	2222	285	2241
290	2360	290	2348	290	2344	290	2349		
295	2468	295	2465						

10.0 ENABLE TEMPERATURE CALCULATION:

10.1 ASME Code Case N-514 Methodology:

ASME Code Case N-514 requires that the LTOP or COMS system to be in operation at coolant temperatures less than 200°F or at coolant temperatures less than a temperature corresponding to a reactor vessel metal temperature less than RT_{NDT} + 50°F, whichever is greater. RT_{NDT} is the highest adjusted reference temperature (ART) for the limiting beltline material at a distance one fourth of the vessel section thickness from the vessel inside surface (ie. clad/base metal interface), as determined by Regulatory Guide 1.99, Revision 2.

10.2 32 EFPY Enable Temperature:

The highest calculated 1/4T ART for the Turkey Point Units 3 and 4 reactor vessel beltline regions at 32 EFPY is 262°F.

From the OPERLIM computer code output for the Turkey Point Units 3 and 4 32 EFPY Pressure-Temperature limit curves without margins the maximum ΔT_{metal} is:

Cooldown Rate (Steady-State Cooldown):
max (ΔT_{metal}) at 1/4T = 0°F

Heatup Rate of 60°F/Hr:
max (ΔT_{metal}) at 1/4T = 24.584°F

Enable Temperature (ENBT) = RT_{NDT} + 50 + max (ΔT_{metal}), °F
= (262 + 50 + 24.584) °F
= 336.584°F

The minimum required enable temperature for the Turkey Point Units 3 and 4 Reactor Vessels will be conservatively chosen to be 340°F for 32 EFPY.

10.3 48 EFPY Enable Temperature:

The highest calculated 1/4T ART for the Turkey Point Units 3 and 4 reactor vessel beltline regions at 48 EFPY is 280°F.

From the OPERLIM computer code output for the Turkey Point Units 3 and 4 48 EFPY Pressure-Temperature limit curves without margins the maximum ΔT_{metal} is:

Cooldown Rate (Steady-State Cooldown):

max (ΔT_{metal}) at 1/4T = 0°F

Heatup Rate of 60°F/Hr:
max (ΔT_{metal}) at 1/4T = 24.584°F

Enable Temperature (ENBT) = RT_{NDT} + 50 + max (ΔT_{metal}), °F
= (280 + 50 + 24.584) °F
= 354.584°F

The minimum required enable temperature for the Turkey Point Units 3 and 4 Reactor Vessels will be conservatively chosen to be 360°F for 48 EFPY.

11.0 REFERENCES

1 Regulatory Guide 1.99, Revision 2, "Radiation Embrittlement of Reactor Vessel Materials", U.S. Nuclear Regulatory Commission, May, 1988.

2 10 CFR Part 50, Appendix G, "Fracture Toughness Requirements", Federal Register, Volume 60, No. 243, dated December 19, 1995.

3 1997 ASME Boiler and Pressure Vessel (B&PV) Code, Section XI, Appendix G, "Fracture Toughness Criteria for Protection Against Failure".

4 Document No. PT-ENG-SESJ-99-0118, Revision 1, "Florida Power & Light Co., Reactor Vessel Data Turkey Point Units 3 & 4", dated February 8, 2000.

5 WCAP-8631, "Analysis of Capsule T from the Florida Power and Light Company Turkey Point Unit No. 3 Reactor Vessel Radiation Surveillance Program", Yanichko, S. E., et al., December 1975.

6 WCAP-7656, "Florida Power and Light Company Turkey Point Unit No. 3 Reactor Vessel Radiation Surveillance Program", Yanichko, S. E., et al., May 1971.

7 1989 Section III, Division 1 of the ASME Boiler and Pressure Vessel Code, Paragraph NB-2331, "Material for Vessels".

8. ASME Boiler and Pressure Vessel Code, Case N-640, "Alternative Reference Fracture Toughness For Development of P-T Limit Curves For Section XI, Division 1", Section XI, Division 1, Approved February 26, 1999

9. WCAP-15315, "Reactor Vessel Closure Head/Vessel Flange Requirements Evaluation For Operating PWR and BWR Plants", W. Bamford, et.al., October 1999.

10. Document No. PT-ENG-SESJ-99-0118, "Florida Power & Light Co., Reactor Vessel Data Turkey Point Units 3 & 4"

11. WCAP-7660, "Florida Power and Light Company Turkey Point Unit No. 4 Reactor Vessel Radiation Surveillance Program", Yanichko, S. E., May 1971.

ENCLOSURE 3

Low Temperature Overpressure Protection System Setpoints,

32 and 48 Effective Full Power Years

for Turkey Point Units 3 and 4,

Westinghouse Electric Company LLC,

January 2000.

Westinghouse Electric Company, LLC

Box 355
Pittsburgh Pennsylvania 15230-0355

February 17, 2000

CAW-00-1384

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

Attention: Mr. Samuel J. Collins

APPLICATION FOR WITHHOLDING PROPRIETARY
INFORMATION FROM PUBLIC DISCLOSURE

Subject "LTOPS System Setpoints Report at 32 and 48 EFPY for Turkey Point Units 3 and 4" [Proprietary]

Dear Mr. Collins:

The proprietary information for which withholding is being requested in the above-referenced report is further identified in Affidavit CAW-00-1384 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 First Energy Nuclear Operating Company.

Correspondence with respect to the proprietary aspects of the application for withholding or the Westinghouse affidavit should reference this letter, CAW-00-1384 and should be addressed to the undersigned.

Very truly yours,

H. A. Sepp, Manager
Regulatory and Licensing Engineering

Enclosures

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CAW-00-1384

AFFIDAVIT

COMMONWEALTH OF PENNSYLVANIA:

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COUNTY OF ALLEGHENY:

Before me, the undersigned authority, personally appeared Henry 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:

Henry A. Sepp, Manager
Regulatory and Licensing Engineering

Sworn to and subscribed
before me this 18th day
of February, 2000

Notary Public

Notarial Seal
Janet A. Schwab, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires May 22, 2000
Member, Pennsylvania Association of Notaries

(1) I am Manager, Regulatory and Licensing Engineering, in the Nuclear Services Business Unit of the 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 rulemaking proceedings, and am authorized to apply for its withholding on behalf of the Westinghouse.

(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 "LTOPS System Setpoints Report at 32 and 48 EFPY for Turkey Point Units 3 and 4", being transmitted by FPL 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 Florida Power and Light Company for the Turkey Point Units 3 and 4 is expected to be applicable in other licensee submittals in response to certain NRC requirements.

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

(a) Provide documentation of the methods for determination of equipment operability and acceptable calibration of the noted COMS setpoint development.

(b) Provide the specific design information related to the parameters that are considered for the COMS setpoint development.

(c) Assist the customer to obtain 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 calculation, evaluation 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 for developing testing and analytical methods and performing tests.

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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