FPL Energy Point Beach, LLC, 6610 Nuclear Road, Two Rivers, WI 54241

FPL Energy.
Point Beach Nuclear Plant

January 16, 2009

NRC 2009-0002
10 CFR 50.90

U.S Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555-0001

Point Beach Nuclear Plant, Units 1 and 2
Dockets 50-266 and 50-301
Renewed License Nos. DPR-24 and DPR-27

Supplement to License Amendment Request 241
Summary of PBNP Sump PH Calculation Inputs, Assumptions, Methodology and Results

Reference: (1) FPL Energy Point Beach LLC, License Amendment Request 241 dated December 8, 2008, "Alternative Source Term" (ML083450683)

As a follow-up from the teleconference held with the NRC staff on December 30, 2008, FPL Energy Point Beach, LLC is providing a summary of Units 1 and 2 sump pH calculation inputs, assumptions, methodology, and results. The enclosure contains the information requested to support the acceptance review of FPL Energy Point Beach submittal of License Amendment Request 241, "Alternative Source Term."

Enclosure 1 contains a summary of FPL Energy Point Beach Sump pH calculation inputs, assumptions, methodology, and results.

This supplement involves no significant hazards as defined in 10 CFR 50.92. An evaluation concludes this supplement satisfies the criteria of 10 CFR 51.22 for categorical exclusion from the requirements for an environmental assessment.

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

In accordance with 10 CFR 50.91, a copy of this letter is being provided to the designated Wisconsin Official.

I declare under penalty of perjury that the foregoing is true and correct.
Executed on January 16, 2009.

Very truly yours,

FPL Energy Point Beach, LLC

Larry Meyer
Site Vice President

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Point Beach Nuclear Plant, USNRC
Resident Inspector, Point Beach Nuclear Plant, USNRC
PSCW

ENCLOSURE
FPL ENERGY POINT BEACH, LLC
POINT BEACH NUCLEAR PLANT, UNITS 1 AND 2

LICENSE AMENDMENT REQUEST 241
SUMMARY OF SUMP pH CALCULATION INPUTS, ASSUMPTIONS, METHODOLOGY AND RESULTS

The following information is provided as a follow-up from the teleconference between the NRC staff and representatives from FPL Energy Point Beach, LLC, dated December 30, 2008, regarding the pH of sump water following a loss of coolant accident.

To minimize the conversion of ionic iodine to elemental iodine in the sump, the pH of the sump water should be maintained above a pH of 7 for a period of 30 days after a loss-of-cooling accident (LOCA). During this period, strong acids (hydrochloric and nitric acid) are being generated. Hydrochloric acid is formed from the decomposition of cable insulation, and nitric acid is formed from the irradiation of the environment existing in containment. If the pH of the sump water is not controlled, the pH value may drop below 7. To maintain a pH above the value of 7, a buffer should be added to the sump water.

To ensure that the pH in the sump remains basic over the period of 30 days post-LOCA, the licensee should provide the following information:

Questions 1 and 2:

1. *Identify all sources of post-LOCA strong acid generation in containment and time dependant values of strong acid concentrations in the sump for a period of 30 days post-LOCA.*

2. *Describe the analysis methodology used to determine the pH in the sump water during a period of 30 days post-LOCA. Include detailed calculations of time dependant pH values in the sump during a 30 day period post-LOCA to demonstrate that the pH remains basic throughout this time period.*

Response:

Purpose

This enclosure provides a summary of the approach, inputs, assumptions and results of the PBNP Post-LOCA Sump pH calculation (References 1 and 2). The purpose of the PBNP sump pH calculation includes:

- Determining the pH conditions (minimum and maximum) in Containment Sump B at the completion of addition of sodium hydroxide from the spray additive tank (SAT) during a Large-Break-Loss-of-Coolant-Accident (LOCA),
- Determining the pH conditions (minimum and maximum) of the Containment Spray in the containment atmosphere while injecting from the refueling water storage tank (RWST),
- Determining an allowable amount of residual (pre-accident) boric acid in containment, and
- Assessing the impact of radiolysis and Alternate Source Term (AST) core inventory release on containment sump pH for the 30-day duration of the LOCA.

General Approach

The containment sump pH calculation evaluates the equilibrium aquatic chemistry of a mixture of boric acid and sodium hydroxide taking into account boric acid speciation and water dissociation. Three equations and three unknowns are developed to predict the pH of the boric acid/sodium hydroxide sump solutions. It starts with the fundamental (balanced) chemical equations and applies the temperature-dependent equilibrium quotients for each ionic species.

An iterative approach is used to solve these equations and determine the three unknowns $[B(OH)_3]$, ionic strength and pH. To verify the equilibrium sump pH, the calculated values for $B(OH)_3$, ionic strength and pH are used to verify the three conditions of boron mass balance, electroneutrality, and ionic strength determined from ionic species. No computer codes are used to determine the sump pH.

The sump pH is determined first based on neutralizing boric acid in the refueling water storage tank (RWST), reactor cooling system (RCS), accumulators and the pressurizer. This provides a value for the sump pH after injection spray has terminated.

The impact of a postulated boric acid spill was evaluated by increasing the amount of boric acid in the sump by the amount spilled and repeating the pH calculation for the postulated conditions.

A sensitivity analysis is then performed to address the pH effects of long term radiolysis of air, water, and chloride-bearing electrical cable and release of reactor core inventory into the sump. The greatest impact is on the final pH at 30 days post-LOCA. The sensitivity analyses determines the pH increment that must be added to the lowest calculated pH in order to ensure that the sump remain within the required range 30 days post-LOCA (i.e., above 7.0). Radiolysis of air and water will produce nitric acid (HNO_3), radiolysis of electrical cable insulation and jacketing will produce hydrochloric acid (HCl), and release of reactor core inventory will produce hydriodic acid (HI) and cesium hydroxide (CsOH). The overall combination of these products is acidic, so the addition of these products to the Containment Sump will cause the Containment Sump pH to be lower than that with boric acid alone.

Inputs to the pH Calculation

Inputs to the PBNP sump pH calculations include RCS volume and boron concentration, SI Accumulator volume and boron concentration, RWST volume and boric acid concentration, and spray additive tank (SAT) sodium hydroxide concentration.

The PBNP sump pH calculation includes a series of hydraulic analyses, the results of which are used to derive the minimum and maximum volume of NaOH solution injected from the Spray Additive Tank for the pH determination. The hydraulic analyses are performed using the PBNP ECCS Proto-Flo™ Thermal Hydraulic Model.

The core constituents and containment radiation dose inputs are based on Extended Power Uprate (EPU) conditions. All other input parameters used in the PBNP pH calculation were either not affected by EPU or were bounded by current plant operating parameters.

The following summarizes the inputs used within the PBNP sump pH calculation:

Parameter	Minimum Sump pH	Maximum Sump pH
RCS Volume (ft^3)	6,389	5,231
RCS Boron Concentration (ppm)	2,200	0
SI Accumulator Volume (ft^3) (total for two)	2,272	2,200
SI Accumulator Boron Concentration (ppm)	3,100	2,600
RWST Volume (ft^3)	37,901	30,143
RWST Boric Acid Concentration (ppm)	3,200	2,700
SAT Volume Injected (ft^3)	164.2	403.9
SAT NaOH Concentration	30%	33%

<u>Assumptions used in the pH Calculation</u>

The following assumptions are used in the PBNP pH calculation:

- It is assumed that the extended form of the Debye-Hückel equation is applicable to the range of ionic strength considered in this calculation and can be extrapolated beyond 212°F.
- It is assumed that ionic strength based on molarity (as opposed to molality) can be utilized for computing the equilibrium quotient Q11
- It is assumed that tabulated values of approximate ionic radii at 25°C can be used in this calculation at other temperatures.
- It is assumed that the density of all water except for that educted from the SAT is the density of pure water at the applicable temperature.
- It is assumed that all species and ions in solution are in equilibrium; therefore, the results are based on steady state analysis.
- It is assumed that the effect of the lithium hydroxide used for primary system pH control on the containment sump pH is negligible.
- It is assumed that the impact on containment sump pH and containment spray pH due to carbon dioxide in the containment is negligible.
- It is assumed that the containment sump temperature is 77°F and that the sump pressure is 0 psig.
- It is assumed that the containment spray eductor NaOH flow rate is only a function of the available NaOH pressure at the eductor inlet port.
- It is assumed that the electrical cable and jacket material was PVC with an HCl radiolysis yield (G_{HCl}) value of 7.7 molecules per 100 ev.
- Iodine-127 reactor core inventory is assumed to be 30% of the moles of I-129.

<u>Approach used in the Sensitivity Analysis for Long Term Sump pH Impacts</u>

The impact of radiolysis and releases from the reactor core inventory on containment sump pH is evaluated in the sensitivity analysis by first calculating the amounts of acids and base generated by these sources and then calculating the resulting pH after they are added to the sump. For the sensitivity analysis, the amounts of boric acid and NaOH in the sump are the same as calculated in the first part of calculation for the minimum sump pH. The calculation is done using the basic methodology described in NUREG/CR-5950, "Iodine Evolution and pH Control," and NUREG-1081, "Post-Accident Gas Generation from Radiolysis of Organic Materials."

Radiolysis of Sump Water and Air

HNO_3 formation is determined as a function of a radiolysis yield factor, the radiation dose, and the irradiated water volume contained in the sump. The methodology determines HNO_3 concentrations proportional to radiation dose, so the resulting concentration is independent of sump volume for a given radiation dose.

Radiolysis of Electrical Cables

The general approach to calculate the amount of HCl produced in the cables is to determine the mass of HCl formed as a function of a yield factor, the mass of cable insulation and jacketing, the gamma and beta radiation fluxes in the insulation and jacketing, and the fractions of gamma and beta radiation energies absorbed in the insulation and jacketing. Hydrochloric acid generation in chlorine-bearing material in the cable is determined using equations from NUREG/CR-5950, "Iodine Evolution and pH Control," and NUREG-1081, "Post-Accident Gas Generation from Radiolysis of Organic Materials." The following approach is used:

The type and amount of cable insulation in containment subject to radiolysis is determined based on a review of data from the PBNP Cable and Raceway database.

The general approach to determining the mass of chlorinated cable jacket and insulation material is to:

- Use PBNP cable and raceway data to identify the cables and their properties (length, size, number and size of conductors, materials of construction, weight per foot)
- Use vendor supplied data on conductor weight to determine a lower conservative estimate of the conductor weight per foot,
- Subtract the estimate of the conductor weight per foot from the overall cable weight per foot to determine the weight of jacket and insulation per foot, and
- Multiply the weight per foot of the jacket and insulation by the overall length of each cable to determine the total weight of cable and insulation material.

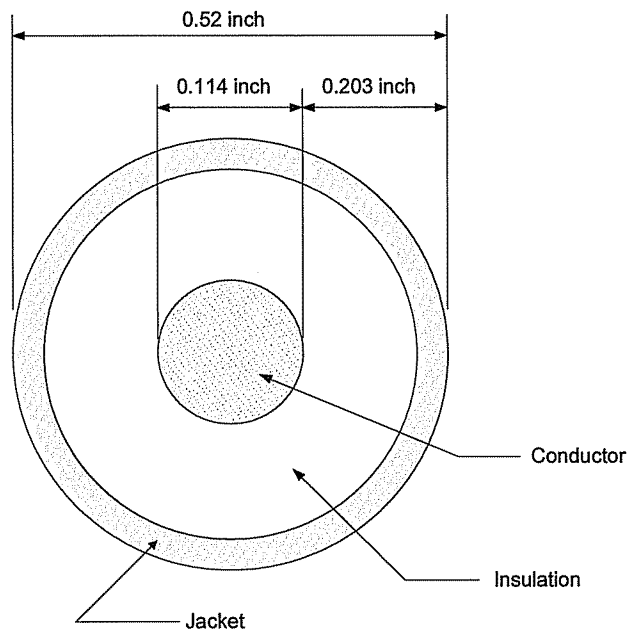
The following inherent conservatisms exist in this approach:

- Many cables have chlorinated cable jackets with non-chlorinated conductor insulation.
- Since the Cable and Raceway database does not include information on jacket thickness and weight per foot, the entire weight and volume of jacket and insulation is conservatively treated as if it was chlorinated material.
- A comparison of the cable data and the raceway data shows that a portion of some of the cables is routed outside of containment. For these cables, the entire length of cable is conservatively taken as being inside containment.
- Jacket or insulation materials are not provided for some cable types in the Cable and Raceway database. These cables are conservatively treated as containing chlorinated materials.
- To simplify the calculations, all of the cables are considered to be routed in cable trays as opposed to conduit which would exempt them from this phenomenon. The Cable and Raceway database provides information that could have been used to derive the length of cable in conduit and junction boxes.
- For coaxial cable, the weight of the conductors and shield is conservatively ignored, thus maximizing the calculated jacket and insulation weight.

- For twisted-shielded pair cables, the weight of the shield is conservatively ignored, thus maximizing the calculated jacket and insulation weight (i.e., the cable weight per foot was taken to be entirely that of jacket and insulation).
- A conservative value of the density of the jacket and insulation density is used, thus maximizing the calculated thickness of the jacket and insulation.

A representative cable with a 0.52 inch outside diameter and the total length of 200,030 ft was derived from the plant data. The electrical cable insulation is conservatively taken to be composed of PVC material. Based on data in NUREG/CR-5950, "Iodine Evolution and pH Control," radiolysis of PVC material releases more hydrochloric acid than other insulation materials (The G_{HCl} value for the cable and jacket insulation material used in the sensitivity analysis is 7.7 molecules HCl per 100 eV).

Representative Cable Model



- The exposure of the cable jacket to radiation energy is represented by the energy flux applied to the cable surface (φ). The term φ is derived in NUREG-1081, "Post-Accident Gas Generation from Radiolysis of Organic Materials," from the radiation source term (energy release rate per unit volume of containment), diminished by attenuation in air between the center of containment and the cable surface. In the sensitivity analysis, input data in the form of Total Integrated Dose (TID) was available instead of the radiation source term. Consequently, an integrated radiation energy emission in containment is determined from the radiation dose (TID) and the density of air by equating the resulting dose absorbed in air to the energy release per unit volume. The energy flux at the cable surface is then determined by integrating the air-attenuated radiation over the distance from the cable. For beta radiation, any distance over several meters was considered to be equivalent to an infinite cloud.

- The absorption fraction of energy flux is calculated as follows per Section 4.2 of NUREG-1081, "Post-Accident Gas Generation from Radiolysis of Organic Materials," based on the linear absorption coefficient for the cable jacket material and the thickness of the jacket. Linear absorption coefficients for cable jacket are determined as discussed in NUREG-1081, "Post-Accident Gas Generation from Radiolysis of Organic Materials," using the mass attenuation coefficients per NUREG-1081, "Post-Accident Gas Generation from Radiolysis of Organic Materials," and conservative density for the PVC jacket material.

Core Inventory Release

Hydriodic acid is formed by the post-LOCA release of elemental iodine (I) and hydrogen iodide (HI) from the reactor core and its absorption in the containment sump water. The radionuclide activities of the core iodine constituents is used along with the Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Table 2 defined percentage of the iodine core inventory released into containment during the Gap Release Phase (5%) and the EIV Phase (35%) to determine the mass of iodine released to the sump. Consistent with Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," NUREG-1465, "Accident Source Terms for Light-Water Nuclear Power Plants - Final Report," and NUREG/CR-5732, "Iodine Chemical Forms in LWR Severe Accidents," the sensitivity analysis considers that 95% of the iodine is released from the RCS in the form of cesium iodide and the remaining 5% is in the form of elemental iodine or organic iodide. Based on this, the sensitivity analysis is based on 2% of the iodine inventory in the core being in the sump.

Cesium hydroxide is formed by the release of cesium from the reactor core and its absorption in the containment sump water. The radionuclide activities of the core cesium constituents is used along with the Regulatory Guide 1.183, "Alternative Radiological Source Terms for Evaluating Design Basis Accidents at Nuclear Power Reactors," Table 2 defined percentage of the cesium core inventory released into containment during the Gap Release Phase (5%) and EIV Phase (25%) to determine the mass of cesium released to the sump. Cesium released in the form of cesium iodide (equal to 95% of the moles of iodine released from the core) does not contribute to formation of cesium hydroxide and is not considered in the sensitivity analysis. Based on this, the number of moles of cesium released to the sump in the sensitivity analysis is equal to 30% of the number of moles of cesium in the core minus 38% of the number of moles of iodine in the core.

Summary of PBNP pH Calculation Results

The results of the minimum and maximum sump pH at the end of injection spray are determined in the PBNP sump pH calculation to be:

Parameter	Minimum Sump pH	Maximum Sump pH
Volume of Water in Sump (liter)	1,279,940	1,029,392
Moles Boron in Sump	363,472	226,546
Boron Concentration in Sump (moles/liter)	0.284	0.220
Moles Na in Sump	46,089	128,334
Na Concentration in Sump (moles/liter)	0.036	0.125
Calculated sump pH	7.646	9.404

The results of the minimum sump pH including the contribution of a 100 lbm boric acid spill (selected as a reasonable upper limit) at the end of injection spray are determined in the PBNP sump pH calculation to be:

Parameter	Minimum Sump pH
Volume of Water in Sump (liter)	1,279,940
Additional Moles on Boron in Spill	734
Boron Concentration in Sump (moles/liter)	0.285
Na Concentration in Sump (moles/liter)	0.036
Calculated sump pH	7.641

The effect of the boric acid spill was considered to be negligible and was not carried over into the assessment of the pH effects of long term radiolysis of air, water, and chloride-bearing electrical cable and release of reactor core inventory into the sump.

The results of the pH effects of long-term radiolysis of air, water, and chloride-bearing electrical cable and release of reactor core inventory into the sump are determined in the containment sump pH calculation to be:

Parameter	Minimum Sump pH
Volume of Water in Sump (liter)	1,279,940
Boron Concentration in Sump (moles/liter)	0.284
Na Concentration in Sump (moles/liter)	0.036
30-day Integrated Gamma Dose (Rad)	5.6×10^{7}
30-day Integrated Beta Dose (Rad)	2.0×10^{8}
HNO_3 Concentration in Sump (moles/liter)	1.870×10^{-3}
HCl Concentration in Sump (moles/liter)	8.743×10^{-3}
HI Concentration in Sump (moles/liter)	1.364×10^{-6}
CsOH Concentration in Sump (moles/liter)	1.363×10^{-4}
Calculated sump pH	7.376

<u>References</u>

1. Calculation 2000-0036, Rev. 2, "pH of Post LOCA Sump and Containment Spray"
2. Calculation 2000-0036, Rev. 002-A, "pH of Post LOCA Sump and Containment Spray"

<u>Question 3:</u>

If a computer program was used, describe the code and provide the input and output data of the program.

<u>Response:</u>

FPL Energy Point Beach, LLC did not use a computer program for the sump pH calculation, as discussed during the teleconference held on December 30, 2008.