ATTACHMENT 3

Response to
NRC Reactor Systems Branch
Request for Additional Information
Regarding Extended Power Uprate
License Amendment Request

NON-PROPRIETARY VERSION

(Cover page plus 15 pages)

AREVA NP Inc.

ANP-2903Q1(NP)
Revision 0

St Lucie Nuclear Plant Unit 1 EPU Cycle Realistic Large Break LOCA Summary Report with Zr-4 Fuel Cladding

September 2011

AREVA NP Inc.

AREVA

Nature of Changes

Item	Page	Description and Justification
1.	All	Responses to NRC RAIs SRXB-41, 48 - 51

Contents

Tables

This document contains a total of 15 pages.

Nomenclature

ASI	Axial Shape Index
BWR	Boiling Water Reactor
CCTF	Cylindrical Core Test Facility
CE	Combustion Engineering Inc.
CFR	Code of Federal Regulations
CPHS	Containment Pressure High Signal
CSAU	Code Scaling, Applicability, and Uncertainty
DC	Downcomer
DEGB	Double-Ended Guillotine Break
DFSS	Design For Six Sigma
DNB	Departure from Nucleate Boiling
ECCS	Emergency Core Cooling System
EFPH	Effective Full Power Hours
EM	Evaluation Model
EPU	Extended Power Uprate
FA	Fuel Assembly
FLECHT-SEASET	Full-Length Emergency Core Heat Transfer Separate Effects and Systems Effects Tests
FP&L	Florida Power & Light
F_Q	Total Peaking Factor
F_r	Nuclear Enthalpy Rise Factor
HPSI	High Pressure Safety Injection
HFP	Hot Full Power
LANL	Los Alamos National Laboratory
LAR	License Amendment Request
LHGR	Linear Heat Generation Rate
LOCA	Loss of Coolant Accident
LOFT	Loss of Fluid Test
LOOP	Loss of Offsite Power
LPSI	Low Pressure Safety Injection
MSIV	Main Steam Isolation Valve
NRC	U. S. Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System

Nomenclature (*Continued*)

PCT	Peak Clad Temperature
PIRT	Phenomena Identification and Ranking Table
PLHGR	Planar Linear Heat Generation Rate
PPLS	Pressurizer Pressure Low Signal
PWR	Pressurized Water Reactor
RAI	Request for Additional Information
RAS	Recirculation Actuation Signal
RCP	Reactor Coolant Pump
RCS	Reactor Coolant System
RHR	Residual Heat Removal
RLBLOCA	Realistic Large Break Loss of Coolant Accident
RV	Reactor Vessel
RWST	Refueling Water Storage Tank
SGLS	Steam Generator Low (pressure) Signal
SIAS	Safety Injection Activation Signal
SIRWT	Safety Injection and Refueling Water Tank
SIT	Safety Injection Tank
SER	Safety Evaluation Report
THTF	Thermal Hydraulic Test Facility
w/o	Weight Percent

1.0 Introduction

AREVA performed an RLBLOCA analysis for the EPU cycle of the St. Lucie Unit 1 nuclear power plant. The analysis was performed to support AREVA 14x14 HTP fuel. The results of the RLBLOCA analysis were summarized in Reference 1 and transmitted to FPL for submittal to the NRC for review. What follows in Section 2.0 are AREVA's responses to the NRC's "DRAFT" Request for Additional Information (RAI), questions SRXB-41, plus SRXB- 48 through 51.

2.0 NRC RAIs with AREVA Responses

RLBLOCA (L-2011-206 Attachment 2 RLBLOCA SR Prop ANP-2903(P) Rev. 1.

SRXB-41: [2.8.5.6.3.i] Demonstrate that Maximum Local Oxidation and Maximum Total Core-Wide Oxidation will remain below the respective limits of 17.0% and 1.00% for the entire cycle.

AREVA Response:

The NRC approval of the EMF-2103 realistic LOCA evaluation model (Reference 2) called for the local metal water or oxidation to be reported for the case with the maximum peak cladding temperature. The reasoning employed was that the initialization of the accident simulation with no oxide layer produced an overprediction of the transient oxidation that more than covered the initial corrosion. However, to cover the requirements of GL98-29, the amount of corrosion which bounds the burnup range for the fresh, once- and twice-burnt fuel should be added to the transient oxidation as the metric to compare to the 17 percent local oxidation criteria. To do this the growth of the corrosion layer during the cycle must be accommodated in the calculation. The values reported in ANP-2903(P) Rev. 1 (Reference 1) were for the limiting case burnup. Thus, to follow GL98-29 (Reference 3) the following table is provided as supplemental information.

Table 2-1 Corrosion and Oxidation

Parameter	Fresh Fuel	Once burned fuel	Twice burned fuel*
Corrosion at the end cycle	1.24%	3.0 %	9.95 %
Transient Oxidation	1.06 %	0.93 %	0.0 %
Maximum Oxidation	2.30%	3.93 %	9.95 %

* Twice burned fuel is sufficiently reduced in energy potential that LOCA significant cladding temperatures and oxidations can not be achieved.

The total core-wide oxidation requirement addresses the release of hydrogen during the LOCA and is, therefore, a limit on the maximum core-wide transient oxidation. The values reported in ANP-2903(P) Rev. 1 are the maximum values of core-wide transient oxidation computed for the case set. The 0.0209% (Table 3-5, Reference 1) bounds the maximum total core-wide oxidation that would be achieved during a LOCA at any time during the cycle.

SRXB-48: Please provide a basis for the range of initial conditions for the following: loop flow, pressurizer level, and containment temperature.

AREVA Response:

The RLBLOCA EM (Reference 2) provides a means to broaden the applicability of a single analysis to the support of a plant licensing basis. This is achieved by careful identification of parameter ranges. Parameter ranges should cover both the normal operational variation allowed and expected measurement and/or other uncertainties. The inputs which were judged, by inference from the Phenomena Identification and Ranking Table (PIRT) or another process, to have a relatively high importance to the calculated results and the use of those results, are sampled in the RLBLOCA analysis. The values for these parameters are modeled as randomly varying quantities, sampled within defined probability distributions. Individual case values for ranged parameters are obtained by sampling the defined probability distribution for each parameter. The range of the probability distribution includes both the expected or desired operational variation as well as the measurement uncertainty of the parameter value as applicable. The treatment of plant parameters is not rigorously defined in this methodology; rather, any representative distribution is considered acceptable. The choice of how to treat plant-parameter ranges needs to be consistent with the applicability of the analysis in supporting the plants design and control specifications. While the methodology provides for flexibility in describing uncertainty, the analyst is encouraged to apply uniform uncertainty distributions for ranged plant-parameters for the initial application of RLBLOCA to a particular plant. Regulation governing best-estimate LOCA recognizes uniform distributions as statistically conservative.

The loop flow is ranged over the Technical Specification (Table 3.2-1)/COLR (Core Operating Limits Report) minimum departure from nucleate boiling (DNB) flow, 375,000 gpm to the upper limit of 438,500 gpm to bound the maximum RCS flow. The pressurizer level range is 62.6% to 68.6%; this covered the measurement uncertainty of ± 3% from the nominal pressurizer level of 65.6% for a T_{ave} above 572 °F. St. Lucie Unit 1 does not have a Technical Specification requirement for pressurizer level. The containment temperature was ranged in the analysis from 80.5 °F – 124.5 °F, this range is from the Technical Specification maximum (Section 3.6.1.5, including 4.5 °F uncertainty) down to a lower bounding containment temperature value.

SRXB-49: Please provide the basis for the analyzed single failure assumption. If the basis is generic, provide a St. Lucie 1 specific justification for the use of the generic assumption.

AREVA Response:

The single failure assumption was based off of the approved RLBLOCA EM, EMF-2103(P)(A) Rev. 0 (Reference 2). Section 6.5 in ANP-2903 Rev. 1 (Reference 1) provides a detailed discussion of the single failure assumption and a sensitivity study on the limiting case for a maximum ECCS injection scenario. Due to the early timing of PCT, the maximum ECCS scenario resulted in the same PCT temperature as the RLBLOCA EM single failure, but the quench time and oxidation calculated were greater for the RLBLOCA EM single failure case.

SRXB-50: Tabulate the initial conditions, operating parameters, PCT, time of PCT, SIT empty time, and safety injection initiation time for all cases (with respect to PCT) both with offsite power and without offsite power. A data file is acceptable (and preferred).

AREVA Response:

The table of requested parameters is found in Section 4.0 at the end of the document.

SRXB-51: Section 6.1 describes a fuel centerline temperature (FCT) bias. Please address any impacts this has on the cladding surface temperature.

AREVA Response:

ANP-2903(P) Rev. 1 (Reference 1) Section 6.1, Item 1.c, discusses the radial temperature profile of the fuel pellet corrected and uncorrected by the burnup dependant bias and uncertainty (thermal conductivity degradation adjustment). This response states, "As the pellet power is not adjusted the radial temperature profile (for the uncorrected centerline temperature) must follow the corrected profile closely and the two must converge at the surface of the pellet." This statement is based on the power, the same in both pellets, requiring the same differential temperatures to remove the energy from the pellet surface through the gap, through the cladding, and finally to the coolant. Because the heat transfer properties in none of these regions are altered by changes in conductivity within the pellet, there is no impact of this bias on the required differential temperatures and the cladding surface temperature. At accident initiation, the cladding temperature is unchanged by the adjustment in pellet thermal conductivity.

3.0 References

1 AREVA NP Doc. ANP-2903(P)-001, "St. Lucie Nuclear Plant Unit 1 EPU Cycle Realistic Large Break LOCA Summary Report with Zr-4 Fuel Cladding," May 2011.

2 AREVA NP Doc. EMF-2103(P)(A), Revision 0, Realistic Large Break LOCA Methodology for Pressurized Water Reactors, April 2003.

3 NRC Information Notice GL 98-29, "PREDICTED INCREASE IN FUEL ROD CLADDING OXIDATION," August 3, 1998.

4.0 Data Tables

Table 4-1 Loss of Offsite Power (LOOP) Case Set

Table 4-1 continued

Table 4-2 Offsite Power Available (No-LOOP) Case Set

Table 4-2 continued