Proprietary Information Withhold Under 10 CFR 2.390(d)(1)
This letter is decontrolled when separated from Enclosure 1

Tennessee Valley Authority, 1101 Market Street, Chattanooga, Tennessee 37402

CNL-15-085

June 3, 2015

10 CFR 50.4
10 CFR 50.90

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

Browns Ferry Nuclear Plant, Units 1, 2, and 3
Renewed Facility Operating License Nos. DPR-33, DPR-52, and DPR-68
NRC Docket Nos. 50-259, 50-260, and 50-296

Subject: **Response to NRC Request for Additional Information Regarding Proposed Technical Specification Change to Modify Technical Specification 2.1.1, Reactor Core Safety Limits (BFN TS-492)**

References:

1. Letter from TVA to NRC, "Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3 - Application to Modify Technical Specification 2.1.1, Reactor Core Safety Limits (BFN TS-492)," dated December 11, 2014 (ADAMS Accession No. ML14363A158)

2. Letter from NRC to TVA, "Browns Ferry Nuclear Plant, Units 1, 2, and 3 - Request for Additional Information Related to License Amendment Request for Technical Specification Changes to Reactor Core Safety Limits," dated May 12, 2015 (TAC Nos. MF5412, MF5413, and MF5414) (ADAMS Accession No. ML15126A530)

By letter dated December 11, 2014 (Reference 1), Tennessee Valley Authority (TVA) submitted a license amendment request (LAR) for Browns Ferry Nuclear Plant (BFN), Units 1, 2, and 3, to modify Technical Specification (TS) 2.1.1, Reactor Core Safety Limits, to revise the reactor dome pressure limit.

By letter dated May 12, 2015 (Reference 2), the Nuclear Regulatory Commission (NRC) transmitted a request for additional information (RAI) from the Reactor Systems Branch. The due date for the response is June 5, 2015. Enclosure 1 contains AREVA report ANP-3408P, Revision 0, that provides the responses to the Reference 2 RAI. Enclosure 1 contains information that AREVA NP considers to be proprietary in nature and subsequently, pursuant to 10 Code of Federal Regulations 2.390, "Public inspections, exemptions, requests for withholding," paragraph (a)(4), it is requested that such information be withheld from public disclosure. Enclosure 2 contains the non-proprietary version of the Enclosure 1 report with the proprietary material removed, and is suitable for public disclosure. Enclosure 3 provides the affidavit supporting this request.

There are no new regulatory commitments contained in this submittal. Please address any questions regarding this submittal to Mr. Edward D. Schrull at (423) 751-3850.

I declare under penalty of perjury that the foregoing is true and correct. Executed on this 3rd day of June 2015.

Respectfully,

J. W. Shea
Vice President, Nuclear Licensing

Enclosures:

1. ANP-3408P Revision 0, "AREVA RAI Responses for Browns Ferry Steam Dome Pressure for Reactor Core Safety Limits" (Proprietary)
2. ANP-3408NP Revision 0, "AREVA RAI Responses for Browns Ferry Steam Dome Pressure for Reactor Core Safety Limits" (Non-proprietary)
3. Affidavit for Enclosure 1

cc (Enclosures):
NRC Regional Administrator – Region II
NRC Senior Resident Inspector – Browns Ferry Nuclear Plant
NRC Project Manager - Browns Ferry Nuclear Plant
NRC Branch Chief - Region II
State Health Officer, Alabama State Department of Health

ENCLOSURE 2

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT UNITS 1, 2, AND 3

ANP-3408NP Revision 0, "AREVA RAI Responses for Browns Ferry Steam Dome Pressure for Reactor Core Safety Limits" (Non-proprietary)

AREVA

AREVA RAI Responses for Browns Ferry Steam Dome Pressure for Reactor Core Safety Limits

ANP-3408NP
Revision 0

May 2015

Nature of Changes

Item	Section(s) or Page(s)	Description and Justification
1	All	Initial Issue

Contents

Nomenclature

Acronym	Definition
BFN	Browns Ferry Nuclear Plant
BOC	Beginning-of-cycle
COLR	Core Operating Limits Report
EOFP	End of Full Power
FHOOS	Feedwater Heaters Out-of-service
HGAP	Pellet-to-Cladding Gap Coefficient
LAR	Licensing Amendment Request
LPIS	Low Pressure Isolation Setpoint
MCPR	Minimum Critical Power Ratio
MOC	Middle-of-cycle
MSIV	Main Steam Isolation Valve
NRC	Nuclear Regulatory Commission
NSS	Nominal Scram Speed
OSS	Optimum Scram Speed
PRFO	Pressure Regulator Failure Open
RAI	Request for Additional Information
RTP	Rated Thermal Power
TS	Technical Specification
TSSS	Technical Specification Scram Speed
TVA	Tennessee Valley Authority

1.0 INTRODUCTION

Tennessee Valley Authority (TVA) submitted a License Amendment Request (LAR) to change the Browns Ferry (BFN) Technical Specifications (TS) in support of steam dome pressure for reactor core safety limits. In response to the LAR, the US Nuclear Regulatory Commission (NRC) has issued an initial set of questions, in the form of Request for Additional Information (RAI), Reference 1.

Based on the information provided in this report, TVA will prepare a formal response to the NRC RAIs.

2.0 NRC QUESTIONS AND AREVA RESPONSE

The NRC questions (i.e., RAIs) listed below are according to Reference 1:

RAI-01: The LAR claims the GE14 fuel in the BFN Unit 1 is third cycle fuel, with large MCPR margins due to the depleted state of the fuel and the lower power locations of those bundles. Provide the normalized bundle power (ratio of bundle power to core-averaged bundle power) at the beginning of the current cycle for: 1) the GE14 fuel with the highest bundle power and 2) the highest powered bundle in the core.

<u>AREVA Response:</u>

The normalized bundle powers for the GE14 fuel with the highest bundle power and the highest powered bundle (ATRIUM-10) in the core are as follows:

GE14 Bundle: 1.1264

ATRIUM-10 Bundle: 1.3453

As a matter of clarification, the GE14 fuel in the BFN Unit 1 Cycle 11 is not all third cycle fuel. GE14 bundle JYP269 was discharged after Cycle 9 and reinserted in Cycle 11 and is in its second cycle of operation. This bundle is not the highest powered GE14 bundle in the Cycle 11 core at beginning-of-cycle (BOC).

RAI-02: AREVA report ANP-3245P Revision 1 (Attachment 5 to the LAR) presented an analysis of the Pressure Regulator Failure Open (PRFO) event in the BFN units. The analysis included sensitivity studies of the effect of key parameters that affect the minimum reactor steam dome pressure obtained during the PRFO event. The lowest steam dome pressure while the reactor power is still above 25% rated thermal power (RTP) is the relevant pressure to use in applying TS safety limits 2.1.1.1 and 2.1.1.2.

a) For the PRFO event represented in Tables 3.1 through 3.6 of ANP-3245P Revision 1, clarify the occurrence of the minimum steam dome pressure with respect to the full closure of the MSIV. Indicate the status of the MSIV, partially or fully closed, when the minimum steam dome pressure occurred.

AREVA Response a):

For all of the Unit 1 cases presented in Tables 3.1 through 3.6, the main steam isolation valve (MSIV) position at the time of the minimum steam dome pressure is given in the table below.

ANP-3245P Table	Sensitivity Parameter	MSIV Position Percentage Open When Minimum Steam Dome Pressure is Reached (Unit 1)
Table 3.1	State Point 100P / 105F 100P / 81F 65P / 110F 65P / 40F	[ ]
Table 3.2	Initial Conditions Nominal Temperature, Increased Pressure Nominal Temperature, Reduced Pressure Reduced Temperature, Increased Pressure Reduced Temperature, Reduced Pressure FHOOS Temperature	[ ]
Table 3.3	MSIV Closure 3-second closure 4-second closure 5-second closure	[ ]
Table 3.4	Cycle Exposure BOC MOC Licensing EOFP Coastdown	[ ]
Table 3.5	Scram Time TSSS NSS OSS OSS reduced by 10%	[ ]
Table 3.6	HGAP condition Nominal HGAP HGAP +20% HGAP -20%	[ ]

b) Table 3.7 of ANP-3245P Revision 1 shows the minimum steam dome pressure for different initial state points (reactor power and core flow). Each row in the table is for a different combination of state points. Clarify the distinction between the pressures in the table with and without an asterisk. For the higher core flow cases (above 35% of rated core flow), indicate if the reactor thermal power is above or below 25% RTP when the minimum steam dome pressure occurred.

AREVA Response b):

The core flows presented in Table 3.7 correspond to the lowest core flow allowed for a given power level on the power/flow map. The sensitivity study performed in Table 3.1 determined that lower core flow, for a given power, yielded the lowest pressure. Using that conclusion, a range of core powers were analyzed with the lowest core flow possible from the power/flow map to determine what power level resulted in the lowest pressure.

For core power levels of 65% and greater (results shown without an asterisk), the lowest pressure was obtained when reactor thermal power was above 25% of rated. For core powers at 60% and below (results shown with an asterisk), the pressure reported is obtained at the time when reactor thermal power decreases below 25% of rated.

RAI-03: TS 2.1.1.2 specifies the safety limit (SL) on the minimum critical power ratio (MCPR). The proposed change in TS 2.1.1.2 expands the range of applicability of the SL on the MCPR to a lower pressure. The LAR requires extending the applicability of the SPCB/GE14 critical power correlation down to pressures as low as 585 psig. Explain the consistency of the approach discussed in ANP-3245P Revision 1 (Attachment 5 to the LAR), for determining the critical power for GE14 fuel at pressures below 685 psig, with the NRC-approved AREVA methodology for applying AREVA critical power correlations to co-resident fuel (as identified in the Core Operating Limits Report (COLR)).

AREVA Response:

The GE14 fuel minimum critical power ratio (MCPR) is modeled with the approved methodology for co-resident fuel, EMF-2245(P)(A). The indirect method is applied to determine additive constants that are applicable to the GE14 fuel. The range of applicability of the SPCB/GE14 critical power correlation is drawn from the range of data that were applied to determine the additive constants, consistent with the methodology of the underlying SPCB critical power correlation. The additive constants for the SPCB/GE14 correlation were developed using critical power data generated with the GE14 GEXL correlation, considering pressures down to the GEXL approved lower bound of 685 psig. In general, the treatment of conditions at the boundaries of the range of applicability is consistent with that of the underlying SPCB correlation. With the exception of the treatment of the low pressure boundary, the MCPR modeling of the GE14 fuel is consistent with the approved methodology for co-resident fuel.

The minimum pressure supported by the SPCB/GE14 correlation is 700 psia. However the pressure in the PRFO event falls below 700 psia in some cases. In the underlying SPCB methodology, exceeding the low pressure limit is normally treated by assuming that dryout occurs. But, this is not an acceptable outcome for this event. Therefore, the treatment for this boundary is changed. The purpose of Section 4 in ANP-3245P is to describe the change in treatment of the low pressure boundary, because it is not consistent with the co-resident fuel methodology. However, since the pressure that will be applied within the SPCB/GE14 critical power correlation is not less than 700 psia, the MCPR calculation for GE14 fuel remains within the range of applicability of the SPCB/GE14 correlation. ANP-3245P section 4 shows that this treatment is conservative.

It should be noted that the PRFO event is not a MCPR limiting event. The lowest MCPR is typically at or near the start of the transient and it increases as the event progresses.

RAI-04: In a PRFO event, the core inlet subcooling will decrease as the water saturation temperature decreases in response to the declining system pressure. Figure 4.1 of ANP-3245P Revision 1 shows that a lower inlet subcooling will reduce the critical heat flux. The SPCB critical power correlation also predicts a lower critical power for a lower inlet subcooling, as indicated in Figures 2.8 and 2.9 of the AREVA topical report EMF-2209(p), Revision 3 (SPCB Critical Power Correlation, December 2009).The last paragraph on page 4-2 of ANP-3245P Revision 1 (Attachment 5 to the LAR) states, "*For pressures that are lower than the SPCB/GE14 700 psia correlation boundary, the critical power will be evaluated as though the pressure was at 700 psia (preserving the same inlet subcooling). The results of applying the SPCB/GE14 correlation to pressures lower than 700 psia is illustrated with dashed lines in Figure 4.5 and indicates that the alternative low pressure boundary treatment is conservative*."

a) Explain how the varying inlet subcooling condition during a PRFO transient is accounted for in the application of the SPCB/GE14 correlation for pressures below 700 psia.

AREVA Response:

At pressures greater than or equal to 700 psia, the inlet subcooling is accounted in the SPCB correlation in the normal expected way. When the system pressure drops below 700 psia, the system pressure used by the SPCB/GE14 correlation is set to 700 psia. The subcooling is referenced to the saturated liquid enthalpy at 700 psia in the SPCB correlation. This is explained further below.

b) Explain in more detail the meaning of "preserving the same inlet subcooling." Does it mean the actual inlet subcooling will be used (accounting for the effect of lower pressure) but the dome pressure will be assumed to stay at 700 psia?

AREVA Response:

In SPCB, the inlet subcooling is used with the saturated liquid enthalpy to determine the nodal enthalpy. The nodal enthalpy is used in the correlation. When the pressure falls *below 700 psia, an enthalpy offset is calculated between the saturated enthalpy at 700 psia and the saturated enthalpy at system pressure p.*

$$\Delta h_{offset} = \begin{cases} h_f\left(700\right) - h_f\left(p\right), & p < 700\ psia \\ 0, & p \geq 700\ psia \end{cases}$$

The offset is added to the nodal enthalpy used by the SPCB/GE14 correlation. This effectively results in applying the actual inlet subcooling, while remaining consistent with applying the correlation at a system pressure of 700 psia.

RAI-05: ANP-3245P Revision 1 (Attachment 5 to the LAR) provides results for a series of sensitivity calculations in Tables 3.1 through 3.7. However the initial conditions are not stated for each series. For each series (i.e. Tables 3.1 through 3.7) provide the initial conditions for cycle exposure, core power, core flow, steam dome pressure, feedwater temperature, MSIV closure time, scram insertion speed, and core average gap conductance.

AREVA Response:

Each series of sensitivity analyses were performed to isolate the effect of the parameter of interest on the minimum steam dome pressure. The following tables provide the initial conditions used in each of the sensitivity analyses presented in ANP-3245P. However, for the core average pellet-to-cladding gap coefficient (HGAP) only the value from the Unit 1 analysis is provided. The value for Units 2 and 3 are similar.

Table 3.1 presents the minimum steam dome pressure for a core flow sensitivity evaluation. Each calculation was performed with the following inputs:

State point	**Cycle exposure**	**HGAP (Btu/hr-°F-ft^2)**	**Initial Conditions Dome Pressure / Feedwater Temperature (psia / °F)**	**MSIV Closure**	**Scram Speed**
Parameter evaluated	BOC	[ ]	100P – 1060 psia / 382.0°F 65P – 1031.40 psia / 342.6°F	3 sec	TSSS

Table 3.2 presents the minimum steam dome pressure for varied initial conditions of dome pressure and feedwater temperature. Each calculation was performed with the following inputs:

State point	Cycle exposure	HGAP (Btu/hr-°F-ft^2)	Initial Conditions Dome Pressure / Feedwater Temperature (psia / °F)	MSIV Closure	Scram Speed
100P / 81F	BOC	[ ]	Parameter evaluated Nominal Temp, Increased Pressure – 1060 psia / 382.0°F Nominal Temp, Reduced Pressure – 1040 psia / 382.0°F Reduced Temp, Increased Pressure – 1060 psia / 372.0°F Reduced Temp, Reduced Pressure – 1040 psia / 372.0°F FHOOS Temperature – 1030 psia / 317.0°F	3 sec	TSSS

Table 3.3 presents the minimum steam dome pressure for a MSIV closure time sensitivity evaluation. Each calculation was performed with the following inputs:

State point	Cycle exposure	HGAP (Btu/hr-°F-ft^2)	Initial Conditions Dome Pressure / Feedwater Temperature (psia / °F)	MSIV Closure	Scram Speed
100P / 81F	BOC	[ ]	FHOOS Temperature – 1030 psia / 317.0°F	Parameter evaluated	OSS reduced by 10%

Table 3.4 presents the minimum steam dome pressure for a cycle exposure sensitivity evaluation. Each calculation was performed with the following inputs:

State point	Cycle exposure	HGAP (Btu/hr-°F-ft^2)	Initial Conditions Dome Pressure / Feedwater Temperature (psia / °F)	MSIV Closure	Scram Speed
100P / 81F	Parameter evaluated	[ ]	FHOOS Temperature – 1030 psia / 317.0°F	5 sec	OSS reduced by 10%

Table 3.5 presents the minimum steam dome pressure for the scram insertion time sensitivity evaluation. Each calculation was performed with the following inputs:

State point	Cycle exposure	HGAP (Btu/hr-°F-ft^2)	Initial Conditions Dome Pressure / Feedwater Temperature (psia / °F)	MSIV Closure	Scram Speed
100P / 81F	BOC	**[ ]**	FHOOS Temperature – 1030 psia / 317.0°F	3 sec	Parameter evaluated

Table 3.6 presents the minimum steam dome pressure for the HGAP sensitivity evaluation. Each calculation was performed with the following inputs:

State point	Cycle exposure	HGAP (Btu/hr-°F-ft^2)	Initial Conditions Dome Pressure / Feedwater Temperature (psia / °F)	MSIV Closure	Scram Speed
100P / 81F	BOC	Parameter evaluated **[ ]**	FHOOS Temperature – 1030 psia / 317.0°F	5 sec	OSS reduced by 10%

Table 3.7 presents the minimum steam dome pressure at the limiting conditions for a range of core powers. The conditions were determined from the sensitivity studies shown in Tables 3.1 – 3.6. Each calculation was performed with the following inputs:

State point	Cycle exposure	HGAP (Btu/hr-°F-ft^2)	Initial Conditions Dome Pressure / Feedwater Temperature (psia / °F)	MSIV Closure	Scram Speed
100P / 81F 90P / 70F 75P / 50F 65P / 40F 60P / 35F 50P / 35F 40P / 35F 30P / 35F	BOC	HGAP +20% **[ ]**	FHOOS Temperature – 1030 psia / 317.0°F	5 sec	OSS reduced by 10%

RAI-06: Explain why the pressures in Tables 3.4 and 3.6 of ANP-3245P Revision 1 (Attachment 5 to the LAR) are significantly lower than values in Tables 3.1, 3.2, 3.3 and 3.5.

<u>*AREVA Response:*</u>

The values in Tables 3.4 and 3.6 are significantly lower because the sensitivity analyses performed for cycle exposure and HGAP were performed using a 5 second MSIV stroke time (determined to be conservative in Table 3.3) when each of the other analyses were performed with a 3 second closure time. See the response to RAI-05 for a listing of the initial conditions supporting each sensitivity evaluation.

RAI-07: Section 3.1.6 of ANP-3245P Revision 1 (Attachment 5 to the LAR) discusses the sensitivity of the minimum steam dome pressure to the core average gap conductance (HGAP). Under steady-state conditions for a given power, the averaged fuel temperature will vary inversely with the HGAP while the fuel cladding surface temperatures will not be affected. Thus the amount of heat transferred from the fuel to the coolant remains the same under steady-state conditions regardless of the value of the HGAP. A statement in the first paragraph of Section 3.1.6 says, "*A higher core average HGAP, assuming all other parameters are held constant, will result in more heat being transferred into the coolant*."

a) Explain if the statement is referring to steady-state or transient conditions and provide results from the analysis to substantiate the claim that a higher HGAP will result in more heat being transferred into the coolant.

<u>*AREVA Response:*</u>

The HGAP impacts both steady-state and transient performance. For steady-state, where the power deposited in the fuel matches the power transferred to the coolant regardless of the HGAP, the equilibrium stored energy is directly proportional to the power and inversely proportional to HGAP. When a transient exhibits a step decrease *in power, the steady-state stored energy will exceed the equilibrium stored energy for the new power level, and the excess stored energy must be conducted through the fuel-to-clad gap until a new steady-state condition is achieved in which the power, stored energy and heat flux are once again in equilibrium. The rate at which this occurs is dependent on HGAP. When HGAP is increased the excess stored energy will be removed to the coolant faster.*

While the power and pressure reduction for the PRFO is dependent on many interrelated thermal-hydraulic and neutronic phenomena, HGAP primarily impacts the rate of change of steam generation in the core due to decreasing power. When HGAP is increased, the excess stored energy is removed faster which results in a faster reduction in the heat flux, steam generation in the core and steam dome pressure. A decrease in HGAP will have the reverse trend and result in a slower decrease in the steam generation and steam dome pressure. For BFN Unit 1 Cycle 10, the Nominal – 20% HGAP simulation results in a 1.2% higher heat flux and 3.1 psi higher dome pressure than the Nominal +20% HGAP simulation at 7.5 seconds which is just prior to the low pressure isolation setpoint (LPIS). These differences in heat flux and pressure become more dramatic at 10.5 seconds as a result of the power reduction to decay heat levels by the reactor scram. Eventually the pressure reduction is terminated by the closure of the MSIV valves.

b) Explain the impact of the HGAP on the timing of the turbine header pressure reaching the low-pressure isolation setpoint (LPIS).

<u>AREVA Response:</u>

As explained in part a), an increase in HGAP results in a faster reduction in the heat flux and steam generation rate in the core. Therefore, increases in HGAP result in the *dome pressure reaching the LPIS earlier* [

] .

3.0 REFERENCES

1. Letter, F. E. Saba (NRC) to J. W. Shea (TVA), “Browns Ferry Nuclear Plant, Units 1, 2, and 3 - Request for Additional Information Related to License Amendment Request for Technical Specification Changes to Reactor Core Safety Limits (TAC Nos. MF5412, MF5413, and MF5414),” USNRC, May 12, 2015. (38-9240539-000)

ENCLOSURE 3

TENNESSEE VALLEY AUTHORITY
BROWNS FERRY NUCLEAR PLANT UNITS 1, 2, AND 3

Affidavit for ANP-3408P Revision 0

AFFIDAVIT

STATE OF WASHINGTON)
) ss.
COUNTY OF BENTON)

1. My name is Alan B. Meginnis. I am Manager, Product Licensing, for AREVA Inc. and as such I am authorized to execute this Affidavit.

2. I am familiar with the criteria applied by AREVA to determine whether certain AREVA information is proprietary. I am familiar with the policies established by AREVA to ensure the proper application of these criteria.

3. I am familiar with the AREVA information contained in the report ANP-3408P, Revision 0, "AREVA RAI Responses for Browns Ferry Steam Dome Pressure for Reactor Core Safety Limits," dated May 2015 and referred to herein as "Document." Information contained in this Document has been classified by AREVA as proprietary in accordance with the policies established by AREVA for the control and protection of proprietary and confidential information.

4. This Document contains information of a proprietary and confidential nature and is of the type customarily held in confidence by AREVA and not made available to the public. Based on my experience, I am aware that other companies regard information of the kind contained in this Document as proprietary and confidential.

5. This Document has been made available to the U.S. Nuclear Regulatory Commission in confidence with the request that the information contained in this Document be withheld from public disclosure. The request for withholding of proprietary information is made in accordance with 10 CFR 2.390. The information for which withholding from disclosure is

requested qualifies under 10 CFR 2.390(a)(4) "Trade secrets and commercial or financial information."

6. The following criteria are customarily applied by AREVA to determine whether information should be classified as proprietary:

(a) The information reveals details of AREVA's research and development plans and programs or their results.

(b) Use of the information by a competitor would permit the competitor to significantly reduce its expenditures, in time or resources, to design, produce, or market a similar product or service.

(c) The information includes test data or analytical techniques concerning a process, methodology, or component, the application of which results in a competitive advantage for AREVA.

(d) The information reveals certain distinguishing aspects of a process, methodology, or component, the exclusive use of which provides a competitive advantage for AREVA in product optimization or marketability.

(e) The information is vital to a competitive advantage held by AREVA, would be helpful to competitors to AREVA, and would likely cause substantial harm to the competitive position of AREVA.

The information in the Document is considered proprietary for the reasons set forth in paragraphs 6(b), 6(d) and 6(e) above.

7. In accordance with AREVA's policies governing the protection and control of information, proprietary information contained in this Document have been made available, on a limited basis, to others outside AREVA only as required and under suitable agreement providing for nondisclosure and limited use of the information.

8. AREVA policy requires that proprietary information be kept in a secured file or area and distributed on a need-to-know basis.

9. The foregoing statements are true and correct to the best of my knowledge, information, and belief.

SUBSCRIBED before me this 21st day of May, 2015.

Susan K. McCoy
NOTARY PUBLIC, STATE OF WASHINGTON
MY COMMISSION EXPIRES: 1/14/2016

SUSAN K. McCOY
NOTARY PUBLIC
STATE OF WASHINGTON
COMMISSION EXPIRES 01-14-16