

Mr. C. Randy Hutchinson  
 Vice President, Operations ANO  
 Entergy Operations, Inc.  
 1448 S. R. 333  
 Russellville, AR 72801

February 17, 1999

SUBJECT: ISSUANCE OF AMENDMENT NO. 201 TO FACILITY OPERATING LICENSE  
 NO. NPF-6 - ARKANSAS NUCLEAR ONE, UNIT NO. 2 (TAC NO. MA2244)

Dear Mr. Hutchinson:

The Commission has issued the enclosed Amendment No. 201 to Facility Operating License No. NPF-6 for the Arkansas Nuclear One, Unit No. 2 (ANO-2). This amendment authorizes the proposed modification to the plant protection system (PPS) described in your application dated June 30, 1998 (2CAN069801), as supplemented by your letter dated November 23, 1998 (2CAN119805).

The amendment authorizes the licensee to modify the plant to correct a design deficiency with the PPS. This deficiency could have rendered the system vulnerable to a single failure (i.e., failure of a DC buss) with one channel in bypass. The proposed modification would ensure the required redundancy and independence for the PPS such that no single failure results in a loss of the protection function with a channel in indefinite bypass, and removal from service of any component or channel does not result in a loss of the minimum redundancy required by the Technical Specifications. This modification was submitted to the Nuclear Regulatory Commission for prior approval as an unreviewed safety question per 10 CFR 50.59(a)(2).

A copy of our related Safety Evaluation is also enclosed. A Notice of Issuance will be included in the Commission's next biweekly Federal Register notice.

Sincerely,

**ORIGINAL SIGNED BY:**  
 M. Christopher Nolan, Project Manager  
 Project Directorate IV-1  
 Division of Reactor Projects III/IV  
 Office of Nuclear Reactor Regulation

Docket No. 50-368

Enclosures: 1. Amendment No. 201 to NPF-6  
 2. Safety Evaluation

cc w/encls: See next page

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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

February 17, 1999

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NO. NPF-6 - ARKANSAS NUCLEAR ONE, UNIT NO. 2 (TAC NO. MA2244)

Dear Mr. Hutchinson:

The Commission has issued the enclosed Amendment No.201 to Facility Operating License No. NPF-6 for the Arkansas Nuclear One, Unit No. 2 (ANO-2). This amendment authorizes the proposed modification to the plant protection system (PPS) described in your application dated June 30, 1998 (2CAN069801), as supplemented by your letter dated November 23, 1998 (2CAN119805).

The amendment authorizes the licensee to modify the plant to correct a design deficiency with the PPS. This deficiency could have rendered the system vulnerable to a single failure (i.e., failure of a DC buss) with one channel in bypass. The proposed modification would ensure the required redundancy and independence for the PPS such that no single failure results in a loss of the protection function with a channel in indefinite bypass, and removal from service of any component or channel does not result in a loss of the minimum redundancy required by the Technical Specifications. This modification was submitted to the Nuclear Regulatory Commission for prior approval as an unreviewed safety question per 10 CFR 50.59(a)(2).

A copy of our related Safety Evaluation is also enclosed. A Notice of Issuance will be included in the Commission's next biweekly Federal Register notice.

Sincerely,

A handwritten signature in cursive script that reads "M. Christopher Nolan".

M. Christopher Nolan, Project Manager  
Project Directorate IV-1  
Division of Reactor Projects III/IV  
Office of Nuclear Reactor Regulation

Docket No. 50-368

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2. Safety Evaluation

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Mr. C. Randy Hutchinson  
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Arkansas Nuclear One, Unit 2

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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

ENTERGY OPERATIONS, INC.

DOCKET NO. 50-368

ARKANSAS NUCLEAR ONE, UNIT NO. 2

AMENDMENT TO FACILITY OPERATING LICENSE

Amendment No.201  
License No. NPF-6

1. The Nuclear Regulatory Commission (the Commission) has found that:
  - A. The application for amendment by Entergy Operations, Inc. (the licensee) dated June 30, 1998, as supplemented by letter dated November 23, 1998, complies with the standards and requirements of the Atomic Energy Act of 1954, as amended (the Act), and the Commission's rules and regulations set forth in 10 CFR Chapter I;
  - B. The facility will operate in conformity with the application, the provisions of the Act, and the rules and regulations of the Commission;
  - C. There is reasonable assurance: (i) that the activities authorized by this amendment can be conducted without endangering the health and safety of the public, and (ii) that such activities will be conducted in compliance with the Commission's regulations;
  - D. The issuance of this license amendment will not be inimical to the common defense and security or to the health and safety of the public; and
  - E. The issuance of this amendment is in accordance with 10 CFR Part 51 of the Commission's regulations and all applicable requirements have been satisfied.

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2. Accordingly, the license is amended to authorize revision of the Safety Analysis Report (SAR) as set forth in the application for amendment by the licensee, dated June 30, 1998, as supplemented by letter dated November 23, 1998, and as evaluated in the staff Safety Evaluation attached to this amendment. The licensee shall update the SAR to modify the design basis as described in the SAR by adding a description of the changes utilized to ensure that the plant protection system has the required redundancy and independence and to assure that no single failure would result in a loss of the protection function with a channel in bypass, and removal from service of any component or channel does not result in a loss of the minimum redundancy required by the Technical Specifications, as authorized by this amendment and in accordance with 10 CFR 50.71(e).
3. The license amendment is effective as of its date of issuance to be implemented within six months following the facility's restart from refueling outage 2R14.

FOR THE NUCLEAR REGULATORY COMMISSION



M. Christopher Nolan, Project Manager  
Project Directorate IV-1  
Division of Reactor Projects III/IV  
Office of Nuclear Reactor Regulation

Date of Issuance: February 17, 1999



UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO.201 TO

FACILITY OPERATING LICENSE NO. NPF-6

ENTERGY OPERATIONS, INC.

ARKANSAS NUCLEAR ONE, UNIT NO. 2

DOCKET NO. 50-368

1.0 INTRODUCTION

By letter dated June 30, 1998 (2CAN069801), as supplemented by letter dated November 23, 1998 (2CAN119805), Entergy Operations, Inc. (the licensee) submitted a proposed plant modification for Arkansas Nuclear One, Unit No. 2 (ANO-2) for prior approval as an unreviewed safety question per the requirements of 10 CFR 50.59(a)(2).

The amendment authorizes the licensee to modify the plant to correct a design deficiency with the plant protection system (PPS). This deficiency could have rendered the system vulnerable to a single failure (i.e., failure of a DC buss) with one channel in bypass. The proposed modification would ensure the required redundancy and independence for the PPS such that no single failure results in a loss of the protection function with a channel in indefinite bypass, and removal from service of any component or channel does not result in a loss of the minimum redundancy required by the Technical Specifications (TSs). The proposed modifications will also correct the discrepancy between the Safety Analysis Report (SAR) description of the PPS system and its actual response to the loss of electrical power event.

The November 23, 1998 (2CAN119805), letter provided clarifying information that did not change the initial proposed no significant hazards consideration determination.

2.0 EVALUATION

2.1 Background

On October 30, 1996, while the plant was at 100% power, the licensee discovered that while one PPS channel is in bypass, a scenario consisting of a loss of offsite power (LOOP) concurrent with a single failure, such as a loss of the train A DC bus would result in a failure of certain Engineered Safety Features Actuation System (ESFAS) functions. A failure of a DC bus with an assumed secondary plant trip could result in a loss of offsite power to one division of ESFAS and could de-energize one pair of vital instrument buses (VIBs), thereby disabling two measurement channels for certain ESFAS parameters. The licensee evaluated this condition and concluded that the risk could be minimized to an acceptable level only if the period for a channel to be bypassed is limited to a maximum of 48 hours. As a short term corrective action, the licensee established administrative controls which will prevent a PPS

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channel from remaining in bypass for more than 48 hours. As a long term fix, the licensee decided to implement a design modification which will alleviate the design deficiency and ensure that ESFAS will have the redundancy and independence sufficient to assure that (1) no single failure results in a loss of the protection function with a channel in indefinite bypass, and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy required by the ANO-2 TSs.

The licensee issued LER 96-04 dated November 27, 1996, which was later supplemented by a letter to the staff dated January 30, 1997. The staff included this concern in their Information Notice 97-81, "Deficiencies in Failure Modes and Effects Analyses for Instrumentation and Control systems." With the current design configuration, the Reactor Protection System (RPS) is not affected by the above scenario.

## 2.2 Existing Design

The ESFAS portion of the PPS monitors selected plant parameters and provides an actuation signal to each required individual ESFAS component to mitigate the consequences of an accident when the monitored value reaches its preselected setpoint (SP). For ESFAS associated parameters, the monitoring/actuation string of devices is made up of instrument loops, logic matrix, trip path (TP) circuits and individual actuation circuits. Each of the selected process parameters is monitored using four measurement channels. Signal output from each measurement channel which is normally in the form of bistable relays contact(s), is further fed to a logic matrix. The logic matrix generates an ESFAS actuation signal which is based on two-out-of-four logic combination selection. The ESFAS actuation signal from the logic matrix is fed to four TP circuits which sends an actuation signal to each ESFAS individual-component by de-energizing the solid state relays (SSRs) of the affected TP circuits. Each TP circuit has two SSRs and one lock-out relay. Out of two SSRs in each TP circuit, contacts of one SSR are assigned for actuating ESFAS equipment of one power division and contacts from the other SSR are used for actuating the ESFAS equipment of the redundant power division. The TP output signal for individual ESFAS devices actuation is configured as a one-out-of-two-taken-twice logic basis.

Each of the four measurement channel instrument loops except those employed for the refueling water tank (RWT) level measurement, is powered by a single channelized inverter (channel A gets power from the A inverter, channel B from the B inverter), but the portion of the loop consisting of the bistable relay circuit for each channel is fed from auctioneered power from inverters of both power divisions. The vital power design for the PPS consists of one emergency diesel generator (EDG) and, one battery/DC distribution system feeding two inverters for each power division. Inverters A and C are fed from Division 1 (Red) DC bus and, Inverters B and D are fed from Division 2 (Green) DC bus. In this configuration, loss of power to the Division 1 DC bus will result in loss of power to measurement channels A and C and loss of the Division 2 DC bus will result in a loss of power to measurement channels B and D. Therefore, in the case of a loss of one DC bus, two inverters will be de-energized making two channels inoperable.

As per the existing design configuration, for functions with a decreasing signal setpoint (SP), a loss of power to a single channelized instrument loop would result in the tripping of the bistable (channel trip); but for functions with an increasing signal SP, a loss of a channelized instrument loop power will render the affected channel inoperable. This is the reason why, for a loss of

power, the functions with an increasing signal SP such as the Containment Isolation Actuation System (CIAS), Containment Spray Actuation System (CSAS) and Safety Injection Actuation System (SIAS) which are all triggered by the increasing containment pressure signal, and the Emergency Feedwater Actuation System (EFAS) which is initiated by an increasing differential pressure between two SGs, will fail to actuate. If the loss of one DC bus occurs while one PPS channel fed from the operable DC bus is in a bypassed state (as permitted by the TS), it will disable the additional two channels making the 3-out-of-4 channels inoperable. This will result in a loss of function because a minimum of 2-out-of-4 channels are required to generate an ESFAS actuation signal. The licensee's original failure modes and effects analysis (FMEA) failed to identify this fact. Thus, the original FMEA was in error in its conclusion that "the vital ac power system did not have a single failure mechanism that could cause failure of two vital AC power channel inputs." However, the original FMEA did indicate that any of the PPS channels that generate a trip on a decreasing value of the SP will actuate on loss of power. During a postulated LOOP event concurrent with a loss of a DC bus from one power division, the CIAS, CSAS, SIAS and EFAS functions with an increasing SP will fail to actuate if one PPS channel fed from the operable DC bus is in a bypassed state as permitted by the TS. During this condition, the plant would operate outside its original design basis violating design requirements and stipulations of the SAR design commitments. In their submittal, the licensee acknowledged that the existing design, under the above described situation, would violate the requirements of IEEE-279-1971 and General Design Criteria (GDC) 21, 22, 23, and 24 of Appendix A to 10 CFR Part 50.

At the logic matrix, the output signals from four measurement channels A, B, C and D are selected to provide six output combinations (AB, AC, AD, BC, BD, CD) based on a two-out-of-four logic. Any combination when true, de-energizes a set of four initiating relays arranged in a group of two (1&2 and 3&4 for RPS and 1&3 and 2&4 for ESFAS). Except for a few logic-combinations in RPS, these relay groups in RPS and ESFAS are powered from two redundant power sources. Contacts of four initiating relays from each of the six matrix combinations are connected in series with output relays to form four TP circuits, TP 1 through 4. ESFAS actuation signal logic is configured as a one-out-of-two-taken-twice combination {(TP1 or TP3) and (TP2 or TP4)} of the SSR contacts. In this configuration, if one power-source is lost, only one relay group 1&3 or 2&4 will be de-energized. Since the actuation signal logic is based on a one-out-of-two-taken-twice combination of initiating signals, a loss of one power source will only generate a half trip.

If a channel is not in bypass, all PPS functions except the function that controls feedwater flow/SG level to prevent SG overfill will be available even if one power division is lost concurrent with a LOOP. In their submittal, the licensee stated that the SG overfill prevention feature is not a required safety function for the postulated loss-of-power scenario.

### 2.3 Proposed Modifications

To address the issue noted in Section 2.1 above, the licensee proposed the following design changes to modify the RPS and ESFAS portion of the ANO-2 PPS design. Although with the current design configuration, the RPS system is not affected by the above scenario, the proposed changes are not limited to the ESFAS related equipment circuitry because the PPS logic cabinet wiring for power distribution is common and interconnected between RPS and ESFAS circuits.

1. For functions with an increasing signal SP, the existing auctioneered bistable power supplies for the bistable-relay portions of the instrument loops for the PPS channels A and D, will be replaced by a single channelized power source. Thus, in the modified design, the channel A bistable-relay circuit will be powered by inverter A and the channel D bistable-relay circuit will be powered by inverter D. In this configuration, a loss of power to channels A and/or D will result in a channel-trip by de-energizing the affected bistable relays. The PPS channels B and C auctioneered power supplies remain unchanged to maintain recirculation actuation signal response to a failure of one DC bus. The modification will defeat the trouble alarm contacts for the auctioneered power sources for channels A and D bistable circuits. For the loss of one DC bus event, the modified circuits response will be as follows:
  - a) For increasing SP functions, measurement channels A and D will fail in a tripped state.
  - b) For increasing SP functions, measurement channels B and C will fail in an inoperable state.
  - c) Measurement channels response for functions with decreasing SP function will not be changed by the proposed modification. As per the current configuration, all such channels except RWT measurement channels assume a tripped status on loss of a DC bus. This is because the instrument loop perceives the loss of instrument loop power condition as a decrease in the value of the process signal.
2. For each of the emergency feed water pump discharge valves responding to a main steam isolation signal (MSIS) or EFAS, the actuation logic for the interposing relays will be changed from the existing single TP actuation to a selective 2-out-of-4 TP logic. The MSIS interposing relay will be wired the same as the other MSIS subgroup relays. The modified logic configuration for EFAS actuation will be such that a combination, TP1 or TP3 and TP2 or TP4 will de-energize the interposing relays to provide an "OPEN" demand to the emergency feedwater pump discharge valves, and will provide a "CLOSE" demand by energizing the interposing relays when the logic, TP1 and TP3 or TP2 and TP4 is satisfied. The wiring changes to the interposing relays to incorporate the above selective logic will defeat the existing control room alarms for de-energization of an EFAS lockout relay or an interposing relay. For each EFAS function, the normally open contacts from the two interposing relays and the two lockout relays will be wired in series with the coil of a relay located on the Diverse Emergency Feedwater Actuation System (DEFAS) subpanels. The subpanel relay contacts will be used to maintain the existing control room alarms and the EFAS blocking of the DEFAS. The EFAS actuation interconnection with DEFAS will be wired such that either an interposing relay or a lockout relay de-energization will block the DEFAS function.
3. The TPs for MSIS-lockout require manual reset at both the auxiliary relay cabinets and the PPS cabinet. Therefore, as shown on wiring diagrams for cabinets 2C39 and 2C40 (Attachment 4 to the licensee's submittal), pushbuttons are provided for resetting the MSIS subgroup relays. The existing MSIS interposing relays will be rewired to the primary trip bus in a manner similar to the subgroup relays. In their submittal, the licensee stated that this necessitates relocating the SSR-TP1 and SSR-TP2 from the interposing relay circuit to the primary trip leg circuit. The proposed wiring changes in logic cabinets 2C39 and 2C40 have

no impact on the MSIS functionality, and preclude a single TP inadvertent actuation of the MSIS output relays that closes the associated emergency feedwater pump discharge valves. The discharge valve schemes are wired such that an EFAS signal will override the MSIS close signal based on a "feed only good generator" logic.

#### 2.4 Design Features

The licensee's evaluation of the proposed modification as stated in ANO-2 Engineering Report 97-R-2015-01 concluded that the modified design of the PPS provides the following features:

- a) The PPS has redundancy and independence sufficient to assure that 1) no single failure results in a loss of the protection function, and 2) removal or bypass of any component or channel does not result in a loss of the technical specification required minimum redundancy.
- b) The PPS is designed to fail into a safe state or into a state demonstrated to be acceptable.
- c) The PPS design meets the single failure criterion described in IEEE 279-1971 to the extent that any failure within the PPS does not prevent proper action at the system level and no single failure will defeat more than one of the four protective channels associated with any one trip function.
- d) The PPS design permits bypassing any one channel for maintenance and, when required, test or calibration during power operation without initiating a protective action at the system level. During such operation, the active parts of the system shall, of themselves, continue to meet the single failure criterion.
- e) In a loss of one DC bus scenario, functions with decreasing SP will actuate, and functions with increasing SP will remain functional with one channel tripped per power division (channel A or D). Therefore, only one channel out of four will be rendered inoperable due to a loss of one DC bus and as a result, the proposed modification corrects the PPS response to a loss of one DC bus event and postulated concurrent single failure.
- f) The addition of the selective logic to the actuation (EFAS and MSIS) of the emergency feedwater pump discharge valves decreases the susceptibility to single trip path failures. The function of these valves is not changed. Also, the addition of a selective logic precludes the cycling of these valves during PPS matrix testing.
- g) RPS response to a loss of one DC bus event will not be affected by the proposed modification and the RPS will continue to meet its design basis requirements.

The licensee stated that their revised PPS FMEA indicates the acceptability of the PPS response to all licensing basis events. As indicated in their recent FMEA, de-energization of the two bistable power supplies corrects the response to the loss of one DC bus event. While the modification corrects the description of the plant response, the single channel failure causes have also been expanded to include failure of a single bistable power supply. The licensee further stated that, with the proposed design modification, the PPS will have the redundancy

and independence sufficient to assure that (1) no single failure results in loss of a protection function, and (2) removal from service of any component or channel will not result in loss of the minimum redundancy required by the technical specification. The proposed design change will ensure that the PPS fails in a safe state or into a state demonstrated to be acceptable and will meet the single failure criterion of IEEE 279-1971 to the extent that any single failure within the system will not prevent proper protective action at the system level and no single failure will defeat more than one of the four protective channels associated with any one trip function. Also, with the proposed modification, a loss of function will not occur due to one channel being in bypass for test, maintenance and/or repair. The staff has reviewed the PPS design and associated FMEA and the licensee's determination of the features of the modification to be in accordance with applicable design basis requirements, and therefore, finds the proposed design change acceptable.

In their submittal, the licensee stated that their revised FMEA indicates that the proposed design modification will remove the deficiency associated with the existing design and meet the current SAR description of the PPS response to a loss of one DC bus event with one channel in the non-faulted division bypassed. The staff agrees with the licensee's statement. The licensee is in the process of updating the ANO-2 SAR to include the proposed design change and the revised FMEA.

### 2.5 Conformance with Design and Regulatory Requirements

Based on the above evaluation, the staff concludes that the proposed modification to the ANO-2 PPS, meets the single failure requirements of IEEE 279-1971, and GDC 21, 22, 23, and 24. The proposed design modification provides the redundancy and independence sufficient to assure that no single failure results in loss of a protection function, and the removal from service of any component or channel will not result in loss of minimum redundancy required by the ANO-2 Technical Specifications. The proposed modification corrects the PPS system response to a scenario consisting a postulated LOOP event concurrent with a loss of one division DC bus, with one PPS channel fed from the operable DC bus in a bypassed state and, therefore, alleviates the existing discrepancy between the SAR description of the PPS systems response and its actual response to the loss of one DC bus event. The staff, therefore, concludes the proposed ANO-2 PPS modification is acceptable. This amendment is approved with a license condition requiring modifications to the PPS and update to the plant design basis as described in the SAR by adding a discussion of the changes utilized to demonstrate that the PPS has the required redundancy and independency and to assure that no single failure would result in a loss of the protective function with a channel in bypass, and removal from service of any component or channel does not result in a loss of minimum redundancy required by the Technical Specifications. The modifications to the PPS and update of the SAR shall be implemented within six months following the facility's restart from refueling outage 2R14.

### 3.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Arkansas State official was notified of the proposed issuance of the amendment. The State official had no comments.

#### 4.0 ENVIRONMENTAL CONSIDERATION

The amendment changes a requirement with respect to installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and changes surveillance requirements. The Nuclear Regulatory Commission staff has determined that the amendment involves no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendment involves no significant hazards consideration, and there has been no public comment on such finding (63 FR 66593). Accordingly, the amendment meets the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b) no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

#### 5.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendment will not be inimical to the common defense and security or to the health and safety of the public.

Principal Contributor: S. V. Arthavale

Date: February 17, 1999