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Subject: Arkansas Nuclear One - Unit 2
Docket No. 50-368
License No. NPF-6
Probabilistic Safety Assessment Information to Support the ANO-2 License Amendment Request for Power Uprate

Gentlemen:

Entergy Operations, Inc. submitted a license application dated December 19, 2000 (2CAN120001), to increase the authorized power level for Arkansas Nuclear One, Unit 2 (ANO-2) from 2815 megawatts thermal to 3026 megawatts thermal. The purpose of this letter is to provide additional information regarding the probabilistic safety assessment (PSA) portion of the license application.

Telephone conversations with the NRC staff were held on January 24, February 1 and 26, and April 23, 2001, to discuss the scope of information needed by the staff to complete their review of the license amendment request. The staff requested information that addresses the impact of power uprate on four key PSA areas:

1) initiating events and frequencies,
2) failure rates of equipment,
3) operator response times and human error probability, and
4) success criteria.

Additionally, the staff asked for information regarding the internal fire risk, changes in risk for external events, impact on risk during shutdown operations, quality of the risk model and the effect of power uprate on core damage frequency and large early release fraction.

The majority of the information requested by the staff is contained in the attachment to this letter. Analyses for the following areas are currently in design verification and will be

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provided in a near-term follow-up submittal: 1) Level 1 Internal Events – Success Criteria and Operator Actions, including effects on core damage frequency, 2) Large early release fraction, and 3) Quality of the Model.

The results of the probabilistic safety assessment to date revealed no new vulnerabilities to severe accidents due to increasing the authorized power level by 7.5%. Power uprate will have no unique or significant impacts on Level 1 Internal Events Initiating Event Frequencies, Level 1 Internal Events Component Failure Rates, Independent Plant Examination of External Events (IPEEE) Internal Fire Analysis, IPEEE Seismic Analysis, IPEEE Other External Events Analysis, or Shutdown Risk.

This submittal contains no regulatory commitments. Should you have questions, please contact me.

I declare under penalty of perjury that the foregoing is true and correct.

Very truly yours,

Jimmy D. Vandergrift
Director, Nuclear Safety Assurance

JDV/dwb
Attachment

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Probabilistic Safety Assessment for Power Uprate

TABLE OF CONTENTS

INTRODUCTION

An application for a license amendment to increase the authorized power level was submitted to the NRC staff on December 19, 2000 (2CAN120001). This application is referred to as the power uprate submittal. Subsequently, an evaluation was performed to assess the potential effects on plant risk of an ANO-2 power uprate to 3026 MWt, which represents a 7.5 % increase in reactor thermal power above the currently licensed core power rating of 2815 MWt.

The information in this attachment addresses the following risk areas: 1) Level 1 Internal Events – Initiating Event Frequencies, 2) Level 1 Internal Events – Component Failure Rates, 3) Independent Plant Examination of External Events (IPEEE) Internal Fire Analysis, 4) IPEEE Seismic Analysis, 5) IPEEE Other External Events Analysis, and 6) Shutdown Risk. Section 7) summarizes the conclusions of the discussion.

Information regarding the remaining risk areas will be provided in a follow-up submittal: 1) Level 1 Internal Events – Success Criteria and Operator Actions, 2) Level 2 Internal Events, and 3) Quality of the Model.

1 LEVEL 1 INTERNAL EVENTS – INITIATING EVENT FREQUENCIES

The following initiating events are modeled in the Level 1 Internal Events PSA. The underlying contributors to these initiating events were reviewed to determine the potential effects of the power uprate on the initiating event frequencies, with the following results:

<u>Loss of Coolant Accidents (LOCA)</u>

LOCA initiators include the small break (0.3" to 1.9" diameter), medium break (1.9" to 4.3" diameter) and the large break (above 4.3" diameter). LOCA frequency is dictated by the potential for passive pipe failures, which is independent of power level.

<u>Steam Generator Tube Rupture</u>

Replacement Steam Generators (RSG) were installed during 2R14. The RSG design increased tubing surface area to accommodate power uprate, (Section 2 of Enclosure 5 of the power uprate submittal). The RSG tubing material is Alloy 690, which was chosen as the optimum material for RSGs. Testing and field experience has shown it to be significantly improved in corrosion resistance compared to Alloy 600. In addition, many enhancements were made to the RSG design to provide margin against degradation (including uprated conditions). These include:

- Improved tube-to-tubesheet joint design (closely controlled hydraulic expansion),

- Anti-Vibration Bar (AVB) design (stainless steel material, AVBs in adjacent columns are inserted to different depths to discourage the formation of flow stagnation regions with resulting deposition of sludge, and orientation of supports to minimize contact length and potential for crevice corrosion), and

- Tube support plate design (stainless steel material, broached design to minimize stagnation regions, and shortened contact length).

Thus, the Steam Generator Tube Rupture frequency based on industry experience of tube ruptures is applicable to the uprated conditions.

<u>Loss of Offsite Power</u>

Loss of Offsite Power frequency is dictated by the reliability of the switchyard and grid, which are not degraded by the power uprate (Section 2.2 of Enclosure 5 of the power uprate submittal).

<u>Transient Initiators</u>

ANO Reactor Protection System (RPS) setpoint methodology assures that the trip setpoint values are sufficiently removed from a trip to account for instrumentation uncertainties such as drift. All trip setpoint affected by power uprate demonstrated that a proper balance exists between safety and plant operating margin.

Feedwater Control System, Pressurizer Level Control System, Pressurizer Pressure Control System, and Steam Dump and Bypass Control System setpoints were assessed and are being adjusted as necessary to ensure proper plant response to certain equipment failures (heater drain pump failure, condensate pump failure) and plant maneuvers (load changes, heatup, and cooldown).

Enclosure 5 of the power uprate submittal discusses the hardware changes and setpoint modifications made to maintain margin on trip setpoints at the uprated power level and maintain equipment operation within design constraints. For example, the following changes have been made, or are going to be implemented, to assure reliability of balance of plant systems under uprated conditions:

Turbine Trip	improved stator water cooling supply; rewound stator; replaced high pressure assembly and four stages of low pressure assembly.
Loss of Feedwater	improved reactor trip override; system response improvements, and modified heater drain pumps
Loss of Condenser	increased surface area

These modifications and setpoint changes mitigate the potential for increase of the frequency of transient initiators. Therefore, the power uprate will not increase the frequency of these transient initiators.

Spurious Main Steam Isolation Signal (MSIS)

A spurious MSIS signal will close the Main Steam Isolation Valves (MSIVs) and isolate Component Cooling Water and Auxiliary Cooling Water leading to the loss of Main Feedwater and condensate pumps. Closure of the MSIVs will result in loss of steam flow, challenge the Main Steam Safety Valves, challenge the primary Safety Relief Valves, and render the turbine bypass valves unavailable. Therefore, spurious MSIS signal has been included as a unique initiating event. The NRC staff approved the addition of a containment spray actuation signal (CSAS) on high-high containment building pressure to terminate main feedwater and main steam flow from the unaffected steam generator (reference SER for Amendment 225 dated November 13, 2000). This additional signal from CSAS provides a parallel actuation of selected components actuated by MSIS. Addition of this signal introduces another possible spurious signal path, potentially increasing the frequency of spurious MSIS. However, concurrent with the addition of this signal, the MSIS and CSAS logic circuits were trip hardened, requiring at least two relay failures to isolate the main feedwater or main steam system. This change reduces both the frequency of a spurious MSIS initiator and the probability of a spurious MSIS after a plant trip. Thus, although not quantified, the net effect of the two changes is expected to reduce the core damage frequency contribution due to spurious MSIS.

Transient Initiators – Support Systems

Support systems that may initiate a transient, such as DC Power, AC Power and Service Water, do not directly interface with the primary system and are not adversely affected by changes in power. These systems are being reviewed for any changes in loads and requirements and verified to be within the design capacities of the systems.

Anticipated Transient Without Scram (ATWS)

ATWS sequence initiation occurs under the same primary system conditions as existed prior to the power uprate. Since there is no change in the transient initiator frequency, the potential for ATWS is also unchanged.

In conclusion, the power uprate will have no adverse effect on Level 1 Internal Events PSA initiator frequencies. Any future deviations in initiating event frequencies will be identified via existing monitoring processes, such as the Licensee Event Report (LER), Condition Reporting, and Industry Events databases. Also, safety system actuations are trended under Maintenance Rule as an indicator of unnecessary challenges of safety related equipment.

2 LEVEL 1 INTERNAL EVENTS – COMPONENT FAILURE RATES

Comprehensive reviews of all plant systems and associated equipment with the potential to be affected by power uprate are discussed in the power uprate submittal. Changes in equipment service conditions and process changes, if any, were identified. Modifications were made to improve the performance of certain equipment and systems under uprated conditions. Thus, plant systems and equipment will continue to be operated within design constraints and component failure rates will not change with the power uprate.

Existing component monitoring programs, (e.g., preventive maintenance, vibration analysis, thermography, oil analysis, environmental qualification, erosion/corrosion, and maintenance rule), will account for any additional wear as a result of power uprate. While the power uprate may result in some components being refurbished or replaced more frequently, the functionality and reliability of components will be maintained to the current standard. These monitoring programs will also identify any future deviations in component failure rates. An example of specific power uprate affected components and the associated monitoring programs follows:

> As described in the power uprate submittal, the condensate and feedwater system (CFWS) is affected by power uprate in many ways. The speed of the turbine-driven feedwater pumps will be higher, the flow rate through the piping will be higher, the pump suction pressure will be lower, and the pump discharge pressure will be higher. The original condensate, feedwater, steam supply, extraction and drain systems are generously sized and the new velocities and pressure drops will be well within the acceptable ranges stated in technical manuals and equipment manufacturers' recommendations. Three of ten stages of the heater drain pumps will be replaced and larger horsepower heater drain pump motors installed in refueling outage 2R15. With this change, the CFWS is adequate for power uprate conditions. However, the increase pump speed, increased flow rate and pressure changes could cause specific components to wear out more quickly. This wear will be apparent due to various aspects of the Equipment Reliability Process, as described below:

- Vibration Program: The feedwater pumps, the feedwater pump turbine drivers, the feedwater pump lube oil pumps, the feedwater heater drain pump motors, and the condensate pumps and motors are included in the Vibration Program. The feedwater pump turbine drivers are monitored by proximity probes or shaft riders at the inboard and outboard bearings and alarmed in the Control Room. The remaining components are not continuously monitored, but are part of routine walk around routes.

- Flow Accelerated Corrosion Program: The condensate and feedwater system is included in the flow accelerated corrosion program, so increases in wear rates due to increased flow rates for power uprate will be monitored.

- Motor Operated Valve (MOV) Program: The feedwater isolation valves are included in the MOV program.

- Preventive Maintenance Program: The preventive maintenance program includes periodic inspections, tests, calibrations, measurements, adjustments, cleaning, sampling/analysis, lubrication and the replacement of limited life parts or components. Preventive maintenance also includes any scheduled maintenance activity required to avoid in-service failures to systems or components. These activities are performed to keep equipment in good operating condition and to detect and correct conditions that require component repair, replacement or rebuild. The condensate and feedwater system is part of the preventive maintenance program.

In conclusion, the power uprate will have no adverse effect on Level 1 Internal Events PSA component failure rates. Existing monitoring processes, including preventive maintenance, vibration analysis, thermography, oil analysis, environmental qualification, erosion/corrosion, and the maintenance rule program, will be used to identify any future deviations in component failure rates.

3 IPEEE INTERNAL FIRE ANALYSIS

The ANO-2 IPEEE Fire Analysis was performed using EPRI's Fire Induced Vulnerability Evaluation (FIVE). In this method, a fire initiating frequency is combined with a conditional core damage probability (CCDP) to determine the core damage frequency (CDF) for the zone.

The conditional core damage probability (CCDP) for each fire zone is calculated using the Level 1 Internal Events PSA. This is accomplished by setting the basic events for all fire susceptible equipment in the zone to 'true' and solving the model for transient initiated sequences. If the CDF obtained by combining this CCDP value with the zone's fire initiating frequency is less than 1.0E-06 the zone is screened from further analysis. Zones that did not screen on the first pass were evaluated to determine if conservative assumptions were made, or if operator recovery actions could be applied.

Since the CCDP is calculated using the Level 1 Internal Events PSA, the IPEEE Fire Analysis attributes that could potentially be affected by the proposed power uprate are the same as those for the Level 1 Internal Events PSA: initiating event frequencies, component failure rates, success criteria, and operator actions. Each of these attributes is discussed below.

3.1 Initiating Event Frequencies

The fire initiating frequency for each zone is dictated by combustible loading within the zone and is, therefore, not affected by the power uprate.

3.2 Component Failure Rates

Since the discussion on the Level 1 Internal Events PSA concluded that the power uprate will have no adverse effect on component failure rates, this attribute will also not be affected for the IPEEE Fire Analysis.

3.3 Success Criteria & Operator Actions

Changes in the success criteria of the Level 1 Internal Event PSA, due to the power uprate, have a minimal effect on the IPEEE Fire Analysis. However, since the time available to perform operator actions may decrease with the increase in power, the operator recovery actions applied in the analysis may be affected. For example, most of the recoveries applied in the IPEEE Fire Analysis have an available time based on the time it takes to begin uncovering the core after core cooling is lost.

An available time of 70 minutes was used in the IPEEE Fire Analysis. However, recent CENTS calculations show that this time is 80 minutes before power uprate and that it is 68 minutes after power uprate.

A sensitivity analysis was performed to determine the effect of the decreased available time on the CDF for the unscreened zones. Due to the screening nature of the IPEEE Fire Analysis, it is reasonable to assume that the zones that screened out pre-power uprate would also screen out post-power uprate. Thus, only the unscreened zones were evaluated. In this analysis, the CENTS calculated available times were factored into the recoveries applied to the unscreened zones and new Pre- and Post-Power Uprate CDFs were calculated. In this analysis the original IPEEE cutset files were used without requalification of the model.

The ANO-2 power uprate increases the CDF contribution of the unscreened zones in the IPEEE Fire Analysis as shown in the following table. The increase is due to the decreased time available to recover from loss of core cooling.

In conclusion, the power uprate slightly increases the CDF contribution of the unscreened zones in the IPEEE Fire Analysis. This increase is due to the decreased time available to recover from loss of core cooling. However, no new vulnerabilities or insights were noted. Thus, the power uprate will have negligible adverse impact on the IPEEE Internal Fire Analysis.

Increased CDF for IPEEE Fire Analysis Unscreened Zones Due to Power Uprate

Fire Area	Fire Zone	Description	Pre-Power Uprate CDF	Post-Power Uprate CDF	Change in CDF
N/A	N/A	Transformer Yard	1.09E-06	1.09E-06	0.00E+00
B	B3SC	Aux Bldg Ext	1.11E-06	1.25E-06	1.40E-07
SS	2097-X	East DC Equip Room	1.34E-06	1.85E-06	5.10E-07
HH	2096-M	MCC2B63 Room	1.22E-06	1.90E-06	6.80E-07
G	2098-C	New CPC Room	1.35E-06	1.92E-06	5.70E-07
G	2199-G	Control Room	1.49E-06	2.00E-06	5.10E-07
HH	2063SC	Aux Bldg el. 354'	1.74E-06	1.97E-06	2.30E-07
II	2101-AA	North Switchgear Room	1.77E-06	2.45E-06	6.80E-07
SS	2100-Z	South Switchgear Room	3.03E-06	3.90E-06	8.70E-07
EE	2055SC	Lower South Elect/Piping Penet Rm	4.21E-06	5.44E-06	1.23E-06
TT	2108-S	Electrical Equipment Room	6.03E-06	7.62E-06	1.59E-06
JJ	2109-U	Diesel Corridor	1.08E-06	1.68E-06	6.00E-07
		Diesel Corridor – failure of 2 rows of 2B51	5.58E-06	9.22E-06	3.64E-06
OO	IS	Intake Structure	1.18E-05	1.22E-05	4.00E-07
G	2098-L	Cable Spreading Room	1.26E-05	1.69E-05	4.30E-06
B	B5	Turbine Bldg A1/A2/CST Failed	3.43E-06	3.43E-06	0.00E+00
		Turbine Bldg A1/A2/CST Not Failed	3.65E-05	3.66E-05	1.00E-07

4 IPEEE SEISMIC ANALYSIS

The seismic margins analysis (SMA) performed for ANO-2 demonstrated that all Safe Shutdown Equipment List components, including containment performance and small break LOCA components are able to withstand the 0.3g review level earthquake defined for this evaluation and still provide their safe shutdown function. This "modified, focused scope" analysis consisted of developing a Safe Shutdown Equipment List using the EPRI SMA methodology and performing the applicable plant reviews. High Confidence of Low Probability of Failure calculations were performed only on those components that potentially had a capacity below 0.3 Zero Period Ground Acceleration.

In the SMA Analysis, a dynamic seismic analysis of the reactor coolant system (RCS), which includes the reactor vessel, steam generators, reactor coolant pumps, pressurizer and interconnected piping was conducted for the original design (reference section 3.4.1 of the power uprate submittal). Using conservative techniques for demand prediction and ASME design allowables, the analysis concluded that the RCS was seismically adequate. The RCS system supports were also screened, because they were designed for combined safe shutdown earthquake and pipe break loading.

The Reactor Coolant System Seismic Analysis discussed in Section 5.5 of the power uprate submittal determines the dynamic response of the reactor coolant system (RCS) with replacement steam generators (RSG) to seismic excitations. The seismic effects of the RSG on surge line response were also evaluated. These calculations were performed for system operating parameters consistent with the uprate core power level, so that the results are applicable to power uprate. Seismic response spectra at the surge line hot leg nozzle were generated as an output of the current RCS seismic analysis described above. A comparison of the original operating basis earthquake (OBE) 1/2 % damping response spectra at the surge line hot leg nozzle with the OBE 1/2 % damping response spectra for the RCS with RSG indicated that the original response spectra envelope the current response spectra over the applicable frequency range. Based on that comparison, both the OBE and design basis earthquake (DBE) response loads at the surge line piping assemblies, nozzles and supports from the original analysis were demonstrated to remain bounding for the RSG configuration. Therefore, with the RSGs and other changes for power uprate, the RCS remains seismically adequate.

As discussed previously, existing component monitoring programs will account for any additional wear as a result of power uprate. While the power uprate may result in some components being refurbished or replaced more frequently, the functionality and reliability of components will be maintained to the current standard. Thus, the increase in power level is not expected to affect equipment survivability nor equipment response during an earthquake. Also, the power uprate does not modify the safe shutdown pathway assumed in the SMA. Thus, the SMA is not impacted by the power increase. Therefore, the power uprate will have negligible adverse effect on the IPEEE Seismic Analysis.

5 IPEEE OTHER EXTERNAL EVENTS ANALYSIS

The IPEEE Other Events Analysis Screening for ANO determined that three external events should be addressed as part of the IPEEE program: 1) High Winds and Tornadoes, 2) External Flooding, and 3) Transportation and Nearby Facility Accidents. The power uprate impact on each of these evaluations is discussed below.

5.1 High Winds and Tornadoes

Most of the areas of the ANO wind resistant design satisfy the requirements of the 1975 standard review plan (SRP) and were screened per NUREG-1407. The three areas in which ANO design does not conform to the criteria provided in the Standard Review Plan (SRP) were resolved as follows,

- The maximum tornado wind velocity used for design is lower than that of the Regulatory Guide 1.76 Region I tornado model. The plant design basis is 300 mph. The IPEEE Other Events Analysis showed that the annual probability of a tornado strike at ANO with wind velocities exceeding 300 mph is less than 1.0E-06. Thus, the contribution from tornado wind hazard to core damage frequency is less than 1.0E-06/yr. The power uprate does not change this probability.

- The spectrum of tornado missiles considered in the ANO design is a subset of the missiles required by the SRP. Several of the SRP missiles have higher kinetic energies than those considered in the ANO designs. The IPEEE Other Events calculations and tests concluded that the minimum 1'6" thick reinforced concrete barrier (walls) utilized at ANO are sufficient to preclude perforation or spalling damage from the postulated SRP tornado missiles. The power uprate does not change these barriers.

- The original ANO design did not consider tornado winds and tornado generated missiles in the design of some exposed Category I components. The IPEEE Other Events Analysis concluded that the core damage frequency contribution from tornado generated missiles to the condensate storage tanks, the borated water storage tanks, the diesel fuel oil storage tank and the diesel exhausts is less than 1.0E-06 per year. The power uprate does not change the integrity of any of these components.

5.2 External Flooding

ANO-2 plant design has been shown to generally satisfy the intent of the 1975 SRP. The only area in which the plant design does not satisfy the 1975 SRP criteria is with respect to consideration of local intense precipitation or Probable Maximum Precipitation (PMP). The predicted rainfall intensity is larger than that assumed in the original design. The effect of the increase in rainfall intensity on local site ponding satisfies the intent of the SRP. However, the effect of the increase in rainfall intensity on roof ponding was re-evaluated in the IPEEE Other Events Analysis.

In the IPEEE Other Events Analysis, a rainfall intensity hazard frequency assessment was implemented. The analysis concluded that ANO-2 has adequate structural capacity and drainage capacity to protect safety-related equipment in Seismic Category I structures against the effects of PMP. The power uprate does not change the structural or drainage capacity of these structures.

5.3 Transportation and Nearby Facility Accidents

Most of the areas of the ANO design, with respect to Transportation and Nearby Facility Accidents, satisfy the requirements of the 1975 Standard Review Plan and were screened per NUREG-1407. Hazard frequency evaluations were performed in two areas, and were resolved as follows:

- Hazard frequency evaluations were performed to assess the likelihood of accidents involving a railcar rupture and toxic materials release serious enough to affect the habitability of the control room. The assessment demonstrated that the probability of an accident on the Missouri-Pacific railroad is less than the screening limit of 1.0E-06/yr. The power uprate does not change the probability of a railroad accident.

- Similarly, a hazard frequency evaluation was performed to assess the likelihood of an aircraft crashing into the plant and leading to radiological consequences in excess of 10CFR100 exposure guidelines. The probability of an aircraft crashing into the combined Unit 1 and Unit 2 plant area was calculated as 3.5 E-08/yr, which satisfies the SRP acceptance criteria of less than 1.0E-07/yr. The power uprate does not change the probability of an aircraft crashing.

In conclusion, the power uprate will have negligible adverse effect on the IPEEE Other External Events Analysis.

6 SHUTDOWN RISK

Shutdown risk impacts were examined in a qualitative manner, by answering the four questions posed by standard review plan 19 to determine if impacts on shutdown risk would be important. A discussion of these four points follows.

a. Will these changes affect shutdown schedule?

   The power uprate submittal indicates that the ability of the Shutdown Cooling System (SDCS) to achieve cold shutdown (less than 200°F) in 36 hours has been verified. The SDCS remains adequate to maintain refueling temperatures and a uniform boron concentration in the RCS.

   Since the decay heat levels are expected to be slightly hotter at power uprate conditions, it may take a few hours longer to achieve cold shutdown. This will cause very little change in the shutdown schedule, and has no direct safety impacts on the schedule.

b. Will these changes affect operator ability to respond?

The following shutdown safety functions are typically tracked during an outage:

- Decay Heat Removal,
- Reactor Coolant System Inventory Control,
- Vital Power Control (AC & DC),
- Reactivity Control, and
- Containment Closure

The possible initiating events during shutdown are generally defined as loss of the shutdown safety functions. The power uprate does not increase the frequency of these initiators, but may impact the operators' ability to respond to loss of shutdown safety functions.

Decay Heat Removal

The power uprate submittal notes that the SDCS remains adequate to maintain refueling temperatures and a uniform boron concentration in the RCS. It also notes that, with the increase in decay heat due to power uprate, the spent fuel pool temperature is still kept ≤ 150°F for a full core discharge. The increase in RCS temperature and the increase in decay heat will decrease the time for operators to respond to a loss of shutdown cooling or spent fuel pool cooling.

Maintaining an adequate defense-in-depth for this safety function, at all times, via the Shutdown Operations Protection Plan (SOPP) minimizes the impact of this decreased response time. For example, the SOPP for refueling outage 2R14 requires that:

- When the RCS is closed, at least one steam generator, an associated reactor coolant pump and the pressurizer (heaters/level) should be kept available as a method of decay heat removal. This includes the motor operated emergency feedwater pump, a supply of feedwater and the associated atmospheric steam dump flow path.

- The SDC system motor operated suction valves from the RCS should not be cycled while fuel is in the core unless the steam generators are capable of removing decay heat.

- During reduced inventory conditions, testing or maintenance that could affect reactor decay heat removal should not be performed on any of the protected SDC trains. If work is required, a contingency plan shall be in place prior to removing the system from service.

- Attention is given to the sensitive issue of maintaining an RCS vent path in reduced inventory. This is accomplished by not entering reduced inventory during periods of high decay heat loads directly following plant shutdown and by maintaining an adequate RCS vent path in the event of a loss of SDC by the use of non-restrictive covers.

Inventory Control

The increase in RCS temperature and the increase in decay heat will decrease the time for operators to respond to a loss of RCS inventory control. Maintaining an adequate defense-in-depth for this safety function, at all times, via the Shutdown Operations Protection Plan (SOPP) minimizes the impact of this decreased response time. For example, the SOPP for refueling outage 2R14 requires that:

- The outage schedule shall delay entering reduced inventory during periods of high decay heat loads directly following plant shutdown to allow the RCS metal to stabilize at near ambient (Shutdown Cooling) temperature along with the reduction of decay heat generation.

- Time spent in reduced inventory conditions shall be minimized.

- One flow path which meets the required make-up flow rate shall be operable except when in reduced inventory, then two flow paths shall be operable. During reduced inventory conditions at least one flow path shall be a high pressure safety injection (HPSI) flow path and shall be powered by both an emergency and an off-site power source even when only one flow path is required.

- When the RCS is open, at least one sump flow path to the Emergency Core Cooling System suction should be maintained available.

- When the spray pumps are relied upon for a make-up flow path, the reactor vessel head should be removed.

Vital Power – AC & DC

The increase in RCS temperature and the increase in decay heat will decrease the time for operators to respond to a loss of electrical systems, since the electrical systems support the systems required for the other safety functions. Maintaining an adequate defense-in-depth for this safety function, at all times, via the Shutdown Operations Protection Plan (SOPP) minimizes the impact of this decreased response time. For example, in addition to the requirements for the other safety functions, the SOPP for refueling outage 2R14 requires that:

- Work should not be allowed on electrical buses associated with the protected SDC train. Work is allowed on electrical buses associated with the standby SDC train provided that work will not de-energize the bus unless the RCS level is stable and not in reduced inventory.

- Work on one of the emergency diesel generators may be performed while the RCS is in reduced inventory when the following conditions exist: 1) the station blackout diesel is available to the bus normally supplied by the inoperable emergency diesel, 2) the other emergency diesel is operable, 3) two off-site power supplies are operable, and 4) the operable emergency diesel is on the protected train.

- During reduced inventory conditions with activated fuel in the reactor building, two on-site power sources capable of supplying the Vital 4160 VAC buses and two off-site power supplies should be maintained operable. In addition, both vital electrical distribution trains should be maintained operable along with all necessary support systems. Both emergency diesel generators shall not be intentionally removed from service simultaneously except when there is no fuel in the reactor vessel and the station blackout diesel is available and aligned as a Unit 2 backup on-site power source for a protected vital bus.

- During reduced inventory conditions testing or maintenance should not be allowed on equipment in the switchyard that could affect the power supplies to the plant. In addition, the dispatcher should be notified of reduced inventory conditions and requested to limit maintenance on equipment outside the switchyard that could affect power supplies to the plant switchyard.

- Emergency Diesel Generator work is scheduled when both trains of safety systems and alternate power sources are operable or the water level in the refueling canal is 23' above the fuel seated in the reactor vessel. This is accomplished by maintaining one emergency diesel, two off-site power sources and both loops of safety injection operable until the reactor vessel head is removed and the canal has been filled to at least 390' elevation during any cold shutdown conditions.

Reactivity Control

The power uprate submittal describes the analysis of the uncontrolled boron dilution incident for power uprate conditions. The increase in rated power was found to have a negligible impact on the results of the boron dilution event. The analysis showed that for dilution during refueling, dilution during cold shutdown with the RCS filled and dilution during cold shutdown with the RCS partially drained, the operator will be alerted to the event with more than the minimum response time available.

Containment Closure

The containment closure safety function assures the capability to close the containment following a loss of another safety function. Thus, the response time for this safety function is decreased by the decreased response time for the other safety functions. Maintaining an adequate defense-in-depth for this safety function, at all times, via the Shutdown Operations Protection Plan (SOPP) minimizes the impact of this decreased response time. For example, in addition to the requirements for the other safety functions, the SOPP for refueling outage 2R14 requires that:

- Expedited containment closure capability, including staging of required tools, shall be maintained when there is fuel in the reactor vessel. This shall include contingencies for the loss of AC power.
- With fuel in the reactor vessel, any penetration with maintenance or testing in progress should have the redundant isolation valve closed, or for penetrations without redundant isolation valves (including electrical penetrations), appropriate plugs or sealing material should be installed, with a person present to quickly close the flow path through the penetration.
- Prior to opening systems inside containment ensure containment breaches are considered that are not readily apparent (e.g., steam generator secondary side manway or handhole removed with an associated main steam safety valve removed).
- During reduced inventory conditions, containment breaches are controlled by the Manager, Operations. All containment breaches will have the capability to be closed within 45 minutes and, where possible, within the estimated time to boiling.
- The equipment hatch may remain open during core alterations provided the hatch can be closed within 30 minutes.

c. Will changes affect shutdown equipment reliability?

As discussed previously, existing component monitoring programs will account for any additional wear as a result of power uprate. While the power uprate may result in some components being refurbished or replaced more frequently, the functionality and reliability of components will be maintained to the current standard.

d. Will changes affect availability of equipment or instrumentation used for contingency plans?

As discussed previously, existing component monitoring programs will account for any additional wear as a result of power uprate. While the power uprate may result in some components being refurbished or replaced more frequently, the functionality and reliability of components will be maintained to the current standard.

The increase in decay heat will result in a small decrease in the time available for operator actions during shutdown. However, maintaining an adequate defense-in-depth for the shutdown safety functions, at all times, via the Shutdown Operations Protection Plan (SOPP) minimizes the impact of this decreased response time. In conclusion, the power uprate will have no unique or significant impacts on shutdown risk.

7 CONCLUSION

In conclusion, the power uprate will have no unique or significant impacts on the Level 1 Internal Events Initiating Event Frequencies, the Level 1 Internal Events Component Failure Rates, the IPEEE Internal Fire Analysis, the IPEEE Seismic Analysis, the IPEEE Other External Events Analysis, or the Shutdown Risk.

The power uprate will have no adverse effect on Level 1 Internal Events PSA initiator frequencies. Any future deviations in initiating event frequencies will be identified via existing monitoring processes, such as the Licensee Event Report (LER), Condition Reporting, and Industry Events databases. Also, safety system actuations are trended under Maintenance Rule as an indicator of unnecessary challenges of safety related equipment.

The power uprate will have no adverse effect on Level 1 Internal Events PSA component failure rates. Existing monitoring processes, including preventive maintenance, vibration analysis, thermography, oil analysis, environmental qualification, erosion/corrosion, and the maintenance rule program, will be used to identify any future deviations in component failure rates.

The power uprate slightly increases the core damage frequency contribution of the unscreened zones in the IPEEE Fire Analysis. This increase is due to the decreased time available to recover from loss of core cooling. However, no new vulnerabilities or insights were noted. Thus, the power uprate will have negligible adverse impact on the IPEEE Internal Fire Analysis.

The increase in power level is not expected to affect equipment survivability nor equipment response during an earthquake. Also, the power uprate does not modify the safe shutdown pathway assumed in the SMA. Thus, the SMA is not impacted by the power increase. Therefore, the power uprate will have negligible adverse effect on the IPEEE Seismic Analysis.

The power uprate will have negligible adverse effect on the IPEEE Other External Events Analysis.

The increase in decay heat will result in a small decrease in the time available for operator actions during shutdown. However, maintaining an adequate defense-in-depth for the shutdown safety functions, at all times, via the SOPP minimizes the impact of this decreased response time. In conclusion, the power uprate will have no unique or significant impacts on shutdown risk.