



11/30/83

INTERIM REPORT

NRC TAC No(s), 43126

REPORT No. UCID-XXXX

CONTRACT PROGRAM OR PROJECT TITLE:

Selected Operating Reactor Issues II

SUBJECT OF THIS DOCUMENT:

Technical Evaluation Report on the Electrical, Instrumentation, and Control Design Aspects of the Proposed License Amendment Revision 1 for Single-Loop Operation of the Duane Arnold Energy Center, Unit 1

TYPE OF DOCUMENT:

Informal Report

AUTHOR(S):

Terry R. Donich/Robert White

DATE OF DOCUMENT:

November 30, 1983

RESPONSIBLE NRC INDIVIDUAL AND NRC OFFICE OR DIVISION:

Dick Clark, Division of Licensing

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Prepared for the
U.S. Nuclear Regulatory Commission
Washington, D.C.
Under DOE Contract No. B&R20191011
NRC FIN No. A0250

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PDR FOIA PDR
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TECHNICAL EVALUATION REPORT ON THE
ELECTRICAL, INSTRUMENTATION, AND CONTROL DESIGN ASPECTS OF
THE PROPOSED LICENSE AMENDMENT REVISION 1
FOR SINGLE-LOOP OPERATION OF
THE DUANE ARNOLD ENERGY CENTER, UNIT 1

(Docket No. 50-331)

Terry R. Donich

Lawrence Livermore National Laboratory
Nuclear Systems Safety Program

November 30, 1983

FIN A-0250

Responsible NRC Individual and Division
Dick Clark
Division of Licensing

ABSTRACT

This report documents the technical evaluation of the proposed changes to the plant reactor protection system by the licensee of Duane Arnold Energy Center, Unit 1 to account for single-loop plant operation. This evaluation is restricted to only the electrical, instrumentation, and control design aspects of proposed changes to the plant technical specifications for single-loop operation beyond 24 hours. The conclusion of the evaluation is that the Duane Arnold license amendment for single-loop operation has met the review criteria provided anomalous control room indications are corrected or warning-tagged for the duration of single-loop operation.

FOREWORD

This report is supplied as part of the Selected Operating Reactor Issues Program II being conducted for the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by Lawrence Livermore National Laboratory.

The U. S. Nuclear Regulatory Commission funded the work under the classification entitled "Selected Operating Reactor Issues Program II, B&R 20 19 10 11 1, FIN No. A-0250.

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Lawrence Livermore National Laboratory,

1. INTRODUCTION

By letter to the U. S. Nuclear Regulatory Commission (NRC) dated June 24, 1983 [Ref. 1], the Iowa Electric Light and Power Company submitted information to support its proposed license amendment to operate the Duane Arnold Energy Center, Unit 1 (DAEC-1) with one recirculation loop out of service (i.e., single-loop operation). This request supercedes all other submittals. This information included the licensee's analysis of significant events, which were based on a review of accidents and abnormal operational transients associated with power operations in the single-loop mode provided by General Electric Company, Nuclear Energy Division (GE-NED), the nuclear steam supply system designer. Conservative assumptions were employed, as discussed in the GE-NED report NEDO-24272 dated July, 1980 [Ref. 2], to ensure that the generic analyses for boiling water reactors (BWR 3 and/or 4) were applicable to the DAEC-1. In response to an NRC request, the licensee provided supplemental information in conference calls of September 15, 1983 [Ref. 3] and September 19, 1983 [Ref. 4]. A letter to NRC documenting the conference calls was dated October 11, 1983 [Ref. 5].

The purpose of this report is to document the evaluation of the electrical, instrumentation, and control (EI&C) design aspects of the proposed license amendment change to the DAEC-1 technical specifications. The consideration of proper plant variables, computer models, and the licensee's conclusions on core performance and clad temperature are outside the scope of this evaluation.

This review was conducted using 10CFR50, Appendix A, "General Design Criteria for Nuclear Power Plants" (G.D.C. 20 through 24) [Ref. 6] and IEEE Standard 279-1971 [Ref. 7] with the following guidance from the NRC staff for the application of Section 4.15, multiple setpoints, of the IEEE Standard:

Manual switching to the more restrictive setpoint for the APRMs in the reactor protection system is acceptable for BWRs if sufficient administrative controls exist to assure that the more restrictive setpoints are in effect when required by the plant Technical Specifications.

The NRC has defined sufficient administrative controls as:

1. There is to be an independent check of the gain or setpoint adjustment.
2. The check is to be within the next shift.
3. Checks are by appropriate technical individuals (e.g., shift supervisor or SRO).

The adjustments to the reactor protection system for single-loop operation (i.e., SCRAM trip setpoint adjustments or APRM gain adjustments) must be within and therefore satisfy the functional requirements of the reactor protection system.

2. EVALUATION AND RECOMMENDATIONS

The current DAEC-1 Technical Specifications do not permit single-loop plant operation at reduced power for more than 24 hours. The licensee's proposed technical specification changes would allow the reactor to operate at reduced power, not greater than 50%, with one recirculation loop inoperable for more than 24 hours if certain changes are made to the reactor protection systems. These changes are to the Average Power Range Monitor (APRM) SCRAM trip setpoint and the Rod Block Monitor (RBM) rod block setpoint or to the APRM gain.

A different flow pattern is established in the vessel during single-recirculation-loop operation as compared to the normal two-loop operation [Ref. 2]. In single-loop operation, there is backflow through the jet pumps in the idle loop. The jet pump core flow measurement system is calibrated only when both loops are in operation and all jet pumps are in forward flow. The total core flow is the sum of the measured jet pump flows. In single-loop operation, the measured flow in the backflowing jet pumps must be subtracted from the flow through the other jet pumps. Also, the jet pump flow coefficient is different for reverse flow than for forward flow in the jet pumps.

Because of the different flow rate and flow path during single-recirculation-loop operation, the APRM SCRAM trip settings, which are flow-biased according to the equation in the proposed technical specifications, require resetting to protect the reactor from overpower. The rod block setpoint equation is flow-biased in the same way and with the same flow signal as the APRM setpoint, and must also be modified to provide adequate core protection for a postulated rod withdrawal error. This change is effectively accomplished by an APRM gain adjustment.

The manual APRM gain adjustment to accommodate single-loop operation is the only change imposed upon the DAEC-1 reactor protection system (RPS). This modification adds the term 0.66 W to the APRM readings to compensate for backflow through the jet pumps of the idle loop. This change will not cause the RPS to violate General Design Criteria 20 to 24 of 10CFR50 Appendix A.

The licensee provided in a letter dated October 11, 1983 [Ref. 5] the administrative controls to be used to assure that the gain adjustments are performed correctly. The Duane Arnold staff will write a procedure which implements the requirements of the proposed single-loop operation. The multiple SCRAM trip setpoints will not be used to adjust the reactor protection system for single-loop operation. Instead, the APRM SCRAM and rod block settings will be effectively reset by the APRM gain adjustments. These gain adjustments for starting single-loop operation will be performed by the licensed reactor operator. A second reactor operator will independently review the settings as an administrative control. The Senior Reactor Operator and the Shift Technical Advisor will review the documentation. This meets the NRC definition for sufficient administrative controls.

3. CONCLUSIONS

Based on our review of the information and documents provided by the licensee in References 1 and 5, we conclude that the APRM gain adjustments for single-loop operation will satisfy the functional requirements of the reactor protection system.

The manual APRM gain adjustment settings to accommodate single-loop operation is the only change imposed upon the Duane Arnold Energy Center, Unit 1 reactor protection system (RPS) instrumentation. This change will not cause the RPS instrumentation system to violate 10CFR50 Appendix A General Design Criteria 20 through 24 [Ref. 6] or IEEE 279-1971 [Ref. 7] with the exception of the IEEE standard as discussed below.

Because of backflow through the jet pumps in the idle loop during single-recirculation-loop operation, indications in the control room of individual jet-pump flow and total summed core flow will be misleading. We recommend that these anomalous control room indications be corrected or warning-tagged for the duration of the single-recirculation-loop operation, as required by Section 4.20 of IEEE Standard 279-1971 [Ref. 7].

The administrative controls to be used by the licensee to assure the APRM gain adjustments are performed correctly meet the NRC criteria for sufficient administrative controls.

We recommend to the NRC, that upon implementation of the above recommended actions, the proposed electrical, instrumentation, and control design aspects of the proposed license amendment for single-recirculation-loop operation at Duane Arnold Energy Center, Unit 1 be found acceptable.

REFERENCES

1. Iowa Electric Light and Power Company letter (Richard McGaugh) to NRC (Harold Denton), "Single Recirculation Loop Operation," dated June 24, 1983.
2. General Electric Company, Nuclear Power Systems Division, "Duane Arnold Energy Center Single-Loop Operation," NEDO 24272, July, 1980.
3. Telephone conference call (Jack Donohew); IELPC (Tony Browning); LLNL (Terry Donich), September 15, 1983.
4. Telephone conference call (Jack Donohew); IELPC (Tony Browning); LLNL (Terry Donich), September 19, 1983.
5. Iowa Electric Light and Power Company letter (Richard W. McGaughy) to NRC (Harold Denton) HG-83-3374, "Additional Information on Single-Loop Operation," October 11, 1983.
6. Code of Federal Regulations, Title 10, Part 50, Apendix A, "General Design Criteria for Nuclear Power Plants," 1981.
7. IEEE Standard 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations," dated 1971.

TECHNICAL EVALUATION OF THE
ELECTRICAL, INSTRUMENTATION, AND CONTROL DESIGN ASPECTS
OF
THE PROPOSED LICENSE AMENDMENT REVISION 1 FOR SINGLE-LOOP OPERATION
OF
THE DUANE ARNOLD ENERGY CENTER

(Docket No. 50-331)

Terry R. Donich

Lawrence Livermore National Laboratory
Nuclear Systems Safety Program

August 1983

FIN A0250

Responsible NRC Individual and Division
Dick Clark
Division of Licensing

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ABSTRACT

This report documents the technical evaluation of the proposed changes to the plant reactor protection system by the licensee of Duane Arnold Energy Center to account for single-loop plant operation. This evaluation is restricted to only the electrical, instrumentation and control design aspects of proposed changes to the plant technical specifications for single-loop operation beyond 24 hours. The conclusion of the evaluation is that the Duane Arnold license amendment for single-loop operation has met the review criteria provided sufficient administrative controls are put into effect.

FOREWARD

This report is supplied as part of the Selected Operating Reactor Issues Program II being conducted for the U. S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, Division of Licensing, by Lawrence Livermore National Laboratory.

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I. INTRODUCTION

By letter to the U.S. Nuclear Regulatory Commission (NRC) dated June 24, 1983 [Ref. 1], the Iowa Electric Light and Power Company submitted information to support its proposed license amendment to operate the Duane Arnold Energy Center, Unit 1 (DAEC-1) with one recirculation loop out of service (i.e. single-loop operation). This request supercedes all other submittals. This information included the licensee's analysis of significant events, which were based on a review of accidents and abnormal operational transients associated with power operations in the single-loop mode provided by General Electric Company, Nuclear Energy Division (GE-NED), the nuclear steam supply system designer. Conservative assumptions were employed, as discussed in the GE-NED report NEDO-24272 dated July, 1980 [Ref. 2], to ensure that the generic analyses for boiling water reactors (BWR 3 and/or 4) were applicable to the DAEC-1.

The purpose of this report is to document the evaluation of the electrical, instrumentation, and control (EI&C) design aspects of the proposed license amendment change to the DAEC-1 technical specifications. The consideration of proper plant variables, computer models, and the licensee's conclusions on core performance and clad temperature are outside the scope of this evaluation. This review was conducted using 10CFR50, Appendix A, "General Design Criteria for Nuclear Power Plants" (G.D.C. 20 through 24) [Ref. 3] and ANSI/IEEE Std 279-1971 [Ref. 4] with the following guidance from the NRC staff for the application of Section 4.15 of the ANSI/IEEE Standard:

Manual switching to the more restrictive setpoint for the APRMs in the reactor protection system is acceptable for BWRs if sufficient administrative controls exist to assure that the more restrictive setpoints are in effect when required by the plant Technical Specifications.

II. EVALUATION AND RECOMMENDATIONS

The current DAEC-1 Technical Specifications do not permit single-loop plant operation at reduced power for more than 24 hours. The licensee's proposed Technical Specification changes would allow the reactor to operate at reduced power (not greater than 50%) with one recirculation loop inoperable for more than 24 hours if certain changes are made to the reactor protection systems. These changes are to the Average Power Range Monitor (APRM) SCRAM trip setpoint and the Rod Block Monitor (RBM) rod block setpoint.

A different flow pattern is established in the vessel during single recirculation loop operation as compared to the normal two-loop operation [Ref. 2]. In single-loop operation, there is backflow through the jet pumps in the idle loop. The jet pump core flow measurement system is calibrated only when both loops are in operation and all jet pumps are in forward flow. The total core flow is the sum of the measured jet pump flows. In single-loop operation, the measured flow in the backflowing jet pumps must be subtracted from the flow through the other jet pumps. Also, the jet pump flow coefficient is different for reverse flow than for forward flow in the jet pumps. Because of the different flow rate and flow path during single recirculation loop operation, the APRM SCRAM trip settings, which are flow-biased according to the equation in the proposed technical specifications, require resetting to protect the reactor from overpower. The rod-block setpoint equation is flow biased in the same way and with the same flow signal as the APRM setpoint, and must also be modified to provide adequate core protection for a postulated rod withdrawal error.

The licensee indicated that DAEC-1 Procedure was recently modified to include the APRM gain adjustment to account for single-loop operation. The licensee did not state what administrative controls were to be used to assure that the gain adjustments are performed correctly. We recommend that the licensee provide NRC documentation to ensure the necessary APRM gain adjustments have sufficient administrative controls, and are therefore, consistent with Section 4.18 of 10CFR 50.279-1971.

The Manual APRM gain adjustment to accommodate single-loop operation is the only change imposed upon the DAEC-1 reactor protection system (RPS). This modification adds the term 0.66 kW to the APRM readings to compensate for backflow through the jet pumps of the idle loop. This change will not cause the RPS to violate General Design Criteria 20 to 24 of 10CFR50 Appendix A.

III. CONCLUSIONS

Based on our review of the information and documents provided by the licensee in Ref. 1, we conclude that the more conservative reactor protection system (RPS) setpoint trips for the APRM and RBM will satisfy the functional requirements (i.e., parameters to be monitored, setpoints, etc.) for single-recirculation-loop operation.

The manual APRM gain adjustment settings to accommodate single-loop operation is the only change imposed upon the Duane Arnold Energy Center-1 reactor protection system (RPS) instrumentation. This change will not cause the RPS instrumentation system to violate 10CFR50 Appendix A General Design Criteria 20 through 24 [Ref. 3] or IEEE-279-1971 [Ref. 4] with the exception of the IEEE standard discussed below.

Because of backflow through the jet pumps in the idle loop during single-recirculation-loop operation, indications in the control room of individual jet-pump flow and total summed core flow will be misleading. We recommend that these anomalous control room indications are corrected or warning-tagged for the duration of the single-recirculation-loop operation, as required by section 4.20 of IEEE Std-279-1971 [Ref. 4].

We recommend that the licensee provide assurance that manual switching to the more restrictive setpoint for the APRMs has sufficient administrative controls to assure that the more restrictive setpoints are in effect when required by the plant Technical Specifications.

We recommend that the NRC accept, upon successful implementation of the above recommended actions, the proposed licensee amendment for single-recirculation-loop operation at Duane Arnold Energy Center-1.

REFERENCES

(Duane Arnold Energy Center-1)

- (1) Iowa Electric Light and Power Company Letter (Richard McGaugh) to NRC (Harold Denton), "Single Recirculation Loop Operation" dated June 24, 1983.
- (2) General Electric Company, Nuclear Power Systems Division, "Duane Arnold Energy Center Single-Loop Operation", NEDO 24272, July 1980.
- (3) Code of Federal Regulations, Title 10, Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants", 1981.
- (4) IEEE Std-279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations", dated 1971.



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

FEB 2 1984

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VASSALCO

MEMORANDUM FOR: G. C. Laines, Assistant Director
for Operating Reactors, DL

FROM: L. S. Rubenstein, Assistant Director
for Core and Plant Systems, DSI

SUBJECT: SLO OPERATION SER'S

As discussed in our meeting of January 26, we are withdrawing our SER approvals for all the plants currently requesting permanent SLO. This decision is based on new data which indicates the potential for local thermal hydraulic instabilities which would not be detected by only monitoring APRM flux noise, which we previously recommended.

We are continuing to evaluate this problem and expect to establish criteria for acceptable SLO in the near future.

L. S. Rubenstein
L. S. Rubenstein, Assistant Director
for Core and Plant Systems, DSI

cc: R. Mattson
D. Eisenhut
L. Phillips
R. Lobel

Contact: G. Schwenk, CPB:DSI
X-29421

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