Florida Power & Light Company, 6501 S. Ocean Drive, Jensen Beach, FL 34957

FPL

May 18, 2011

L-2011-187
10 CFR 50.90

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

Re: St. Lucie Plant Unit 1
Docket No. 50-335
Renewed Facility Operating License No. DPR-67

Response to NRC Containment and Ventilation Branch Request for Additional Information Regarding Extended Power Uprate License Amendment Request

References:

(1) R. L. Anderson (FPL) to U.S. Nuclear Regulatory Commission (L-2010-259), "License Amendment Request for Extended Power Uprate, November 22, 2010, Accession No. ML103560419.
(2) Email from T. Orf (NRC) to C. Wasik (FPL), "St. Lucie Unit 1 EPU – request for additional information (Containment and Ventilation)," April 22, 2011, Accession No. ML111120264.

By letter L-2010-259 dated November 22, 2010 [Reference 1], Florida Power & Light Company (FPL) requested to amend Renewed Facility Operating License No. DPR-67 and revise the St. Lucie Unit 1 Technical Specifications (TS). The proposed amendment will increase the unit's licensed core thermal power level from 2700 megawatts thermal (MWt) to 3020 MWt and revise the Renewed Facility Operating License and TS to support operation at this increased core thermal power level. This represents an approximate increase of 11.85% and is therefore considered an extended power uprate (EPU).

By email from the NRC Project Manager dated April 22, 2011 [Reference 2], additional information related to containment considerations and ventilation system performance was requested by the NRC staff in the Containment and Ventilation Branch (SCVB) to support their review of the EPU LAR. The request for additional information (RAI) identified fifteen questions. The response to these RAIs is provided in Attachment 1 to this letter.

A001
NRR

In accordance with 10 CFR 50.91(b)(1), a copy of this letter is being forwarded to the designated State of Florida official.

This submittal does not alter the significant hazards consideration or environmental assessment previously submitted by FPL letter L-2010-259 [Reference 1].

This submittal contains no new commitments and no revisions to existing commitments.

Should you have any questions regarding this submittal, please contact Mr. Christopher Wasik, St. Lucie Extended Power Uprate LAR Project Manager, at 772-429-7138.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Executed on May 18, 2011.

Very truly yours,

Richard L. Anderson
Site Vice President
St. Lucie Plant

Attachment

cc: Mr. William Passetti, Florida Department of Health

Response to Request for Additional Information

The following information is provided by Florida Power & Light in response to the U.S. Nuclear Regulatory Commission's (NRC) Request for Additional Information (RAI). This information was requested to support Extended Power Uprate (EPU) License Amendment Request (LAR) for St. Lucie Nuclear Plant Unit 1 that was submitted to the NRC by FPL via letter (L-2010-259) dated November 22, 2010 (Accession Number ML103560419).

In an email dated April 22, 2011 from NRC (Tracy Orf) to FPL (Chris Wasik), "St. Lucie Unit 1 EPU – request for additional information (Containment and Ventilation)" (Accession Number ML 111120264), the NRC staff requested additional information regarding FPL's PSL1 EPU LAR. The RAI consisted of fifteen (15) questions from the NRC's Containment and Ventilation Branch (SCVB). The 15 RAI questions and the associated FPL responses are documented below.

Note that all references to Licensing Report (LR) Sections discussed below are with respect to the LRs provided in Attachment 5 of the PSL1 EPU LAR.

SCVB-1

In reference to LR Section 2.6.3.1.2.2, what computer code was used and what assumptions were made for the short term mass and energy (M& E) release analysis for subcompartment analysis. If it is different from the current licensing basis, please justify.

Response to SCVB-1

There is no change to the current licensing basis. No new analysis was performed; instead the current analysis was evaluated for EPU conditions. Each such evaluation employed hand calculations to determine how the current analysis would behave if it were run at the new EPU conditions. To accomplish that, each evaluation considered:

(a) the conditions of the current analysis including the specific enthalpy at the break, and the resulting break mass flux and break energy flux;
(b) the new conditions with EPU, including the specific enthalpy at the break;
(c) how the changed conditions would impact the choked break flux and energy flux, as given by the critical flow correlations.

In order to ensure validity of the evaluation method, the evaluations considered applicable trends near and at the break, including the effects of initial and transient break flow enthalpy, the effect of break enthalpy on the M&E release, the pressure losses leading to the break, and the event's time-of-interest.

In order to ensure that the releases are evaluated conservatively for the EPU, the following assumptions were employed:

- Minimum core inlet temperature, including uncertainty.
- Nominal RCS flow rate, including uncertainty.
- Nominal full reactor power, including uncertainty.

The current M&E releases were found to either remain bounding or there was sufficient margin in the sub-compartment analysis to absorb the small increases in M&E releases due to EPU conditions (as discussed in LR Section 2.6.2.2.2).

SCVB-2

In reference to LR Section 2.6.6.2.1, editorial comment: clarify if Branch Technical Position (BTP) 6-2, Rev 3, was used instead of BTP 6-1. Please correct in references also.

Response to SCVB-2

The guidance provided in BTP 6-2 Rev. 3 was used versus BTP 6-1 as cited in LR Section 2.6.6.2.1 and associated Reference 2. Appendix C to Attachment 5 of the St. Lucie Unit 1 EPU LAR provided the Realistic Large Break LOCA Summary Report (RLBLOCA), ANP-2903(P). ANP-2903(P) correctly makes reference to BTP 6-2.

SCVB-3

In reference to LR Section 2.6.6.2.1, specify which guidance of BTP 6-2, Rev 3, was not used in setting the containment model input parameters and provide justification for not using the conservative guidance.

Response to SCVB-3

BTP 6-2 is provided below along with comments to note where BTP 6-2 was and was not used in setting the containment model input parameters. As discussed below, where the guidance provided in BTP 6-2 was not used, the applicable guidance provided in Regulatory Guide 1.157 was used.

Branch Technical Position CSB 6-2 was established to provide guidance to plant licensees and vendors as to how containment systems are to be modeled for Appendix K-based LOCA evaluations. The intent of CSB 6-2 is to provide guidance for the performance of a minimum containment backpressure analysis. The RLBLOCA methodology was approved as a "Best-Estimate" methodology that conforms to Regulatory Guide 1.157. With regard to containment pressure, the Regulatory Guide states (Section 3.12.1):

"The containment pressure used for evaluating cooling effectiveness during the post-blowdown phase of a loss-of-coolant accident should be calculated in a best-estimate manner and should include the effects of operation of all pressure reducing equipment assumed to be available. Best-estimate models will be considered acceptable provided their technical basis is demonstrated with appropriate data and analyses."

BTP 6-2
1. Input Information for Model

> *A. Initial Containment Internal Conditions. The minimum containment gas temperature, minimum containment pressure, and maximum humidity encountered under limiting*

normal operating conditions should be used. Ice condenser plants should use the maximum containment gas temperature.

The RLBLOCA containment model does not follow the guidance in BTP 6-2 Item 1.A for temperature and pressure. Regulatory Guide 1.157 is followed; the containment gas temperature is sampled and the containment initial pressure is nominal. The humidity is set to 100-percent, which follows the guidance provided in BTP 6-2 Item 1.A.

B. Initial Outside Containment Ambient Conditions. A reasonably low ambient temperature external to the containment should be used.

A reasonably low ambient temperature of 38 °F has been used in containment models for RLBLOCA, thus following the guidance in BTP 6-2 Item 1.B.

C. Containment Volume. The maximum net free containment volume should be used. This maximum free volume should be determined from the gross containment volume minus the volumes of such internal structures as walls and floors, structural steel, major equipment, and piping. The individual volume calculations should reflect the uncertainty in the component volumes.

BTP 6-2 guidance is not explicitly followed for Item 1.C; Regulatory Guide 1.157 is followed.

The maximum containment volume used in the sampled range of containment volume includes a conservative allowance on the calculated net free containment volume to cover uncertainty in the component volumes and also accommodate additional margin to the variations in the containment initial conditions. This sampled range is conservative since the larger containment volume suppresses the containment response following a LOCA, resulting in lower containment pressures.

D. Purge Supply and Exhaust Systems. If purge system operation is proposed during the reactor operating modes of startup, power operation, hot standby, and hot shutdown, the system lines should be assumed to be initially open.

As discussed in LR Section 2.7.7.2.4, FP&L is modifying the existing containment hydrogen purge system to provide a new function to control containment pressure. To support this function, the two hydrogen purge system exhaust isolation valves will be modified to allow remote-manual control capability. These modified containment isolation valves will automatically close on a containment isolation actuation signal (CIAS). The purge flow was not included in the RLBLOCA containment model as its impact on containment pressure is determined to be insignificant, < 0.004%, when considering the volume of containment and the purge fan capacity.

2. Active Heat Sinks

A. Spray and Fan Cooling Systems. The operation of all engineered safety feature containment heat removal systems operating at maximum heat removal capacity (i.e., with all containment spray trains operating at maximum flow conditions and all emergency fan cooler units operating) should be assumed. In addition, the minimum temperature of the stored water for the spray cooling system and the cooling water supplied to the fan coolers, based on technical specification limits, should be assumed.

Deviations from the foregoing are accepted if the worst conditions for a single active failure, stored water temperature, and cooling water temperature can be shown to have been selected from the standpoint of the overall ECCS model.

The RLBLOCA containment model follows the guidance in BTP 6-2 Item 2.A.

B. Containment Steam Mixing With Spilled ECCS Water. The spillage of subcooled ECCS water into the containment provides an additional heat sink as the subcooled ECCS water mixes with the steam in the containment. The effect of the steam-water mixing should be considered in the containment pressure calculations.

The double-ended guillotine break (DEGB) and the double-ended split break (DESB) do not spill subcooled water into containment[1]. The modeling of the DEGB and the DESB model does not follow BTP 6-2 Item 2.B, but follows Regulatory Guide 1.157.

C. Containment Steam Mixing With Water from Ice Melt. The water from ice melting in an ice condenser containment provides an additional heat sink as the subcooled water mixes with the steam while draining from the ice condenser into the lower containment volume. The effect of the steam-water mixing should be considered in the containment pressure calculations.

St. Lucie Unit 1 does not have an ice condenser; therefore, containment steam mixing with water from ice melt is not applicable to St. Lucie Unit 1.

3. Passive Heat Sinks

A. Identification. The passive heat sinks that should be included in the containment evaluation model should be established by identifying structures and components within the containment that could influence the pressure response. Structures and components that should be included are listed in Table 1. Data on passive heat sinks have been compiled from previous reviews and used as a basis for the simplified model outlined below. This model is acceptable for minimum containment pressure analyses for construction permit applications until a complete identification of available heat sinks can be made (i.e., at the operating license review). Where no detailed listing of heat sinks within the containment is provided, the following procedure may model the passive heat sinks within the containment:

(i) Use the surface area and thickness of the primary containment steel shell or steel liner, anchors, and concrete, as appropriate.

The RLBLOCA containment model follows the guidance in BTP 6-2 Item 3.A.i. ANP-2903(P) provides the data in Table 3-9.

(ii) Estimate the exposed surface area of other steel heat sinks in accordance with Figure 1 and assume an average thickness of 9.53 mm (3/8 inch).

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[1] Further along in the transient, as the ECCS depressurizes the RCS, the RCS can reach a pressure below the containment pressure and a small amount of subcooled water (at low subcooling) can be transported to the containment. This spillage would have insufficient energy absorption potential to significantly impact the containment pressure.

The RLBLOCA containment model follows the guidance in BTP 6-2 Item 3.A.ii. ANP-2903(P) provides the data in Table 3-9.

(iii) Model the internal concrete structures as a slab with a thickness of 30.5 cm (one foot) and exposed surface of 15,000 m2 (160,000 ft2). Acceptable heat sink thermo-physical properties are shown in Table 2. Applicants should provide a detailed list of passive heat sinks with appropriate dimensions and properties.

The RLBLOCA containment model follows the guidance in BTP 6-2 Item 3.A.iii. ANP-2903(P) provides the data in Table 3-9.

B. *Heat Transfer Coefficients. The following conservative condensing heat transfer coefficients for heat transfer to the exposed passive heat sinks during the blowdown and post-blowdown phases of the loss-of-coolant accident should be used:*

(i) During the blowdown phase, assume a linear increase in the condensing transfer coefficient from $h_{initial}$ = 8 Btu/hr-ft^2-°F, at t = 0, to a peak value four times greater than the maximum calculated condensing heat transfer coefficient at the end of blowdown, using the Tagami correlation,

$$h_{max} = 7.25(Q/Vt_p)^{0.62}$$

where h_{max} = maximum heat transfer coefficient, Btu/hr-ft^2-°F
Q = primary coolant energy, Btu
V = net free containment volume, ft^3
t_P = time interval to end of blowdown, sec.

The RLBLOCA containment model does not follow the guidance in BTP 6-2 Item 3.B.i, but uses 1.7 x Uchida and follows Regulatory Guide 1.157. A validation of the models appropriateness was demonstrated for the first time application to St. Lucie Unit 1.

(ii) During the long-term post-blowdown phase of the accident characterized by low turbulence in the containment atmosphere, assume condensing heat transfer coefficients 1.2 times greater than those predicted by the Uchida data and given in Table 3.

The RLBLOCA containment model does not follow the guidance in BTP 6-2 Item 3.B.ii, but uses 1.7 x Uchida and follows Regulatory Guide 1.157. A validation of the models appropriateness was demonstrated for the first time application to St. Lucie Unit 1.

(iii) During the transition phase of the accident between the end of blowdown and the long-term post-blowdown phase, a reasonably conservative exponential transition in the condensing heat transfer coefficient should be assumed (See Figure 2). The calculated condensing heat transfer coefficients based on this method should be applied to all exposed passive heat sinks, both metal and concrete, and for both painted and unpainted surfaces. Heat transfer between adjoining materials in passive heat sinks should be based on the assumption of no resistance to heat flow at the material interfaces. An example is the containment liner to concrete interface.

The RLBLOCA containment model does not follow the guidance in BTP 6-2 Item 3.B.iii, but uses 1.7 x Uchida and follows Regulatory Guide 1.157. A validation of the models appropriateness was demonstrated for the first time application to St. Lucie Unit 1.

(iv) Variations from these guidelines may be acceptable if the overall ECCS performance evaluation model produces an acceptable peak calculated fuel cladding temperature.

The RLBLOCA containment model does not follow the guidance in BTP 6-2 Item 3.B.iv, but uses 1.7 x Uchida and follows Regulatory Guide 1.157. A validation of the models appropriateness was demonstrated for the first time application to St. Lucie Unit 1.

SCVB-4

In reference to LR Section 2.6.5.2.4, under heading "Net Positive Suction Head (NPSH)"; list the conservative assumptions for the NPSH analysis that minimized the available pump NPSH during the injection and recirculation phases.

Response to SCVB-4

The NPSH calculations utilize assumptions that tend to maximize the flow rate. These include reduced containment pressure (see the response to SCVB-6 for specific values), maximum IST acceptance criteria, instrument uncertainty and EDG over frequency. Maximizing the flow maximizes the fluid pressure drop and reduces the available NPSH ($NPSH_A$). The manufacturer's NPSH required ($NPSH_R$) values are increased to account for the increased pump speed due to EDG overfrequency. The methodology for adjusting the $NPSH_R$ values is based on an article in Pumps and Systems Magazine, Aug 2009 edition by Terry Henshaw, P.E, *"Do Pumps Require Less NPSH on Hydrocarbons? Stepping NPSHR to Different Speeds".* The NPSH margin calculation does not consider the reduction in NPSH required that can be realized when pumping water at temperatures that exceed the water temperature during the NPSH test.

Injection mode

The RWT level used in the pump NPSH calculation is the centerline of the tank outlet nozzle, which is approximately 12" below the RAS setpoint minus instrument uncertainty. This minimizes the static head between the RWT water level and the pump suction.

The NPSH calculation also assumes that all of the ECCS and CS pumps are operating (no pump failures) and drawing water from the RWT. This maximizes the pressure drop in the tank outlet/pump suction header piping, which reduces NPSH available.

Recirculation Mode

The volume of water injected into the containment is minimized. All sources are at their minimum allowable values. Heldup water volumes are maximized. Volume shrinkage due to the mixing of sources that are initially at different temperatures is considered in establishing the minimum sump water level. This minimizes the static head between the sump water level and the pump suction.

Debris and chemical precipitate losses, in addition to friction losses, are included in the sump screen losses considered in the NPSH calculation.

SCVB-5

Provide a discussion of how the post accident debris generation is impacted by the extended power uprate (EPU). What effect should it have on response to Generic Letter (GL) 2004-02, which relates to the resolution of Generic Safety Issue (GSI)-191? Also, provide the impact of the EPU on the sump strainer head loss and on the emergency core cooling system (ECCS) pump NPSH evaluations during post-loss of coolant accident (LOCA) operation of the ECCS pumps. Confirm that the GSI-191 resolution will assume plant condition after EPU implementation.

Response to SCVB-5

As explained in the following paragraphs EPU has no effect on the issues that need to be addressed to resolve NRC concerns on the resolution of GSI-191 for St Lucie Unit 1. Therefore the review and approval of the St Lucie Unit 1 EPU LAR should be considered to be independent of the resolution of GSI-191.

EPU has no effect on post accident debris generation. The zone of influence used in calculating debris destruction radii is independent of RCS operating conditions (temperature, pressure). The zone of influence is only affected by the inside diameter of the pipe break and the insulation type, which is not being changed by EPU.

The recirculation phase flows are driven by the flow rates of the ECCS and CS pumps. These flow rates are not a function of RCS operating parameters or post-LOCA decay heat rates. EPU has no effect on total sump flow.

The sump strainer head loss values are a function of sump flow rate, temperature and debris loading. The sump flow rates used in the NPSH calculations are conservatively selected to be greater than the sump design flow rates. The EPU NPSH calculations include consideration of the current sump screen head losses. These head losses are adjusted for the EPU NPSH calculation flow rates and sump water temperatures. This results in sump head loss values that are conservatively high.

As part of the resolution of GSI-191, the sump strainer head losses will be re-evaluated to include consideration of changes resulting from EPU as well as potential changes in strainer debris loading.

SCVB-6

Provide a summary of the NPSH analyses at the EPU conditions, including NPSH required (NPSHR), containment accident pressure (CAP) used, and the method of calculating NPSH available (NPSHA). What was the containment atmospheric pressure used in the analyses? Provide the basis for the NPSHR of the ECCS and containment spray pumps, including flow rates assumed, and a comparison with the flow rate for the LOCA peak cladding temperature (PCT) analyses. Does the NPSHR value used in the analysis correspond to the '3-percent pump head drop' basis suggested in the hydraulic

institute (HI) standard? Describe any uncertainty or sensitivity analysis performed for NPSHR margins.

Response to SCVB-6

NRC Safety Guide 1 (i.e., Regulatory Guide 1.1) provides guidance on the determination of available NPSH for the ECCS pumps. The Safety Guide notes that it is important that proper performance of ECCS pumps be independent of calculated increases in containment pressure caused by Loss of Coolant Accident (LOCA). The Safety Guide notes that changes in NPSH caused by increases in temperature of the pumped fluid can be accommodated through plant design without reliance on the calculated increase in the containment pressure. The regulatory position stated in Regulatory Guide 1.1 is that ECCS pumps should be designed so that adequate NPSH is provided assuming:

1. Maximum expected temperature of the pumped fluid, and
2. No increase in containment pressure from that present prior to the postulated LOCA

The $NPSH_A$ for the ECCS and CS pumps can be found by application of the classical NPSH formula.

$NPSH_A = ((P_A - P_V) \times 144)/\rho + H_S - H_L$

where,

P_A = total ambient or containment pressure (sum of air partial pressure and steam partial pressure), as applicable, psia

P_V = vapor pressure of the pumped fluid, psia

ρ = density of the pumped fluid, lb/ft^3

H_S = static elevation head (difference between the RWT or containment sump water elevation and the elevation of impeller eye of the pump), ft

H_L = suction piping head losses including as applicable strainer piping / plenum loss, sump screen head loss, and the suction line friction loss, ft

Calculations have demonstrated that throughout the recirculation mode duration the containment sump water temperature never exceeds 200 °F. In order to be consistent with Regulatory Guide 1.1, the minimum allowable containment air partial pressure (P_A) under normal operation is used as the total containment pressure (P_A). Accordingly, the CAP is not credited in the analysis.

As part of EPU, hydraulic calculations determine the maximum flow rates that would be delivered by the CS, LPSI and HPSI pumps. These calculations use a Fathom hydraulic model of the piping systems. Enhanced pump performance curves are part of the input to these calculations.

The enhanced pump curves are based on the following assumptions:

1. The shape of the pump curve is based on the manufacturer's certified test pump curve.
2. The pump curve is shifted vertically upward so that it passes through the flow/head point defined by the maximum IST acceptance criteria
3. The pump curve is shifted vertically upward a second time to account for the uncertainty associated with the test instrumentation
4. The curve is modified again to account for EDG overfrequency of 1%. Using the pump affinity laws the flow is multiplied by a factor of 1.01 and the head is multiplied by a factor of 1.02.

Using these adjusted pump curves HPSI and LPSI pump delivery rates are determined as a function of RCS pressure. For the CS pump, flow rates are calculated as a function of containment pressure and RWT and containment sump level. The Fathom model provides the following flow rate results:

- HPSI pump - 689 gpm at an RCS pressure of 15 psia
- LPSI pump – 4590 gpm at an RCS pressure of 17 psia
- LPSI pump - 349 gpm at an RCS pressure of 14.7 psia for hot leg injection
- CS pump - 3755 gpm at max RWT level and a containment pressure of 40 psig
- CS pump - 4047 gpm at min RWT level and a containment pressure of 0 psig
- CS pump - 4439 gpm at max containment sump level (includes 640 gpm to HPSI pump suction)

Based on the above information the following flow rates are used in the NPSH calculations:

- HPSI pump – 690 gpm for injection mode
- HPSI pump - NPSH calculation is not performed for recirculation mode since pump suction is normally aligned to CS pump discharge
- LPSI pump – 4590 gpm for injection mode
- LPSI pump - 404 gpm for hot leg injection (recirculation mode)
- CS pump - 4050 gpm for the injection mode
- CS pump - 4450 gpm for the recirculation mode

The $NPSH_R$ values used in the NPSH evaluation are obtained from the manufacturer's $NPSH_R$ curves, which were based on the HI 3% head drop standard. This value is then adjusted to account for the 1% EDG over frequency. The methodology for adjusting the $NPSH_R$ values is based on an article in Pumps and Systems Magazine, Aug 2009 edition by Terry Henshaw, P.E, *"Do Pumps Require Less NPSH on Hydrocarbons? Stepping NPSHR to Different Speeds".*

Injection mode NPSH calculations are performed at RWT water temperatures of 40 °F and 100 °F and at minimum and maximum RWT levels. The minimum RWT level and higher RWT temperature is the bounding case. The results for this set of boundary conditions are provided in Table 1.

For the recirculation mode, NPSH calculations are performed for sump water temperatures ranging from 65 °F to 198.4 °F, which conservatively is greater than the calculated maximum sump water temperature of approximately 192 °F. This maximum sump water temperature corresponds to the saturation temperature at 11.14 psia. This is equal to the technical specification allowable minimum containment initial air partial pressure based on the containment total pressure of -0.7 psig. At this temperature, the air partial pressure of the containment is equal to the vapor pressure of the water in the sump. The difference between the minimum containment air partial pressure and the vapor pressure of the pumped fluid is credited in the NPSH calculation. The results for this set of boundary conditions are provided in Table 2.

The HPSI pump flow rates used in the PCT analysis for a) loss of one HPSI pump, and b) single failure of one EDG varied as a function of RCS backpressure.

The LPSI pump flow rates used in the PCT analysis for a) loss of one LPSI pump, and b) single failure of one EDG varied as a function of RCS backpressure (the flow rate listed below includes a 300 gpm reduction on one loop's available flow).

Conservatively high CS pump flow rates in the PCT analysis are used to minimize containment backpressure, thereby increasing break flow.

The HPSI and LPSI flow rates below are at the lowest pressure for the LOCA analysis:

Type of Analysis	HPSI	LPSI	CS
LBLOCA	463.4 gpm	2213 gpm	9000 gpm
SBLOCA	616.3 gpm	Not modeled	Not modeled

The lowest RCS pressure will yield the maximum HPSI/LPSI flow into the vessel. The maximum HPSI and LPSI flow values used in the PCT analysis are less than the NPSH calculation flow rates listed above. A minimum HPSI/LPSI flow rate yields worse PCT results. The CS flow used in the PCT analysis conservatively exceeds the value from the NPSH calculation.

Table 1 NPSH Calculation Injection Mode

Pump		Flow Rate-Min RWT	Atm Press	Vapor Press (1)	Density (1)	Static Head-Min RWT	Friction Loss-Min RWT	$NPSH_A$ Min RWT	$NPSH_R$ Min RWT (3)	NPSH Margin Min RWT	NPSH Margin percent (2)
		gpm	psia	psia	lb/ft3	ft	ft	ft	ft	ft	%
CS Pump 1A		4,050	14.7	0.94924	62.00	29.31	9.58	51.7	11.2	40.5	362
CS Pump 1B		4,050	14.7	0.94924	62.00	29.31	9.64	51.6	11.2	40.4	361
HPSI Pump 1A		690	14.7	0.94924	62.00	29.23	11.50	49.7	28.6	21.1	74
HPSI Pump 1B		690	14.7	0.94924	62.00	29.23	10.14	51.0	28.6	22.5	78
LPSI Pump 1A		4,590	14.7	0.94924	62.00	27.98	11.92	48.0	21.4	26.6	124
LPSI Pump 1B		4,590	14.7	0.94924	62.00	27.98	12.11	47.8	21.4	26.4	123

(1) RWT temperature assumed to be 100 °F.

(2) Margin percent =($(NPSH_A - NPSH_R)/NPSH_R$) x 100

(3) Includes adjustment for operation at EDG over frequency speed

Table 2 NPSH Calculation Recirculation Mode Design Case

Pump		Flow Rate-	Static Head at Min Sump Level (6)	Sump Screen Head Loss	Sump Piping Head Loss	Suction Piping Friction Loss	$NPSH_A$ Min Sump Level (4) (6)	$NPSH_R$ (7)	NPSH Margin Min Sump Level	NPSH Margin percent (5)
		gpm	ft	ft	ft	ft	ft	ft	ft	%
CS Pump 1A		4,450 (1)	31.96	4.53	7.4	3.54	16.50	13.2	3.30	25
CS Pump 1B		4,450 (1)	31.96	4.53	7.4	3.54	16.50	13.2	3.30	25
HPSI Pump 1A		Note 2								
HPSI Pump 1B		Note 2								
LPSI Pump 1A		404 (3)	30.56	4.53	7.4	1.11	17.53	9.1	8.43	93
LPSI Pump 1B		404 (3)	30.56	4.53	7.4	1.11	17.53	9.1	8.43	93

(1) Includes 640 gpm supplied to HPSI pump suction
(2) NPSH calculation not performed for recirculation mode since pump suction is normally aligned to CS pump discharge
(3) Hot Leg Injection flow rate
(4) At sump water temperature of 198.4 F
(5) Margin percent =(($NPSH_A$-$NPSH_R$)/$NPSH_R$) x 100
(6) These values are applicable to the LBLOCA. For the SBLOCA subtract 0.51 feet from these values. Margin for SBLOCA is 21.1%
(7) Includes adjustment for operation at EDG over frequency speed

SCVB-7

In reference to LR Section 2.6.6, "Pressure Analysis for ECCS Performance Capability." How does the EPU affect the minimum containment pressure transient calculated during the reflood phase?

Response to SCVB-7

The EPU will increase the minimum containment pressure transient calculated during the reflood phase due to increased plant power and T_{cold} temperature. The transient containment pressure response from the limiting RLBLOCA case is shown in Figure 2.6.6.6-1 of LR 2.6.6. The containment pressure response for the current analysis is shown in UFSAR Figure 15.4.1-14. As specified in 10 CFR 50.46 Appendix K, the transient calculations used a conservative range of sampled containment parameters and, as outlined in LR Table 2.6.6-1, included the effects of operation of all pressure reducing equipment to minimize the containment pressure.

SCVB-8

In reference to LR Section 2.6.2.2.2, item 3, "Pressurizer Surge Line Guillotine Break;" explain how from the pre-EPU St. Lucie Unit 2 pressurizer surge line break M&E release data, the St. Lucie Unit 1 EPU M&E release rates were conservatively obtained and estimated to be 0.9-percent and 0.4-percent higher than pre-EPU M&E release rates for St. Lucie Unit 2.

Response to SCVB-8

The evaluation of the St. Lucie Unit 1 Surge Line break at EPU conditions is documented in LR Section 2.6.3.1.2.2.3.

A pre-EPU pressurizer surge line break M&E release analysis is not currently analyzed in the UFSAR for Unit 1. However, a pre-EPU surge line break M&E release analysis is documented for Unit 2. Therefore, the evaluation performed for Unit 1 at EPU conditions was based on the Unit 2 pre-EPU analysis.

Evaluation of differences in RCS design between Units 1 and 2 concluded that the two units are sufficiently similar that one M&E analysis can apply to both units. The evaluation did note dissimilarities in the EPU operating conditions, and in the designs of replacement steam generators (RSGs), reactor vessel upper head (RVUH), pressurizer and surge line. Those were addressed separately:

- *EPU Conditions.* EPU conditions at Units 1 and 2 have identical values of NSSS power and cold leg temperature (T_{COLD}), but different RCS flow rates – 406,966 gpm in Unit 1; 400,756 gpm in Unit 2. The measurement uncertainties in Units 1 and 2 are identical for power, T_{COLD} and flow. The higher RCS flow in Unit 1 would produce a lower hot leg temperature, which was shown to make the surge line break M&E results more adverse.

An evaluation was performed that assessed the expected differences between M&E release rates at Unit 2 EPU conditions but with the higher RCS flow of Unit 1 at EPU, and those reported for Unit 2 at pre-EPU. The evaluation employed hand calculations to determine how the Unit 2 pre-EPU analysis would behave if it were run at the Unit 2 EPU conditions with the higher RCS flow rate. To accomplish that, the evaluation considered:

(a) the conditions of the Unit 2 pre-EPU analysis, including the specific enthalpy at the break, and the resulting mass and energy fluxes at the break;
(b) the conditions for Unit 2 at EPU with the Unit 1 EPU flow rate, including the specific enthalpy at the break;
(c) how the changed conditions would impact the choked break flux and energy flux, as given by the critical flow correlations.

In order to ensure validity of the approach, the evaluation considered applicable trends near and at the break, including the effects of initial and transient break flow enthalpy, the effect of break enthalpy on the M&E release, the pressure losses leading to the break, and the event's time-of-interest.

In order to ensure that the releases are evaluated conservatively for the EPU, the following assumptions were employed:

- Minimum core inlet temperature, including uncertainty.
- Nominal RCS flow rate, including uncertainty.
- Nominal full reactor power, including uncertainty.

The evaluation determined hot leg enthalpy and transient break flow enthalpy, comparing them to the corresponding values from the Unit 2 pre-EPU analyses. This enabled a comparison of the mass and energy fluxes.

- *RSGs and RVUH.* The impact of these differences on the M&E release results was determined to be negligible.

- *Pressurizer.* The evaluation determined that the calculated M&E release rates from the pressurizer side of the break are the same for Units 1 and 2, and that the M&E release from the hot leg side of the break is completely independent of the pressurizer.

- *Surge Line.* A comparison of the geometric loss K-factors, flow areas and line volumes of the surge lines in Units 1 and 2 determined that their design differences are small, with nearly identical flow losses that would produce nearly identical M&E release rates for given operating conditions.

As documented in LR Section 2.6.3.1.2.2.3, it was determined that if the pre-EPU Unit 2 pressurizer surge line break M&E release data were adjusted to reflect the higher Unit 1 EPU RCS flow, it could be applied to Unit 1 EPU conditions. The resulting Unit 1 EPU M&E release rates were conservatively estimated as 0.9% higher in mass rate and 0.4% higher in energy rate than the pre-EPU Unit 2 M&E release rates.

SCVB-9

In reference to LR Section 2.6.1.2.1.3, fifth paragraph; please explain why the calculated containment vessel temperature (245 degrees F with a vapor temperature of 261.64 degrees F) for the double ended discharge leg slot (DEDLS) break case, is higher than the containment vessel temperature (229 degrees F with a vapor temperature of 265.57

degrees F) for the double ended hot leg slot (DEHLS) break case, even though the vapor temperature for the DEDLS break case is lower than for DEHLS case.

Response to SCVB-9

The duration of the mass & energy releases to the containment is much longer for the double ended discharge leg slot (DEDLS) break case than that for the double ended hot leg slot (DEHLS) break case due to the continued energy addition from the steam generators. Thus, the containment vapor temperature in the DEDLS break case will decrease more slowly than in the DEHLS break case and, after a short time, the vapor temperature in the DEDLS break case exceeds the vapor temperature in the DEHLS break case. The containment vessel liner temperature lags the containment vapor temperature with the peak liner temperature occurring 1235 seconds and 1430 seconds later in the transient for the DEDLS and DEHLS break cases, respectively. Therefore, due to containment liner temperature lagging the containment vapor temperature, the peak containment liner temperature will be higher for the DEDLS break case than that for the DEHLS case.

LOCA Containment Response Results for Long-Term Temperature Response Cases		
Case	Peak Containment Temperature @ Time	Peak Containment Vessel Temperature @ Time
DEHLS	265.57 °F @ 18.17 sec	229 °F @ 1449 sec
DEDLS	261.64 °F @ 13.97 sec	245 °F @ 1249 sec

As mentioned in LR Section 2.6.3.1.2.1.1, LOCA containment blowdown and reflood/post-reflood mass & energy releases are generated using the NRC-approved CEFLASH-4A and FLOOD3 Mod2 computer codes, respectively.

SCVB-10

In reference to LR Section 2.6.1.2.2, third paragraph, please describe in more detail how the computer code SGNIII and CONTRANS are used to simultaneously determine the time dependent containment pressure and temperature response with the M&E releases. What is meant by the last sentence: "The containment response in SGNIII is represented by the integration of the containment module from the NRC approved CONTRANS computer code?"

Response to SCVB-10

The CONTRANS code (containment response) and the SGNIII code (mass & energy generation) have been combined to run together. For the current time step, SGNIII generates the mass and energy (M&E) flow rates. This data is sent to the CONTRANS module which calculates the containment temperature and pressure for that time step. The containment temperature and pressure is then fed back to SGNIII and the M&E rates for the next time step are generated. The last sentence in LR Section 2.6.1.2.2 means the SGNIII mass and energy code and the CONTRANS code have been integrated into one code that generates the M&E

rates and the containment temperature and pressure response concurrently. The combined code has maintained the name SGNIII.

SCVB-11

During normal plant operation under EPU conditions, what is the effect of loss of spent fuel pool cooling on the fuel handling building ventilation system?

Response to SCVB-11

The Fuel Handling Building Ventilation System is non safety related. During normal plant operation the fuel handling building ventilation system is designed to reduce plant personnel doses by preventing the accumulation of airborne radioactivity in the fuel handling building due to diffusion of fission products from the spent fuel pool. The system consists of two separate supply and exhaust systems serving two separate areas; one serving the spent fuel pool area and the other serving the spent fuel pool equipment areas (cooling and purification pumps, heat exchanger and pool filter areas) and the new fuel storage area. The Fuel Handling Building Ventilation System is typically in service during normal plant operation. The Fuel Handling Building Ventilation System is separate and independent from the Reactor Building Ventilation System.

The normal spent fuel pool temperature is typically below 90°F, except for summer months when the temperature approaches 95°F. An alarm for low spent fuel pool pump discharge header pressure and a subsequent alarm for high spent fuel pool temperature set at 137.5°F will notify the operator that a loss of spent fuel pool cooling has occurred. Attachment 5 of LAR submittal LR Section 2.5.4.1, Spent Fuel Pool Cooling and Cleanup System, contains the results of loss of Spent Fuel Pool cooling analyses.

If the fuel pool cooling capability has been lost and cannot be reestablished the following actions are initiated:

- The cause of the failure is determined and an estimate of the time necessary to make the repairs is made
- If the fuel pool ventilation is not in service, it is placed in service
- Makeup is provided through an existing pipe from the Refueling Water Tank utilizing procedural guidance which does not require entry into the spent fuel pool area.

If the total loss of forced convection were to occur, it is anticipated that the spent fuel pool area temperature would eventually follow the spent fuel pool temperature due to the heat contribution from pool evaporation.

The spent fuel pool cooling pumps and heat exchangers area is ventilated by its separate ventilation system and access to make any necessary repairs to the spent fuel pool cooling system equipment can be accomplished without entering the spent fuel pool area.

SCVB-12

In reference to LR Section 2.7.5.2.2, states that EPU modifications will results in less than 1-percent increase in load currents from the existing total nameplate motor ratings

supplied by the switchgear and load centers in the turbine switchgear room. Explain why the increase does not significantly impact the heat load and the turbine switchgear room ventilation system.

Response to SCVB-12

The increase in heat releases from the electrical equipment at EPU conditions is less than 1%. With the addition of the increase in heat releases from electrical equipment due to EPU, the available margin of the Turbine Building Switchgear Room Ventilation system is 11.6%. The pre-EPU margin of the Turbine Building Switchgear Room Ventilation system is 12.5%, therefore the heat load impact due to EPU is not significant.

SCVB-13

In reference to LR Section 2.7.6.2.2, first sentence states: "Changes in heat loads which affect the ventilation subsystems in areas served by the ESF ventilation systems were evaluated to ensure that the ventilation subsystems are capable of performing their intended functions and performance under EPU conditions." Specify which ventilations subsystems were evaluated for changes in the heat loads and what were the results?

Response to SCVB-13

Safety-related ventilation systems identified in RS-001 that provide a suitable and controlled environment for ESF components are discussed in the following LR sections:

- Section 2.7.1, Control Room Habitability System
- Section 2.7.2, Engineered Safety Feature Atmosphere Cleanup
- Section 2.7.3, Control Room Ventilation System
- Section 2.7.5, Auxiliary and Radwaste Area and Turbine Areas Ventilation Systems
- Section 2.7.7, Other Ventilation Systems (Containment).

The ESF Ventilation Systems at St. Lucie Unit 1 are the remainder of the systems not addressed in the above systems. They are the Emergency Core Cooling System (ECCS) Area Ventilation System and the Diesel Generator (EDG) Building Ventilation System.

Emergency Core Cooling System (ECCS) Area Ventilation System:

The safety injection, containment spray, and CCW piping systems, associated heat exchangers and pumps in the ECCS areas were evaluated for operating temperatures and pump loading at EPU conditions. The ECCS areas affected consist of the ECCS pump room (which houses the high and low pressure safety injection and the containment spray pumps), the pipe tunnels at elevation -0.50' and 19.50', and the shutdown heat exchanger room.

A Gothic model was developed for EPU and was used to calculate the temperature response in the above ECCS rooms following a design basis Loss of Coolant Accident (LOCA) in support of the Extended Power Uprate (EPU). The analysis was performed to determine the ECCS Area room temperatures considering pump operating durations, transient temperature profiles for the containment sump water and component cooling water (CCW), and the associated heat load of the ECCS equipment (CS, HPSI and LPSI pumps, heat exchangers and associated piping).

The results of the analysis determined that the ECCS Area rooms will remain below 120°F.

Diesel Generator (EDG) Building Ventilation System:

The EDG building ventilation system is designed to provide ambient conditions suitable for occupancy when the EDGs are not in operation. The system maintains the EDG rooms at 104°F during normal operation when the emergency generators are not in operation.

The key design parameters to maintain EDG room temperature during EDG standby are the roof ventilator fans' capacity, outside air temperature and heat loads from solar transmission, lighting, the diesel engines' lube oil and the generator electrical control cabinet.

During EDG standby, EPU has no impact on the above EDG standby design parameters; therefore, operation at EPU conditions will have no effect on the Diesel Generator Building Ventilation System. EPU does not result in any change to the roof ventilator fan capacity, outside air temperature, heat loads from solar transmission, lighting, the engines' lube oil or the generator electrical control cabinet.

When the EDGs are in operation the operation of the roof ventilator fans are not credited. The EDG radiator fans serving the engine cooling system radiators provide the ventilation air flow through the building to maintain the design temperature of 104°F during operation of the EDGs. They key design parameters to maintain EDG room temperature during EDG operation are the radiator fan capacity, outside air temperature, heat loads from solar transmission, lighting, the engines, the generator and the exhaust piping and silencers. Heat load from the engines and generator are based on rated conditions for the EDG.

During EDG operation, EPU has no impact on the EDG operational design parameters. Although EDG loading has increased as a result of EPU, the EDG ratings are not exceeded by the cumulative EPU loads applied and the EDG loading remains bounded by the EDG rating as demonstrated in LR Section 2.3.3 "AC Onsite Power System". EPU also does not result in any change to the radiator fan capacity, outside air temperature, heat loads from solar transmission, lighting or the exhaust piping and silencers; therefore, operation of the EDG radiator fans will continue to maintain the design temperature of 104°F following EPU.

SCVB-14

In reference to LR Section 2.7.7.2.4, under heading "Reactor Support Cooling System", what is the margin between the predicted post-EPU operating temperature and the containment design temperature.

Response to SCVB-14

The margin between the predicted post-EPU operating temperature and the containment design temperature is 10°F based on a post-EPU containment operating temperature of 110°F and the containment design temperature of 120°F.

SCVB-15

Demonstrate that NPSH margin still exist after including the uncertainties in the required NPSH without crediting containment accident pressure. The NRC staff, in consultation with a pump expert, determined that a 21-percent margin on the '3%-required NPSH' would conservatively envelope the uncertainties discussed in the draft guidance document. It is acceptable to the NRC staff, if desired, to use this value in lieu of performing detailed plant specific uncertainty evaluation. The draft guidance document, which is publicly accessible, was transmitted by NRC to PWR Owners Group by letter dated March 24, 2010 (ADAMS No. ML100740516) with attachment (ADAMS No. ML100550869).

Response to SCVB-15

UFSAR Table 6.2-9A presents a summary of the NPSH calculation for the recirculation mode design configuration of two CS pumps operating along with one LPSI pump providing hot leg injection flow. As discussed in the response to RAI SCVB-6, as part of the EPU project new higher pump flow rates are used in the NPSH calculations. An update to the UFSAR table using the new pump flow rates and associated $NPSH_R$ is presented in Table 2 of the response to RAI SCVB-6. As documented in Table 2 the recirculation mode NPSH calculation demonstrates a margin greater than 21% without taking any credit for the CAP. Note that this margin is based on a conservative sump water temperature of 198.4 °F, which exceeds the maximum calculated sump water temperature of approximately 192 °F.