St. Lucie Unit 1
Extended Power Uprate
Licensing Report

Attachment 5
Appendix E

Supplement to Licensing Report Section 2.4.1
Reactor Protection,
Engineered Safety Features Actuation,
and Control Systems

This coversheet plus 6 pages

Purpose

This appendix provides supplemental information related to the design basis of the reactor protection system (RPS) setpoint for the low steam generator (SG) level trip function. The low SG level trip was the only RPS setpoint changed for the extended power uprate (EPU). The appendix is formatted in three major sections: (1) an overview of the safety system setpoint control program pertaining to work performed for EPU, (2) a description of the compliance with recent setpoint methodology changes as described in NRC Regulatory Issue Summary (RIS) 2006-17, NRC Staff Position on the Requirements of 10 CFR 50.36, "Technical Specifications," Regarding Limiting Safety System Settings During Periodic Testing and Calibration of Instrument Channels, and (3) a summary of the low SG level setpoint/uncertainty calculations.

I. Overview of the St. Lucie Safety System Setpoint Control Program Pertaining to Work Performed for EPU

St. Lucie Unit 1 has three distinct cabinet based electronic systems that collectively constitute the safety systems (a.k.a., protection systems). These individual systems are the RPS, the engineered safety features actuation system (ESFAS), and the auxiliary feedwater actuation system (AFAS). The RPS trip setpoints and surveillance requirements are controlled in Technical Specification (TS) Table 2.2-1 and Table 4.3-1 respectively. The ESFAS and AFAS setpoints and surveillance requirements are controlled in TS Table 3.3-4 and Table 4.3-2, respectively.

FPL uses a combination of three documents to initially establish, and subsequently maintain compliance with, each TS setpoint value. These three documents are the instrument channel uncertainty calculation, the safety analysis plant parameters document, and the instrument channel setpoint calculation.

An instrument uncertainty calculation exists for each safety system input parameter. These calculations determine the various elements of uncertainty applicable to each component within that instrument channel from the sensor/transmitter up to the protection system cabinet input. These loop uncertainty calculations have been prepared by FPL in accordance with FPL discipline standard IC-3.17, Instrument Setpoint Methodology. IC-3.17 is in turn based on ISA Standard 67.04, Setpoints for Nuclear Safety Related Instrumentation, and Regulatory Guide (RG) 1.105, Instrument Setpoints for Safety Related Systems. Elements of uncertainty for individual components, such as setting tolerance, measuring & test equipment (M&TE), and drift are specifically based on associated surveillance procedure requirements and test frequencies. Environmental effects for both normal and harsh conditions are determined for each loop component as applicable. All safety system instrument channel uncertainty calculations were reviewed and revised as necessary in support of the EPU.

The safety analysis plant parameters (SAPP) document serves as a bridge between the instrument channel setpoint calculations and the safety analysis. The bounding uncertainty allowance applicable to each protection system function is documented and managed in the SAPP. Where applicable, the SAPP includes individual bounding uncertainty allowances for both normal and harsh conditions. The rationale for managing the trip function uncertainty allowances in the SAPP is as follows:

- All inputs used for the safety analysis are managed in the SAPP. This organization facilitates the safety analysis work required for each reload. In this regard, the trip function uncertainty allowances are no different than any other SAPP managed analysis input parameter.
- Including bounding trip function uncertainty allowances in one common document promotes consistent use of analytical limit values throughout the safety analysis which facilitates effective margin management. For example, the analytical limit used for the high pressurizer pressure trip should ideally be the same for all events that credit this trip function.
- Including bounding trip function uncertainty allowances in the SAPP eliminates the need for documenting the analytical limits in the setpoint calculations. Therefore the purpose of the setpoint calculations is to verify that the trip function uncertainty allowances in the SAPP are bounding with respect to the calculated total channel uncertainty.
- Including bounding trip function uncertainty allowances in the SAPP reflects St. Lucie operating experience where protection system TS setpoints are infrequently changed in comparison with analytical limits and calculated loop uncertainties.

A second calculation exists for each safety system input parameter. Each of these calculations combines the loop component uncertainties (from the corresponding FPL calculations) with the protection system cabinet uncertainties to determine an overall total loop uncertainty (TLU). These setpoint calculations also verify that the uncertainty allowances defined in the SAPP are bounding. Further, these setpoint calculations determine operability limits (OL) for the related actuation functions. These calculations have been prepared in accordance with IC-3.17, ISA Standard 67.04, and RG 1.105. All safety system instrument channel setpoint calculations were reviewed and revised as necessary in support of the EPU.

II. Compliance with Recent Setpoint Methodology Changes as Described in RIS 2006-17

As discussed in the preceding section, there is an uncertainty calculation and a setpoint calculation associated with each protection system input parameter. These calculations were revised as necessary as part of the EPU to comply with recent setpoint methodology changes described in RIS 2006-17. Conformance with key issues raised in RIS 2006-17 is summarized in the following paragraphs:

NRC guidance provided in RIS 2006-17 stipulates that as-left setting tolerance should be explicitly accounted for in the setpoint determination. More specifically, since the walk-away equipment setpoint may be left anywhere within the as-left band, this allowed setting tolerance must be treated as a bias in the setpoint determination. RIS 2006-17 further stipulates that the surveillance procedures must ensure that the trip setpoint is restored to within the as-left band before the channel is returned to service. To comply with this NRC guidance, the verification that the SAPP defined uncertainty allowance is bounding (as performed in the setpoint calculations per above discussion) has been structured to ensure that TLU plus setting tolerance (ST) is less than or equal to SAPP allowance (TLU + ST SAPP uncertainty allowance). To clarify, the ST is algebraically added to TLU (for SAPP allowance verification) and is also included as a random/independent term in the root-sum-square TLU calculation. In addition, St. Lucie protection system surveillance procedures require that trip setpoints are restored to within the as-left band before the channel is returned to service. Using this methodology, the SAPP uncertainty allowances have been verified to be bounding for all protection system functions at EPU conditions. Since the safety analysis Analytical Limits are based on the algebraic combination of the TS setpoint and the SAPP uncertainty allowance, it has also been verified that all TS setpoints are sufficiently conservative at EPU conditions to ensure that applicable safety limits will not be exceeded if a design basis event occurs before the next periodic surveillance.

Additional NRC guidance provided in RIS 2006-17 stipulates use of an as-found acceptance criteria band centered about the nominal equipment setpoint as a measure of instrument channel operability. To comply with this NRC guidance, the setpoint calculations have been structured to include determination of an operability limit (OL) band. For St. Lucie, the OL band is synonymous with the as-found acceptance criteria band. The St. Lucie Unit 1 protection system monthly functional surveillance procedures will be revised as necessary to ensure an evaluation of loop conditions is performed under the corrective action program when the as-found setpoint is outside of the as-found acceptance criteria.

Historically, St. Lucie has used an as-found tolerance band width equal to 2 times the procedure ST as the basis for initiation of corrective action under the CAP program. This existing as-found tolerance band width meets the intent of the NRC guidance since the previous as-left setting may be anywhere within one ST band width, leaving just one ST band width for accommodation of drift and other periodic test uncertainties. As-found readings within the allowed ST are not typically optimized in the monthly functional surveillance procedures. Therefore the as-left setting tolerance is treated as a bias. Several other methodologies for calculation of OL band width based on statistical combination of drift and other periodic test uncertainty effects were considered, but rejected, since the resultant OL bands were either larger or smaller than reasonable. This result is due to differences in the relative magnitude of manufacturer' specifications for bistable uncertainty effects between the three protection systems (e.g., RPS bistable drift spec is 0.25%, but the AFAS bistable drift spec is 0.05%). Therefore, the OL band (synonymous with the as-found acceptance criteria) is based on 2 times the ST and is normally centered about the nominal equipment setting. It is noted that for some trip functions the existing ST is non-symmetrical about the nominal trip setpoint and for these functions the OL band is structured to provide equal tolerance above and below the ST limits.

As discussed in LR Section 2.4.1, the following two notes will be added to TS Table 2.2-1, and these notes will be designated as being applicable to the RPS Low SG Level trip function since this is the only setpoint change for EPU.

1. If the as-found channel setpoint is either outside its predefined as-found acceptance criteria band or is not conservative with respect to the Allowable Value, then the channel shall be declared inoperable and shall be evaluated to verify that it is functioning as required before returning the channel to service.

2. The instrument channel setpoint shall be reset to a value that is within the as-left tolerance of the Trip Setpoint, or a value that is more conservative than the Trip Setpoint, otherwise that channel shall not be returned to Operable status. The Trip Setpoint and the methodology used to determine the Trip Setpoint, the as-found acceptance criteria band, and the as-left acceptance criteria are specified in the UFSAR.

III. Summary of Low SG Level Setpoint/Uncertainty Calculations

This summary uses the following terms and acronyms:

A	Device reference accuracy
BTU	Bistable trip unit
D	Drift
FTSP	Field trip setpoint
LT	Level transmitter
M	Measuring and test equipment (M&TE)
OL+	Upper operability limit
OL-	Lower operability limit
R	Radiation effects (Ra and Rn for accident and normal)
RLE	Reference leg effect (RLEa and RLEn for accident and normal)
SAPP	Safety analysis plant parameters
SPE	Static pressure effect
SRSS	Square root sum of squares
ST	Setting tolerance
T	Temperature Effect (Ta and Tn for accident and normal)
TLU	Total loop uncertainty (TLUa and TLUn for accident and normal)

For the RPS Low SG Level trip function, the channel consists of a Rosemount Model 1154 transmitter and the RPS bistable trip unit (BTU). Device uncertainties that were determined to be both applicable and non-negligible are summarized in Table E-1. Although not referenced herein, other effects, including dynamic effects, were also evaluated.

Total Loop Uncertainty Calculations and SAPP Uncertainty Allowance Verification

The Total Loop Uncertainty (TLUn) with normal environmental conditions for the RPS Low Steam Generator Level trip function is calculated as follows:

$$TLUn = SRSS(A\_LT^2 + M\_LT^2 + ST\_LT^2 + D\_LT^2 + Tn\_LT^2 + SPE\_LT^2 + A\_BTU^2 + M\_BTU^2 + ST\_BTU^2 + D\_BTU^2 + Tn\_BTU^2) + RLEn\_LT$$

TLUn = 2.01% span

TLUn + ST = 2.26% span

SAPP normal uncertainty allowance = 5% span

The Total Loop Uncertainty (TLUa) with accident environmental conditions for the RPS Low Steam Generator Level trip function is calculated as follows:

$$TLUa = SRSS(A\_LT^2 + M\_LT^2 + ST\_LT^2 + D\_LT^2 + Ta\_LT^2 + SPE\_LT^2 + Ra\_LT^2 + A\_BTU^2 + M\_BTU^2 + ST\_BTU^2 + D\_BTU^2 + Tn\_BTU^2) + RLEa\_LT$$

TLUa = 12.51% span

TLUa + ST = 12.76% span

SAPP accident uncertainty allowance = 14% span

Operability Limit Calculations

RPS Low S/G Level BTU Signal Range = -1 Vdc to -5 Vdc for 0% to 100%

RPS Low S/G Level BTU FTSP = -2.420 Vdc or 35.5% span

RPS Low S/G Level BTU ST = -2.410 Vdc to -2.448 Vdc

RPS Low S/G Level BTU ST Band Width = 38 mV

RPS Low S/G Level BTU OL+ = -2.467 Vdc or 36.68% span

RPS Low S/G Level BTU OL- = -2.391 Vdc or 34.78% span

RPS Low S/G Level BTU OL Band Width = 76 mV

Table E-1
RPS Low SG Level Instrument Loop Device Uncertainties

	Level Transmitter (LT)	RPS BTU
Reference accuracy (A)	±0.25% span	±0.125% span
M&TE (M)	±0.35% span	±0.125% span
Setting tolerance (ST)	±0.25%span	±0.25% span
Drift (D)	±0.32% span	±0.25% span
Temperature effect (Tn)	±0.70% span	±0.25% span
Temperature effect (Ta)	±4.20%span	N/A
Static pressure effect (SPE)	±0.43% span	N/A
Radiation effect (Ra)	±1.61% span	N/A
Reference leg effect (RLEn)	+0.89%span	N/A
Reference leg effect (RLEa)	+7.93%span	N/A