The Power Range Negative Rate trip provides protection to ensure that the minimum DNBR is maintained above 1.30 for multiple control rod drop accidents. The analysis of a single control rod drop accident indicates a return to full power may be initiated by the automatic control system in response to a continued full power turbine load demand or by the negative moderator temperature feedback. This transient will not result in a DNBR of less than 1.30, therefore single rod drop protection is not required.

Intermediate and Source Range, Nuclear Flux

The Intermediate and Source Range, Nuclear Flux trips provide reactor core protection during reactor startup. These trips provide redundant protection to the low setpoint trip of the Power Range, Neutron Flux channels. The Source Range Channels will initiate a reactor trip at about 10^5 counts per second unless manually blocked when P-6 becomes active. The Intermediate Range Channels will initiate a reactor trip at a current level of 4×10^{-4} amps unless manually blocked when P-10 becomes active. No credit was taken for operation of the trips associated with either the Intermediate or Source Range Channels in the accident analyses; however, their functional capability at the specified trip settings is required by this specification to enhance the overall reliability of the Reactor Protection System.

Overtemperature ΔT

The Overtemperature ΔT trip provides core protection to prevent DNB for all combinations of pressure, power, coolant temperature, and axial power distribution, provided that the transient is slow with respect to piping transit delays from the core to the temperature detectors (about 4 seconds), and pressure is within the range between the High and Low Pressure reactor trips. This setpoint includes corrections for changes in density and heat capacity of water with temperature and dynamic compensation for piping delays from the core to the loop temperature detectors. With normal axial power distribution, this reactor trip limit is always below the core safety limit as shown in Figure 2.1-1. If axial peaks are greater than design, as indicated by the difference between top and bottom power range nuclear detectors, the reactor trip is automatically reduced according to the notations in Table 2.2-1.

TABLE 2.2-1

REACTOR TRIP SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUES
1. Manual Reactor Trip	Not Applicable	Not Applicable
2. Power Range, Neutron Flux	Low Setpoint - ≤25% of RATED THERMAL POWER	Low Setpoint - ≤26% of RATED THERMAL POWER
	High Setpoint- ≤109% of RATED THERMAL POWER	High Setpoint - ≤110% of RATED THERMAL POWER
3. Power Range, Neutron Flux, High Positive Rate	≤5% of RATED THERMAL POWER with a time constant ≥2 seconds	≤5.5% of RATED THERMAL POWER with a time constant ≥2 seconds
4. Power Range, Neutron Flux, High Negative Rate	≤5% of RATED THERMAL POWER with a time constant ≥2 seconds	≤5.5% of RATED THERMAL POWER with a time constant ≥ 2 seconds
5. Intermediate Range, Neutron Flux	$\leq 4\times10^{-4}$ amps	$\leq 5\times10^{-4}$ amps
6. Source Range, Neutron Flux	$\leq 10^{5}$ counts per second	$\leq 1.3 \times 10^{5}$ counts per second
7. Overtemperature ΔT	See Note 1	See Note 3
8. Overpower ΔT	See Note 2	See Note 3
9. Pressurizer Pressure-Low	≥1870 psig	≥1860 psig
10. Pressurizer Pressure-High	≤2385 psig	≤2395 psig
11. Pressurizer Water Level-High	≤92% of instrument span	≤93% of instrument span
12. Loss of Flow	≥90% of design flow per loop*	≥89% of design flow per loop*

*Design flow is 95,000 gpm per loop.

ATTACHMENT 2

Technical Specification Changes - Unit 2

Intermediate and Source Range, Nuclear Flux

The Intermediate and Source Range, Nuclear Flux Trips provide reactor core protection during reactor startup. These trips provide redundant protection to the low setpoint trip of the Power Range, Neutron Flux channels. The Source Range Channels will initiate a reactor trip at about 10^5 counts per second unless manually blocked when P-6 becomes active. The Intermediate Range Channels will initiate a reactor trip at a current level of 4×10^{-4} amps unless manually blocked when P-10 becomes active. No credit was taken for operation of the trips associated with either the Intermediate or Source Range Channels in the accident analyses; however, their functional capability at the specified trip settings is required by this specification to enhance the overall reliability of the Reactor Protection System.

Overtemperature Delta T

The Overtemperature Delta T trip provides core protection to prevent DNB for all combinations of pressure, power, coolant temperature, and axial power distribution, provided that the transient is slow with respect to piping transit delays from the core to the temperature detectors (about 4 seconds), and pressure is within the range between the High and Low Pressure reactor trips. This setpoint includes corrections for changes in density and heat capacity of water with temperature and dynamic compensation for piping delays from the core to the loop temperature detectors. With normal axial power distribution, this reactor trip limit is always below the core safety limit as shown in Figure 2.1-1. If axial peaks are greater than design, as indicated by the difference between top and bottom power range nuclear detectors, the reactor trip is automatically reduced according to the notations in Table 2.2-1.

Operation with a reactor coolant loop out of service below the 3 loop P-8 setpoint does not require reactor protection system setpoint modification because the P-8 setpoint and associated trip will prevent DNB during 2 loop operation exclusive of the Overtemperature Delta T setpoint. Two loop operation above the 3 loop P-8 setpoint is permissible after resetting the K1, K2 and K3 inputs to the Overtemperature Delta T channels and raising the P-8 setpoint to its 2 loop value. In this mode of operation, the P-8 interlock and trip functions as a High Neuron Flux trip at the reduced power level.

TABLE 2.2-1

REACTOR TRIP SYSTEM INSTRUMENTATION TRIP SETPOINTS

FUNCTIONAL UNIT	TRIP SETPOINT	ALLOWABLE VALUES
1. Manual Reactor Trip	Not Applicable	Not Applicable
2. Power Range, Neutron Flux	Low Setpoint - ≤25% of RATED THERMAL POWER	Low Setpoint - ≤26% of RATED THERMAL POWER
	High Setpoint- ≤109% of RATED THERMAL POWER	High Setpoint - ≤110% of RATED THERMAL POWER
3. Power Range, Neutron Flux, High Positive Rate	≤5% of RATED THERMAL POWER with a time constant ≥2 seconds	≤5.5% of RATED THERMAL POWER with a time constant ≥2 seconds
4. Power Range, Neutron Flux, High Negative Rate	≤5% of RATED THERMAL POWER with a time constant ≥2 seconds	≤5.5% of RATED THERMAL POWER with a time constant ≥ 2 seconds
5. Intermediate Range, Neutron Flux	$\leq 4\times10^{-4}$ amps	$\leq 5\times10^{-4}$ amps
6. Source Range, Neutron Flux	$\leq 10^{5}$ counts per second	$\leq 1.3 \times 10^{5}$ counts per second
7. Overtemperature ΔT	See Note 1	See Note 3
8. Overpower ΔT	See Note 2	See Note 3
9. Pressurizer Pressure-Low	≥1870 psig	≥1860 psig
10. Pressurizer Pressure-High	≤2385 psig	≤2395 psig
11. Pressurizer Water Level-High	≤92% of instrument span	≤93% of instrument span
12. Loss of Flow	≥90% of design flow per loop*	≥89% of design flow per loop*

*Design flow is 92,800 gpm per loop.

Attachment 3

SAFETY EVALUATION OF FIXED-CURRENT SETPOINTS FOR THE NORTH ANNA INTERMEDIATE RANGE FLUX TRIPS

1.0 INTRODUCTION

The Intermediate Range Nuclear Flux Trips provide backup reactor core protection during reactor startup. The Intermediate Range channels are fed by two redundant gamma compensated ion chambers which are located external to the core in air cooled instrument wells along a major core axis. The detectors are wrapped in polyethylene to thermalize fast leakage neutrons and provide a more accurate representation of the incore flux. The IR circuitry provides monitoring of the flux level over an eight decade range (10**-11 to 10**-3 amperes). A reactor trip is generated based on one out of two channels exceeding a current equivalent to 25% of rated thermal power. The channels can be manually bypassed when permissive P-10 (2 of 4 power range channels > 10 % of rated thermal power) is active.

No credit was taken for operation of the trips associated with the IR channels in any of the accident analyses presented in the UFSAR. Redundant protection against reactivity and power excursions during startup is provided by the following channels:

1. Power range neutron flux, low setpoint (2/4 channels = 25% of rated thermal power).
2. Power range neutron flux, high setpoint (2/4 channels = 109% of rated thermal power).
3. Positive or Negative power range neutron flux rate (2/4 channels = ±5% of rated thermal power with a time constant = 2 seconds).

Because the IR flux detectors are located outside the core, the IR signal has been shown historically to be sensitive to the core loading pattern in use. For example, the high-burnup, low leakage patterns currently in use at North Anna give a different IR detector response than the more traditional type of pattern used for the initial core loadings. In addition, because the detectors do not cover the full core length as do the power range channels, the detector response is also sensitive to the core axial flux distribution. As a result, such effects as varying core burnups or control rod positions also can have a significant impact on the IR channel response. The variability in the channel response has made it difficult to maintain the channels in proper calibration.

References 1 and 2 provided Licensee Event Reports (LER's) describing instances in which the IR high neutron flux trip setpoints were higher than the current equivalent to 30% of Rated Thermal Power (RTP), which is the allowable value specified in Section 2.2-1 of the Technical Specifications. The Reference 2 event, which occurred on Unit 2, was the more severe violation, in that the effective trip setpoint was determined to be equivalent to approximately 55% of RTP. This condition existed shortly after the Cycle 3 startup.

As a result of these difficulties, Vepco has performed a safety evaluation which justifies a change to the Technical Specifications to allow the IR trip setpoint to be specified in terms of a fixed IR current. Upon implementation of this change, the IR trip will be consistent with all of the other reactor trips in the plant in that the trip setpoint specified in the Technical Specifications and reflected in plant operating documents will be expressed in the same units as the channel's indicated output.

The sections below present the results of the safety evaluation.

2.0 IR Flux Trip Variability

Vepco has performed a review of available historical data which correlates the measured IR current values against the indicated power range signal. The data covers both IR channels for both North Anna units and covers five and one-half years (4 cycles) of operation for Unit 1 and three years (3 cycles) of operation for Unit 2.

Figure 1 shows data for Channel N36 of Unit 2 for three operating cycles. A best fit linear correlation is also shown, along with 95% confidence limits on individual predicted values. The dependent variable (NI POWER) represents the auctioneered high power range signal. In developing the correlation and confidence limits the Cycle 3 data were weighted more heavily than other data points in determining the fit. This was done because only a limited amount of data was included in the Cycle 3 data base. As Figure 1 shows, the effects of varying loading patterns are significant. The added weighting on the Cycle 3 data has the effect of widening the confidence band to more adequately reflect the potential effects of this cycle-to-cycle variability. Similar plots were generated for the other Intermediate Range channels.

The figure shows that there is a practical lower limit to the IR trip setpoint of about 0.3 milliamperes. At lower values, there is a possibility that the unit could trip on high IR current before the power range channels exceed 10% of rated thermal power, allowing the IR trips to be manually blocked. The figure also shows that at the proposed maximum allowable setpoint of 0.5 milliamperes, it can be stated with a high degree of confidence that the effective trip setpoint is not expected to exceed 70% of rated thermal power.

3.0 UFSAR Review

A review of the accident analysis chapter of the UFSAR (Chapter 15) confirms that none of the accident analyses take credit for the IR high flux trips for protection or mitigation. Those accidents which are initiated from powers below permissive P-10 (where the IR trip would be unblocked) include the Hot Zero Power (HZP) rod ejection event, the uncontrolled rod withdrawal from subcritical, inadvertant boron dilution from hot, cold or refueling shutdown, and excessive heat removal at no load conditions. The review showed that the results and conclusions of the FSAR with respect to these accidents are not impacted in any way by the Intermediate Range channels. As discussed in the Bases of Section 2.2.1 of the Technical Specifications, the IR functional capability is required to enhance the overall reliability of the reactor protection system.

4.0 Impact on Trip Effectiveness

A· discussed in the previous section, the proposed fixed-current IR trip se point has no impact on the plant safety analyses, since these trips only provide redundant protection. However, Vepco has performed analyses to assess the effects of varying the assumed high power trip setpoints on the limiting Condition II and IV reactivity excursion transients analyzed in the UFSAR. In this way a measure of the impact of the proposed setpoint on the effectiveness of the redundant protection afforded by these channels can be made.

Sensitivity studies were performed using the Vepco RETRAN capability documented in References 3 and 4 to investigate the effects of varying the flux trip setpoint on the analyses of the rod withdrawal from subcritical and rod ejection accidents (the limiting Condition II and Condition IV low power reactivity addition events, respectively). The base case analysis for each event assumed a flux trip setpoint equivalent to 35% of rated thermal power, consistent with the UFSAR safety analyses. The sensitivity cases assumed a trip setpoint equivalent to 118% power, which is the UFSAR assumption for the power range high setpoint.

Tables I and II present the results for the rod withdrawal and rod ejection events, respectively. Table I shows that the conservative assumption of 118% for the high flux trip setpoint resulted in less than a 3% increase in peak heat flux and less than a 10 °F increase in average fuel temperature. Since the peak temperatures and heat fluxes remain below hot full power values, there is no DNB or fuel damage and all ANS Condition II criteria continue to be met for this event.

As shown in Table II, the impact of raising the high flux trip setpoint on the rod ejection event is insignificant. This results from the fact that the prompt power increase following the ejection is so rapid that the flux trip setpoint has effectively no influence on the time at which the reactor trip is generated. Note also that the energy release is increased by only a fraction of a percent, and peak fuel and clad temperatures at the hot spot location are only increased by a few degrees F. The results presented are for a case which is representative of Beginning of Life (BOL) conditions. Similar results would be obtained for End of Life (EOL).

The significance of these results is that the potential increase in the effective flux trip setpoint resulting from the proposed change will have no impact on its contribution to the overall reliability and effectiveness of the reactor protection system.

5.0 Conclusions

A study of the feasibility and safety impact of implementing a fixed current setpoint value for the Intermediate Range High Flux Trips for North Anna Units 1 and 2 has been conducted. The conclusions of the study are as follows:

1. The proposed change to the method of implementing the IR setpoints can be made with no adverse impact on the safety analysis (since no credit is taken for the trips in the existing analyses) and with no significant degradation of the protection system redundancy or reliability. This latter conclusion is based on sensitivity studies which show that the effectiveness of the flux trip system in protecting against the low power reactivity excursions examined in the FSAR is not sensitive to the actual flux trip setpoint.

2. Since none of the safety analysis input or assumptions are changed, neither the probability nor consequences of any previously analyzed accidents are increased, nor is there a reduction in any safety margin.

3. Since the severity of the analyzed accidents is unchanged, and since only a setpoint change to the existing reactor protection system is involved, the possibility of an accident or malfunction of a different type than already evaluated in the UFSAR is not created.

5.0 References

1. Letter from E. W. Harrell (Vepco) to J. P. O'Reilly (NRC), Serial No. N-83-094, transmitting LER 83-038/03L-06, July 6, 1983.

2. Letter from E. W. Harrell (Vepco) to J. P. O'Reilly (NRC), Serial No. N-83-095, transmitting LER 83-038/03L-07, July 6, 1983.

3. N. A. Smith, "Reactor System Transient Analyses Using the RETRAN Computer Code," Topical Report VEP-FRD-41, March 1981, transmitted by Vepco letter, Serial No. 215, April 14,1981.

4. J. G. Miller and J. O. Erb, "Vepco Evaluation of the Control Rod Ejection Transient", Topical Report VEP-NFE-2, October 1983, transmitted by Vepco letter, Serial No. 657, November 23, 1983.

TABLE I
HIGH FLUX TRIP SENSITIVITY STUDY RESULTS
ROD WITHDRAWAL FROM SUBCRITICAL

Case	Base Case	Raise Trip	% Change
Trip Setpoint, %FP	35.0	118.0	+237%
Peak Power, % Full power	433.3	433.3	0.0%
Peak Heat Flux, btu/hr-sq.ft.	1.3706E+5	1.4007E+5	+2.2%
Peak Fuel Temp., (Core ave) °F	864.9	872.8	+7.9 °F
Peak Clad Temp., (Core ave) °F	605.7	615.3	+9.6 °F
Peak Pressure, psia	2401.8	2407.2	+5.4 psia
Trip time, sec	10.97	11.01	+.04 sec

TABLE II
HIGH FLUX TRIP SENSITIVITY STUDY RESULTS
ROD EJECTION

Case	Base Case	Raise Trip	% Change
Trip Setpoint, %FP	35.0	118.0	+237%
Peak Power, % Full power	427.1	427.1	0.0%
Peak Heat Flux, btu/hr-sq.ft.	7.210E+4	7.210E+4	0.0%
Peak Fuel Temp., °F(Core ave)	720.0	720.0	0.0 °F
Energy Release to 10 seconds, full power-seconds	1.883	1.885	+0.1%
Trip time, sec	0.670	0.677	+.007 sec
Peak fuel centerline temp, °F(hot spot)	4000	4004	+4 °F
Peak clad temp, °F(hot spot)	2392	2393	+1 °F
Peak pellet enthalpy, btu/lb (hot spot)	265	265	<1 btu/lb

FIGURE 1
IR36 AMPS VS POWER
UNIT 2