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10 CFR 50.90

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

ATTENTION: Document Control Desk

Duke Energy Carolinas, LLC
McGuire Nuclear Station, Units 1 and 2
Docket Nos. 50-369 and 50-370
Catawba Nuclear Station, Units 1 and 2
Docket Nos. 50-413 and 50-414

SUBJECT: Response to Request for Additional Information Regarding License Amendment Request to Support Plant Modifications to the Nuclear Instrumentation System

By letter dated July 1, 2009, Duke Energy Carolinas, LLC submitted a License Amendment Request (LAR) for the McGuire Nuclear Station Renewed Facility Operating Licenses and Technical Specifications (TS) and the Catawba Nuclear Station Renewed Facility Operating Licenses and TS. The proposed LAR is in support of plant modifications planned for the McGuire and Catawba Nuclear Stations. The existing Source Range (SR) and Intermediate Range (IR) excore detector systems, which utilize boron triflouride (BF_3) detectors and compensated ion chamber detectors, respectively, are to be replaced with equivalent neutron monitoring systems in order to increase system reliability. The new instrumentation will utilize fission chamber detectors that will perform both the SR and the IR monitoring functions.

On April 8, 2010, the NRC staff electronically requested additional information regarding this LAR. The enclosure provides the requested additional information.

Duke Energy considers that the changes described in the enclosure have no effect on the regulatory considerations discussed in the original LAR, including the "No Significant Hazards Consideration" and the "Environmental Consideration".

There are no regulatory commitments made in this submittal.

A001
NRR

If there are any questions or if additional information is needed, please contact Mr. M. K. Leisure at (980)875-5171.

Sincerely,

Regis T. Repko

Enclosure and Attachment

xc with enclosure and attachment:

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Regis T. Repko affirms that he is the person who subscribed his name to the foregoing statement, and that all the matters and facts set forth herein are true and correct to the best of his knowledge.

Regis T. Repko
Regis T. Repko, Vice President, McGuire Nuclear Station

Subscribed and sworn to me: May 20, 2010
Date

Lori C. Dibby, Notary Public

My commission expires: July 1, 2012
Date

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION (RAI)

1. For the SR, IR and P-6 instruments, provide values, including reference information on the source of the data used, for the following parameters: Total Loop Uncertainty (TLU), As Left (including tolerances), As Found (including tolerances), Allowable Value (AV), Analytical Limit (AL), and Nominal Trip Set Point (NTSP).

Response

A summary calculation providing the requested information is attached.

2. Provide information on the reliability of Gamma-metrics instrumentation currently installed.

Response

The replacement Source Range/Intermediate Range fission chamber detector configuration for the McGuire and Catawba Nuclear Stations is functionally equivalent to the two Wide Range (WR) Neutron Flux monitoring channels (per unit) installed during 1987 at McGuire and 1986/1988 at Catawba (Units 1 and 2, respectively) for Post-Accident Monitoring (PAM) capability (both stations) and for boron dilution mitigation (Catawba only). The reliability of these WR channels has been very good. There has only been one WR detector assembly replacement between the sites. This replacement occurred at McGuire in 1994.

3. Identify specific language where you are adopting the proposed TSTF-493, rev. 4, footnote changes.

Response

The July 1, 2009 License Amendment Request (LAR) was developed utilizing applicable aspects of Technical Specification Task Force Traveler TSTF-493, "Clarify Application of Setpoint Methodology for LSSS Functions," Revision 3. Duke Energy desires to adopt certain elements of TSTF-493 Revision 4. Specifically, the LAR proposed two new lettered footnotes, designated (j) and (k) for McGuire and (l) and (m) for Catawba, applicable to particular Surveillance Requirements in Technical Specification Table 3.3.1-1. The TSTF-493 Revision 4 version of the second footnote includes a clarification that adds a parenthetical expression, "field setting" to the footnote. The revised footnotes, (k) for McGuire and (m) for Catawba, would read as follows (emphasis added):

> The instrument channel setpoint shall be reset to a value that is within the as-left tolerance around the Nominal Trip Setpoint (NTSP) at the completion of the surveillance; otherwise, the channel shall be declared inoperable. Setpoints more conservative than the NTSP are acceptable provided that the as-found and as-left tolerances apply to the actual setpoint implemented in the Surveillance procedures **(field setting)** to confirm channel performance. The methodologies used to determine the as-found and the as-left tolerances are specified in the UFSAR.

As described in the LAR, Duke Energy will make conforming changes to the Technical Specification Bases in accordance with TS 5.5.14, "Technical Specifications (TS) Bases Control Program." Attachments 2a and 2b to Enclosure 1 of the LAR provided the affected TS Bases markups for McGuire and Catawba, respectively. These Bases markups were included for information only. The proposed revision to the TS Table 3.3.1-1 footnote, as described above, affects the Bases changes that will be implemented in conjunction with the LAR. Specifically, a statement made in INSERTS 1, 2, and 6 of the McGuire Bases markups (Attachment 2a to Enclosure 1 of the LAR), and INSERT 1 of the Catawba Bases markups (Attachment 2b to Enclosure 1 of the LAR) would be modified to add a parenthetical expression, "field setting," as follows (emphasis added):

> Where a setpoint more conservative than the NTSP is used in the plant surveillance procedures **(field setting)**, the as-left and as-found tolerances, as applicable, will be applied to the surveillance procedure setpoint.

<u>Calculation Summary</u>

(18 pages follow)

Below are sample uncertainty calculations for the Source Range Neutron Flux (SR), Intermediate Range Neutron Flux (IR) and P-6 Interlock instrumentation which provide the requested information for the following parameters: Total Loop Uncertainties (TLU), As Left tolerances, As Found tolerances, Allowable Values (AV), Analytical Limits (AL), and Nominal Trip Set Points (NTSP).

MNS/CNS Source Range Neutron Flux Instrument Uncertainty

The new Thermo Scientific signal processors are designed to replace the existing source and intermediate range drawers located in Nuclear Instrumentation System (NIS) cabinets in the control room. The processor will combine the functions of the existing SR and IR drawers into a single drawer.

The setpoint and Allowable Value calculations use the method described in Section 4 of the LAR (square root of the sum of the squares) to determine the TLU and Allowable Value.

The source range indication scale will change from 10^0 - 10^6 cps to 10^{-1} - 10^6 cps. This change in source range scale from six to seven decades will change the scaling for the Source Range Neutron Flux reactor trip setpoint and Allowable Value.

Details of Analysis

The following instrument uncertainties for the replacement equipment are provided (Table 1, Reference 1):

Rack Accuracy (SRCA) = ± 2.0% span

Rack Measurement & Test Equipment (SRMTE) = ± 0.05 % span

Rack Comparator Setting Accuracy (SRCSA) = ± 0.25% span

Rack Temperature Effects (SRTE) = ± 0.0% span (included in RCA)

Rack Drift, SRD (24 Months) = ± 1.0% span

$SRCA := 2.0\%\ \text{span}$ $\qquad$ $SRMTE := 0.05\%\ \text{span}$

$SRD := 1.0\%\ \text{span}$ $\qquad$ $SRTE := 0.0\%\ \text{span}$

$SRCSA := 0.25\%\ \text{span}$

Source Range Neutron Flux replacement equipment uncertainty

$$SR\_Rack := \sqrt{SRCA^2 + SRCSA^2 + SRD^2 + SRMTE^2 + SRTE^2}$$

$$SR\_Rack = 2.25\cdot\%\ \ \text{span}$$

Total Loop Uncertainty Determination

The Total Loop Uncertainty (TLU) will be determined utilizing the square root of the sum of the squares and the device uncertainties for the replacement equipment calculated above along with the Process Measurement Allowance (PMA) uncertainties shown below.

Process Measurement Allowance (PMA)

An all inclusive assumed value for process measurement allowance associated with the Source Range detectors includes the effects of downcomer temperature changes, radial power redistribution and burn-up of the active components of the detector. These effects are treated as random independent terms with the assumed values given below.

$\text{DownComerTemp} := 5\%$ span $\text{RadialPowerRedist} := 5\%$ span $\text{DetectorBurnup} := 6\%$ span

The following total process measurement allowance is calculated and used in the calculations below.

$$\text{PMA} := \sqrt{\text{DownComerTemp}^2 + \text{RadialPowerRedist}^2 + \text{DetectorBurnup}^2}$$

$\text{PMA} = 9.27 \cdot \%$ span

High Flux Level Reactor Trip and High Flux At Shutdown Alarm

The source range high flux level reactor trip and high flux at shutdown alarm uncertainties are calculated using the uncertainties presented above.

$\text{SR\_Rack} = 2.25 \cdot \%$ span

$$\text{TLU\_HiFlux\_Trip\_RE} := \sqrt{\text{PMA}^2 + \text{SR\_Rack}^2}$$

$\text{TLU\_HiFlux\_Trip\_RE} = 9.543 \cdot \%$ span

The indication scale for the Source Range Channel is logarithmic and the final uncertainty is expressed in terms of percent span. When the uncertainty is specified in engineering units the error in percent span is calculated in the standard fashion while accounting for the logarithmic nature and the 7 decades of the scale:

$$\text{Err\_span} := \log\left(\frac{E}{P}\right) \cdot \frac{100\%}{d}$$

Where,

E = Error in Engineering Units
P = Point of interest in Engineering Units
Err_span = Error in % Span
d = number of decades

The percent span uncertainty is constant across the scale, but the engineering units vary across the scale. The trip setpoint and allowable value calculated are converted to engineering units since the uncertainty is to be applied at a single point on the scale.

By rearranging the formula above the following formula is developed to express a percent span error at a specific point in engineering units.

$$E := P \cdot \left(10^{\frac{Err\_span \cdot d}{100\%}} \right)$$

Using the above conversion, the high flux level reactor trip span uncertainty above is converted to cps on a logarithmic scale about the current MNS and CNS Technical Specification Nominal Trip Setpoint, 1 x 10^5 cps:

$$TLU\_HiFlux\_Trip\_CPS\_RE := \left(1 \cdot 10^5\right) \cdot \left(10^{\frac{TLU\_HiFlux\_Trip\_RE \cdot 7}{100\%}} \right)$$

$$TLU\_HiFlux\_Trip\_CPS\_RE = 4.66 \times 10^5 \text{ cps}$$

The source range neutron flux reactor trip channel uncertainty presented above shows that the total loop uncertainty is conservative with respect to the suggested total allowance (5.0 x 10^5 cps, see Allowable Value Section below). Therefore, if the suggested total allowance is used in future analyses the allowance will bound the calculated instrument channel uncertainties

Allowable Value

Source Range High Neutron Flux Level Trip Allowable Value

The source range high neutron flux level trip function is not currently credited in any McGuire/Catawba accident analyses. Therefore, no safety analysis analytical limit has been established for use in the accident analyses. However, a reasonable value for future use would be 6.0 x 10^5 cps per the above calculated total loop uncertainty.

The Technical Specification setpoint for the source range high neutron flux level trip is 1.0 x 10^5 cps. Using the suggested safety analysis analytical limit above, a total allowance of 5.0 x 10^5 cps (6.0 x 10^5 cps - 1.0 x 10^5 cps) is calculated. The current source range neutron flux reactor trip allowable value, as documented in the current McGuire and Catawba Technical Specifications, is 1.3 x 10^5 cps and 1.4 x 10^5 cps respectively.

The new allowable value will be calculated using the two methods outlined in Section 4 of the LAR.

Method 1

$AV_1 = SP \pm RU_{T\text{-cal}}$

where $RU_{T\text{-cal}} = \sqrt{SRCA^2 + SRCSA^2 + SRD^2 + SRMTE^2}$ or SR_Rack

The components of interest are the Thermo Electron source range replacement drawers.

$SR\_Setpoint := 1 \cdot 10^5$ cps

$SRHiFlux\_AV1\_RE := SR\_Rack$

$$SRHiFlux\_AV1\_CPS\_RE := (SR\_Setpoint) \cdot \left(10^{\frac{SRHiFlux\_AV1\_RE \cdot 7}{100\%}} \right)$$

$SRHiFlux\_AV1\_CPS\_RE = 1.44 \times 10^5$ cps

$AV1\_SRHiFlux\_RE := SRHiFlux\_AV1\_CPS\_RE$

$AV1\_SRHiFlux\_RE = 1.44 \times 10^5$ cps

Method 2

$AV_2 = AL \pm RU_{NT} = AL \pm \{[(TLU - Biases)^2 - RU_{T\text{-cal}}^{\,2}]^{1/2} + Biases\}$

$SR2\_AL := 6.0 \cdot 10^5$ cps

$$AV2\_SRHiFlux\_Span\_RE := \log\left(\frac{AV1\_SRHiFlux\_RE}{SR\_Setpoint}\right) \cdot \frac{1}{7}$$

$AV2\_SRHiFlux\_Span\_RE = 2.251 \cdot \%$ span

$$AV2\_Right\_Side\_RE := \sqrt{TLU\_HiFlux\_Trip\_RE^2 - AV2\_SRHiFlux\_Span\_RE^2}$$

$AV2\_Right\_Side\_RE = 9.274 \cdot \%$ span

$$AV2\_Right\_Side\_CPS\_RE := (SR\_Setpoint) \cdot \left(10^{\frac{AV2\_Right\_Side\_RE \cdot 7}{100\%}} \right)$$

$$AV2\_Right\_Side\_CPS\_RE = 4.458 \times 10^{5} \text{ cps}$$

$$AV2\_HiFlux\_RE := SR2\_AL - AV2\_Right\_Side\_CPS\_RE$$

$$AV2\_HiFlux\_RE = 1.54 \times 10^{5} \text{ cps}$$

Choosing the smaller of the Allowable Value calculations (Method 1 or Method 2) gives:

$$SR\_AV\_RE := \min(AV1\_SRHiFlux\_RE, AV2\_HiFlux\_RE)$$

$$SR\_AV\_RE = 1.44 \times 10^{5} \text{ cps}$$

The Allowable Value results above show that the calculated Allowable Value for the source range high neutron flux reactor trip channel is larger than the current Technical Specification values {1.3×10^5 cps (MNS) and 1.4×10^5 cps (CNS)}.

Source Range Channel "As Found" Acceptance Criteria

The purpose of this section is to determine how much uncertainty, which may appear during the "as-found" portion of the loop calibration, has been accounted for in the total loop uncertainties calculated above. Values recorded during loop as-found calibration which are less than those documented in this section would clearly indicate the loop is operating as intended. Values recorded during loop as-found calibration which exceed those documented in this section would require a more detailed review to determine the effects of the increased uncertainty on the operability of the loop.

All values documented in this section are to aid in determining loop operability only. The limits for loop as-found values associated with Engineering notification requirements should be based on the requirements specified in the calibration procedure.

The following uncertainty terms are applicable when determining an acceptable as-found tolerance, reference accuracy (SRCA), drift (SRD), setting tolerance (SRCSA), measurement and test equipment (SRMTE).

Source Range Channel As-Found Criteria

The as-found Source Range Channel acceptance criteria limit is determined as follows:

$$As\_Found\_SR\_Criteria\_Span := \sqrt{SRCA^2 + SRD^2 + SRCSA^2 + SRMTE^2}$$

$$As\_Found\_SR\_Criteria\_Span = 2.25 \cdot \% \quad \text{span}$$

Converting uncertainty in span to As-Found tolerance in cps about the High Flux Level Trip setpoint of 1.0 x 10^5 cps gives:

$$SR\_HL\_Trip\_AF\_Tol\_Neg := (SR\_Setpoint) \cdot \left(10^{\frac{-As\_Found\_SR\_Criteria\_Span \cdot 7}{100\%}} \right) = 6.96 \times 10^4 \quad \text{cps}$$

$$SR\_HL\_Trip\_AF\_Tol\_Pos := (SR\_Setpoint) \cdot \left(10^{\frac{As\_Found\_SR\_Criteria\_Span \cdot 7}{100\%}} \right) = 1.44 \times 10^5 \quad \text{cps}$$

Source Range Channel "As-Left" Tolerance

The As-Left tolerance is used to ensure that the analytical limit is not exceeded during an anticipated operational occurrence (AOO) before the next periodic surveillance or calibration.

Source Range High Neutron Flux Level Trip As-Left Tolerance

The As-Left Source Range Channel tolerance is determined as follows:

$$As\_Left\_SR\_Tolerance\_Span := \sqrt{SRCA^2 + SRCSA^2 + SRMTE^2} = 2.02 \cdot \% \quad \text{span}$$

Converting uncertainty in span to As-Left tolerance in cps about the High Level Trip setpoint of 1.0 x 10^5 cps gives:

$$SR\_HL\_Trip\_AL\_Tol\_Neg := (SR\_Setpoint) \cdot \left(10^{\frac{-As\_Left\_SR\_Tolerance\_Span \cdot 7}{100\%}} \right) = 7.23 \times 10^4 \quad \text{cps}$$

$$SR\_HL\_Trip\_AL\_Tol\_Pos := (SR\_Setpoint) \cdot \left(10^{\frac{As\_Left\_SR\_Tolerance\_Span \cdot 7}{100\%}} \right) = 1.38 \times 10^5 \quad \text{cps}$$

MNS/CNS Intermediate Range Neutron Flux Instrument Uncertainty

The new Thermo Scientific signal processors are designed to replace the existing source and intermediate range drawers located in Nuclear Instrumentation System (NIS) cabinets in the control room. The processor will combine the functions of the existing SR and IR drawers into a single drawer.

The outputs of the new system, both safety-related and non-safety-related, (i.e., level trips, Plant Safety Monitoring System (PSMS), indicators, annunciators, etc.) will replace the outputs of the existing system. The existing remote system indicators will be re-used and re-scaled as needed to support the new design. The intermediate range indication, which currently displays in "amperes", will be re-scaled to display in "percent of full power". The change in units for the intermediate range will result in a change in the Technical Specification value of the P-6 permissive setpoint and allowable value, which is currently in amperes, to a value in percent rated thermal power (% RTP). The full range of the new Intermediate Range Neutron Flux channel will be 10^{-8} to 200% RTP or slightly more than 10 decades.

The current Technical Specification Nominal Trip Setpoints and Allowable Values for this channel are:

Reactor Trip = 25 % RTP
Allowable Value = 30 % RTP (MNS) and 31 % RTP (CNS)

P-6 Interlock Setpoint = 1.0 x 10^{-10} amps
P-6 Interlock Allowable Value = 4.0 x 10^{-11} amps (MNS) and 6.0 x 10^{-11} amps (CNS)

The setpoint and Allowable Value calculations use the method described in Section 4 of the LAR (square root of the sum of the squares) to determine the TLU and Allowable Value uncertainties.

Details of Analysis

The following instrument uncertainties are provided (Table 2, Reference 1):

Rack Accuracy (IRCA) = ± 1.5% span

Rack Measurement & Test Equipment (IRMTE) = ± 0.05 % span

Rack Comparator Setting Accuracy (IRCSA) = ± 0.25% span

Rack Temperature Effects (IRTE) = ± 0.0% span (included in IRCA)

Rack Drift, IRD (24 Months) = ± 1.0% span

The following uncertainty allowances are used for this channel:

IRCA := 1.5% span IRMTE := 0.05% span

IRD := 1.0% span IRTE := 0.0% span

IRCSA := 0.25% span

Intermediate Range Neutron Flux replacement equipment uncertainty

$$IR\_Rack := \sqrt{IRCA^2 + IRCSA^2 + IRD^2 + IRMTE^2 + IRTE^2}$$

$IR\_Rack = 1.82 \cdot \%$ span

Total Loop Uncertainty Determination

The Total Loop Uncertainty (TLU) will be determined utilizing the square root of the sum of the squares and the device uncertainties for the replacement equipment calculated above along with the Process Measurement Allowance (PMA) uncertainties shown below.

Process Measurement Allowance (PMA)

An all inclusive assumed value for process measurement allowance associated with the Intermediate Range detectors includes the effects of the power calorimetric, downcomer temperature changes, radial power redistribution and rod shadowing. These effects are treated as random independent terms with the assumed values given below.

$PowerCalorimetric := 2\%$ span

$CNSDownComerTemp := 1.3\%$ span

$MNSDownComerTemp := 0.0\%$ span

$RadialPowerRedist := 4.0\%$ span

$RodShadowing := 6.25\%$ span

The following total process measurement allowances for MNS and CNS are used in the calculations below.

$$MNSPMA := \sqrt{PowerCalorimetric^2 + MNSDownComerTemp^2 + RadialPowerRedist^2 + RodShadowing^2}$$

$MNSPMA = 7.69 \cdot \%$ span

$$CNSPMA := \sqrt{PowerCalorimetric^2 + CNSDownComerTemp^2 + RadialPowerRedist^2 + RodShadowing^2}$$

$CNSPMA = 7.79 \cdot \%$ span

Intermediate Range High Level Trip

The Intermediate Range high flux level reactor trip and power above P-6 permissive uncertainties are calculated using the component uncertainties presented above.

MNS

$$\text{MNSTLU\_HiFlux\_Trip\_RE} := \sqrt{\text{MNSPMA}^2 + \text{IR\_Rack}^2}$$

$$\text{MNSTLU\_HiFlux\_Trip\_RE} = 7.9 \cdot \% \text{ span}$$

Converting the above High Level Trip uncertainty in % span to % RTP in the conservative direction about the current MNS Technical Specification Nominal Trip Setpoint of 25% RTP obtains:

$$\text{IR\_High\_Level\_Trip} := 25 \quad \%\,\text{RTP}$$

$$\text{MNSTLU\_IR\_RTPPOS\_RE} := (\text{IR\_High\_Level\_Trip}) \cdot \left(10^{\frac{\text{MNSTLU\_HiFlux\_Trip\_RE} \cdot 10}{100\%}} \right)$$

$$\text{MNSTLU\_IR\_RTPPOS\_RE} = 154.08 \quad \%\text{RTP}$$

CNS

$$\text{CNSTLU\_HiFlux\_Trip\_RE} := \sqrt{\text{CNSPMA}^2 + \text{IR\_Rack}^2}$$

$$\text{CNSTLU\_HiFlux\_Trip\_RE} = 8 \cdot \% \quad \text{span}$$

Converting the above High Level Trip uncertainty in % span to % RTP in the conservative direction about the current CNS Technical Specification Nominal Trip Setpoint of 25% RTP obtains:

$$\text{CNSTLU\_IR\_RTPPOS\_RE} := (\text{IR\_High\_Level\_Trip}) \cdot \left(10^{\frac{\text{CNSTLU\_HiFlux\_Trip\_RE} \cdot 10}{100\%}} \right)$$

$$\text{CNSTLU\_IR\_RTPPOS\_RE} = 157.89 \quad \%\text{RTP}$$

Power Above P-6 Permissive

The MNS and CNS P-6 Interlock setpoint for the new equipment is assumed to be 1.0×10^{-5}% RTP and was chosen to allow an approximate 3 decade overlap between the Source and Intermediate Range instrumentation.

MNS

$$P6\_Interlock\_Trip := 1.0 \cdot 10^{-5} \ \% RTP$$

$$MNSTLU\_P6\_Perm\_RE := MNSTLU\_HiFlux\_Trip\_RE = 7.9 \cdot \% \ span$$

Converting the above P-6 Permissive uncertainty in % span to % RTP in the conservative direction about the permissive setpoint in RTP obtains:

$$MNSTLU\_P6\_RTPNEG\_RE := (P6\_Interlock\_Trip) \cdot \left(10^{\frac{-MNSTLU\_P6\_Perm\_RE \cdot 10}{100\%}} \right)$$

$$MNSTLU\_P6\_RTPNEG\_RE = 1.62 \times 10^{-6} \ \% RTP$$

CNS

$$CNSTLU\_P6\_Perm\_RE := CNSTLU\_HiFlux\_Trip\_RE = 8 \cdot \% \ span$$

Converting the above P-6 Permissive uncertainty in % span to % RTP in the conservative direction about the permissive setpoint in RTP obtains:

$$CNSTLU\_P6\_RTPNEG\_RE := (P6\_Interlock\_Trip) \cdot \left(10^{\frac{-CNSTLU\_P6\_Perm\_RE \cdot 10}{100\%}} \right)$$

$$CNSTLU\_P6\_RTPNEG\_RE = 1.58 \times 10^{-6} \ \% RTP$$

Allowable Value

Intermediate Range High Level Trip & Power Above P-6 Permissive Allowable Values

The Intermediate Range high level trip function is not currently credited in any McGuire or Catawba accident analyses. Therefore, no safety analysis analytical limit has been established for use in the accident analyses. However, a reasonable value for future use would be 155 % RTP (McGuire) and 160 % RTP (Catawba) per the above calculated total loop uncertainties.

The Technical Specification setpoint for the intermediate range high level trip is 25% RTP. Using the suggested safety analysis analytical limit above, a total allowance of 130 % RTP (155 % RTP - 25 % RTP) for McGuire and 135 % RTP (160 % RTP - 25 % RTP) for Catawba is calculated. The current overpower high range reactor trip Allowable Value, as documented in the current McGuire and Catawba Technical Specifications, is 30 % RTP and 31% RTP, respectively.

Intermediate Range Neutron Flux High Level Trip Allowable Value

The new Intermediate Range channel will have a range of 1.0×10^{-8} % RTP to 200% RTP or slightly more than 10 decades. Assume the range is equal to 10 decades.

Method 1

$$IRHiFlux\_AV1\_RE := \sqrt{IRCA^2 + IRCSA^2 + IRD^2 + IRMTE^2 + IRTE^2}$$

$$IRHiFlux\_AV1\_RE = 1.82 \cdot \% \ \text{span}$$

$$IRHiFlux\_AV1\_RTP\_RE := (IR\_High\_Level\_Trip) \cdot \left(10^{\frac{IRHiFlux\_AV1\_RE \cdot 10}{100\%}} \right)$$

$$IRHiFlux\_AV1\_RTP\_RE = 38.0 \quad \%RTP$$

The Method 1 calculation above applies to both MNS and CNS as the component uncertainties and the Technical Specification IR High Level trip setpoint (25% RTP) is the same for both units.

Method 2

$$MNSIR\_AL\_RE := 155 \ \%RTP$$

$$CNSIR\_AL\_RE := 160\% \ RTP$$

The TLU for the High Flux Trip setpoint as defined above consists of the PMA terms combined with the rack related terms for the amplifier and the bistable. Since the only PMA term which is likely to impact a surveillance is the Power Calorimetric portion, that term will be used to calculate the Method 2 AV.

$$IRHiFlux\_AV2\_RE := -PowerCalorimetric$$

$$IRHiFlux\_AV2\_RE = -2 \cdot \% \quad span$$

MNS

$$MNSIRHiFlux\_AV2\_RTP\_RE := (MNSIR\_AL\_RE) \cdot \left(10^{\frac{IRHiFlux\_AV2\_RE \cdot 10}{100\%}}\right)$$

$$MNSIRHiFlux\_AV2\_RTP\_RE = 97.8 \ \%RTP$$

CNS

$$CNSIRHiFlux\_AV2\_RTP\_RE := (CNSIR\_AL\_RE) \cdot \left(10^{\frac{IRHiFlux\_AV2\_RE \cdot 10}{100\%}}\right)$$

$$CNSIRHiFlux\_AV2\_RTP\_RE = 100.95 \ \%RTP$$

Choose the limiting Allowable Value from the two methods calculated above:

MNS

$$IR\_AV\_RE\_MNS := \min(IRHiFlux\_AV1\_RTP\_RE, MNSIRHiFlux\_AV2\_RTP\_RE)$$

$$IR\_AV\_RE\_MNS = 38.0 \quad \%RTP$$

CNS

$$IR\_AV\_RE\_CNS := \min(IRHiFlux\_AV1\_RTP\_RE, CNSIRHiFlux\_AV2\_RTP\_RE)$$

$$IR\_AV\_RE\_CNS = 38.0 \quad \%RTP$$

Intermediate Range Neutron Flux Power Above P-6 Permissive Allowable Value

The P-6 Interlock setpoint for the new equipment is assumed to be 1.0 x 10^{-5}% RTP and was chosen to allow an approximate 3 decade overlap between the Source and Intermediate Range instrumentation. The P-6 permissive setpoint is not currently used in any safety analyses. Since this setpoint is not likely to ever be used in any analyses, an AL will not be assumed and the Method 2 Allowable Value calculation is not performed.

Using the Method 1 allowable value uncertainty adjustment from the High Level trip setpoint allowable value calculation above, the P-6 Permissive Interlock Allowable Value uncertainty adjustment is calculated in the conservative direction.

$$\text{P6\_Interlock\_Trip} = 1 \times 10^{-5} \quad \%\,\text{RTP}$$

$$\text{P6\_Interlock\_AV\_RE} := -\text{IRHiFlux\_AV1\_RE}$$

$$\text{P6\_Interlock\_AV\_RE} = -1.82 \cdot \% \quad \text{span}$$

Converting this allowable value uncertainty in percent span to percent RTP on a logarithmic scale about the nominal trip setpoint (P6_Interlock_AV_RE):

$$\text{P6\_Interlock\_RTP\_RE} := (\text{P6\_Interlock\_Trip}) \cdot \left(10^{\frac{\text{P6\_Interlock\_AV\_RE} \cdot 10}{100\%}} \right)$$

$$\text{P6\_Interlock\_RTP\_RE} = 6.6 \times 10^{-6} \quad \%\,\text{RTP}$$

Intermediate Range Channel "As Found" Acceptance Criteria

The purpose of this section is to determine how much uncertainty, which may appear during the "as-found" portion of the loop calibration, has been accounted for in the total loop uncertainties calculated above. Values recorded during loop as-found calibration which are less than those documented in this section would clearly indicate the loop is operating as intended. Values recorded during loop as-found calibration which exceed those documented in this section would require a more detailed review to determine the effects of the increased uncertainty on the operability of the loop.

All values documented in this section are to aid in determining loop operability only. The limits for loop as-found values associated with Engineering notification requirements should be based on the requirements specified in the calibration procedure.

The following uncertainty terms are applicable when determining an acceptable as-found tolerance, reference accuracy (IRCA), drift (IRD), setting tolerance (IRCSA), measurement and test equipment (IRMTE).

Intermediate Range Neutron Flux High Level Trip & P-6 Permissive As-Found Criteria

The as-found Intermediate Range Channel acceptance criteria limit is determined as follows:

$$As\_Found\_IR\_Criteria\_Span := \sqrt{IRCA^2 + IRD^2 + IRCSA^2 + IRMTE^2} = 1.82 \cdot \% \quad span$$

Converting uncertainty in span to As-Found tolerance in % RTP about the High Level Trip setpoint of 25 % RTP gives:

$$IR\_HL\_Trip\_AF\_Tol\_Neg := (IR\_High\_Level\_Trip) \cdot \left(10^{\frac{-As\_Found\_IR\_Criteria\_Span \cdot 10}{100\%}} \right) = 16.4 \quad \%RTP$$

$$IR\_HL\_Trip\_AF\_Tol\_Pos := (IR\_High\_Level\_Trip) \cdot \left(10^{\frac{As\_Found\_IR\_Criteria\_Span \cdot 10}{100\%}} \right) = 38 \quad \%RTP$$

Converting uncertainty in span to As-Found tolerance in % RTP about the new P-6 Permissive assumed setpoint of 1.0×10^{-5} % RTP gives:

$$IR\_P6\_AF\_Tol\_Neg := (P6\_Interlock\_Trip) \cdot \left(10^{\frac{-As\_Found\_IR\_Criteria\_Span \cdot 10}{100\%}} \right) = 6.6 \times 10^{-6} \quad \%RTP$$

$$IR\_P6\_AF\_Tol\_Pos := (P6\_Interlock\_Trip) \cdot \left(10^{\frac{As\_Found\_IR\_Criteria\_Span \cdot 10}{100\%}} \right) = 1.5 \times 10^{-5} \quad \%RTP$$

Intermediate Range Channel "As-Left" Tolerance

The As-Left tolerance is used to ensure that the analytical limit is not exceeded during an anticipated operational occurrence (AOO) before the next periodic surveillance or calibration.

Intermediate Range Neutron Flux High Level Trip & P-6 Permissive As-Left Tolerance

The As-Left Intermediate Range Channel tolerance is determined as follows:

$$\text{As\_Left\_IR\_Tolerance\_Span} := \sqrt{\text{IRCA}^2 + \text{IRCSA}^2 + \text{IRMTE}^2} = 1.52 \cdot \%\,\text{span}$$

Converting uncertainty in span to As-Left tolerance in % RTP about the High Level Trip setpoint of 25 % RTP gives:

$$\text{IR\_HL\_Trip\_AL\_Tol\_Neg} := (\text{IR\_High\_Level\_Trip}) \cdot \left(10^{\frac{-\text{As\_Left\_IR\_Tolerance\_Span} \cdot 10}{100\%}} \right) = 17.6 \quad \%\text{RTP}$$

$$\text{IR\_HL\_Trip\_AL\_Tol\_Pos} := (\text{IR\_High\_Level\_Trip}) \cdot \left(10^{\frac{\text{As\_Left\_IR\_Tolerance\_Span} \cdot 10}{100\%}} \right) = 35.5 \quad \%\text{RTP}$$

Converting uncertainty in span to As-Left tolerance in % RTP about the new P-6 Permissive assumed setpoint of 1.0 x 10^{-5} % RTP gives:

$$\text{IR\_P6\_AL\_Tol\_Neg} := (\text{P6\_Interlock\_Trip}) \cdot \left(10^{\frac{-\text{As\_Left\_IR\_Tolerance\_Span} \cdot 10}{100\%}} \right) = 7 \times 10^{-6} \quad \%\text{RTP}$$

$$\text{IR\_P6\_AL\_Tol\_Pos} := (\text{P6\_Interlock\_Trip}) \cdot \left(10^{\frac{\text{As\_Left\_IR\_Tolerance\_Span} \cdot 10}{100\%}} \right) = 1.4 \times 10^{-5} \quad \%\text{RTP}$$

References

1. Letter from Robert Barnes (Thermo Electron Corporation) to Eric Forster (Duke Energy), July 20, 2006, Setpoint Methodology.

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July 20, 2006

Duke Energy Corporation
McGuire Site
Attn: Mr. Eric Forster
13225 Hagers Ferry Rd., Hwy. 73
Huntersville, NC 28078

Subject:	Setpoint Methodology
Reference:	Purchase Order No. DS 1270
	DEC Spec. no. MCS-1346.23-00-0002, Rev. 002
Attachments:	Table 1 - Source Range Values
	Table 2 - Intermediate Range Values

Eric,

Attached please find two tables that provide information that can be used to upgrade your Westinghouse Setpoint Methodology Calculations to reflect the more modern electronics that will be included in your new Thermo Source and Intermediate Range Neutron Flux Monitoring Systems.

Please feel free to call me if there are any questions.

Robert Barnes

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TABLE 1

SOURCE RANGE, NEUTRON FLUX

PARAMETER		ALLOWANCES*
PROCESS MEASUREMENT ACCURACY	(PMA)	**
PRIMARY ELEMENT ACCURACY (Included in RCA)	(PEA)	0% OF SPAN
SENSOR CALIBRATION (Included in RCA)	(SCA)	0% OF SPAN
SENSOR MEASUREMENT & TEST SENSOR TEMPERATURE EFFECTS SENSOR PRESSURE EFFECTS (Included in RCA)	(SMTE) (STE) (SPE)	0% OF SPAN 0% OF SPAN 0% OF SPAN
SENSOR DRIFT	(SD)	0% OF SPAN
ENVIRONMENTAL ALLOWANCES	(EA)	0% OF SPAN
RACK CALIBRATION RACK ACCURACY MEASUREMENT & TEST	 (RCA) (RMTE)	 +/- 2.0% OF SPAN +/- 0.05% OF SPAN
COMPARATOR	(RCSA)	+/- 0.25% OF SPAN
RACK TEMPERATURE EFFECTS (RCA includes temperature effects)	(RTE)	0% OF SPAN
RACK DRIFT (24 MONTHS)	(RD)	+/-1.0% of SPAN

* In percent of span (0.1 to 10E6 CPS)
** Duke McGuire determined value

TABLE 2

INTERMEDIATE RANGE, NEUTRON FLUX

PARAMETER		ALLOWANCES*
PROCESS MEASUREMENT ACCURACY	(PMA)	**
PRIMARY ELEMENT ACCURACY (Included in RCA)	(PEA)	0% OF SPAN
SENSOR CALIBRATION (Included in RCA)	(SCA)	0% OF SPAN
SENSOR MEASUREMENT & TEST SENSOR TEMPERATURE EFFECTS SENSOR PRESSURE EFFECTS (Included in RCA)	(SMTE) (STE) (SPE)	0% OF SPAN 0% OF SPAN 0% OF SPAN
SENSOR DRIFT	(SD)	0% OF SPAN
ENVIRONMENTAL ALLOWANCES	(EA)	0% OF SPAN
RACK CALIBRATION RACK ACCURACY (RCA includes temperature effects) MEASUREMENT & TEST	 (RCA) (RMTE)	 +/- 1.5% OF SPAN +/- 0.05% OF SPAN
COMPARATOR	(RCSA)	+/- 0.25% OF SPAN
RACK TEMPERATURE EFFECTS (RCA includes temperature effects)	(RTE)	0% OF SPAN
RACK DRIFT (24 MONTHS)	(RD)	+/-1.0% of SPAN

* All parameters are shown in percent of span (logarithmic scale 1 E-8% to 200%)
** Duke McGuire determined value.