

TECHNICAL EVALUATION REPORT ON THE  
ELECTRICAL, INSTRUMENTATION, AND CONTROL  
DESIGN ASPECTS OF THE PROPOSED LICENSE  
AMENDMENT REVISION 1 FOR SINGLE-LOOP  
OPERATION OF THE  
PILGRIM NUCLEAR POWER STATION, UNIT 1

(Docket No. 50-293)

Terry R. Donich

December 14, 1983



This is an informal report intended primarily for internal or limited external distribution. The opinions and conclusions stated are those of the author and may or may not be those of the Laboratory.

This work was supported by the United States Nuclear Regulatory Commission under a Memorandum of Understanding with the United States Department of Energy.

NRC FIN No. A-0250

8406070246 840319  
PDR FOIA  
BELL84-105 PDR

## ABSTRACT

This report documents the technical evaluation of the proposed changes to the plant reactor protection system by the licensee of Pilgrim Nuclear Power Station, 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 Pilgrim Nuclear Power Station, Unit 1, 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 operations and the title or position of the appropriate technical individual to make the independent check of the setpoint adjustment be identified.

## 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.

TABLE OF CONTENTS

|   | Page |
|---|------|
| 1. INTRODUCTION . . . . .                   | 1    |
| 2. EVALUATION AND RECOMMENDATIONS . . . . . | 2    |
| 3. CONCLUSIONS . . . . .                    | 3    |
| REFERENCES . . . . .                        | 4    |

TECHNICAL EVALUATION REPORT ON THE ELECTRICAL,  
INSTRUMENTATION, AND CONTROL DESIGN ASPECTS OF  
THE PROPOSED LICENSE AMENDMENT REVISION 1  
FOR SINGLE-LOOP OPERATION OF THE  
PILGRIM NUCLEAR POWER STATION, UNIT 1

(Docket No. 50-293)

Terry R. Donich

Lawrence Livermore National Laboratory

1. INTRODUCTION

By letter to the U. S. Nuclear Regulatory Commission (NRC) dated May 12, 1981 [Ref. 1], the Boston Edison Power Company submitted information to support its proposed license amendment to operate the Pilgrim Nuclear Power Station, Unit 1 (PNPS-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-24268 dated June, 1980 [Ref. 2] to ensure that the generic analyses for boiling water reactors (BWR 3 and/or 4) were applicable to the PNPS-1. In response to an NRC request, the licensee provided supplemental information in a letter dated April 11, 1983 [Ref. 3] and a conference call on September 27, 1983 [Ref. 4]. A letter to NRC documenting the conference call was dated October 25, 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 PNPS-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 Std 279-1971 [Ref. 7] with the following guidance from the NRC staff for the application of Section 4.15, Multiple Set Points, 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 S.R.O.).

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 PNPS-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 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 back-flowing 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 accomplished by adjusting the trip setpoints.

The manual adjustment of the trip setpoints to accommodate single-loop operation is the only change imposed upon the PNPS-1 reactor protection system (RPS). This modification subtracts the term 0.65W from the trip setpoints to compensate for backflow through the jet pumps in the idle loop. This change is similar to one which is routinely made to adjust for peaking factors in excess of design [Ref. 4]. The licensee stated that sufficient range exists in the settings to make the necessary changes to the RPS for single-loop operation [Ref. 3]. 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 25, 1983 [Ref. 5] the draft procedures which includes the administrative controls to be used to assure that the trip setpoint adjustments are performed correctly. The multiple scram trip setpoints will be used to adjust the reactor protection system for single-loop operation. These adjustments for starting single-loop operation will be performed by a technician. A second person will independently review the settings as an administrative control. The NRC definition for sufficient administrative controls defines the second person as a person "such as a shift supervisor or senior reactor operator." We recommend that the licensee change the procedure to include the position or title of the person who will independently review the settings.

### 3. 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 for single-recirculation-loop operation.

The manual adjustment of the trip setpoints to accommodate single-loop operation is the only change imposed upon the Pilgrim Nuclear Power Station 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 the backflow through the jet pumps during single-recirculation-loop operation, indications in the control room of individual jetpump 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 Std 279-1971 [Ref. 7].

The administrative controls to be used by the licensee to assure the trip setpoint adjustments are performed correctly meet the NRC criteria for sufficient administrative controls except that the appropriate position or title of the individual to make the independent check of the setpoint adjustments should be defined.

We recommend that the NRC accept, upon successful implementation of the above recommended action, the proposed licensee amendment for single-recirculation-loop operation at Pilgrim Nuclear Power Station, Unit 1.

#### REFERENCES

1. Boston Edison Company letter (J. Edward Howard) to NRC (Thomas Ippolito), "Revised Request for Technical Specification Changes Concerning Single Loop Operations," dated May 12, 1981.
2. General Electric Company, Nuclear Power Systems Division, "Pilgrim Nuclear Power Station Single-Loop Operation," NEDO 24268, June 1980.
3. Boston Edison Company letter (William D. Harrington) to NRC (Dominic B. Vassallo), "Single-Loop Operation for Pilgrim Nuclear Power Station, Response to Questions," dated April 11, 1983.
4. Telephone conference call NRC (Jack Donohew); BECO (Marie Lenhart, Paul Smith, John Abaltin); LLNL (Terry Donich), September 27, 1983.
5. Boston Electric Company letter (William D. Harrington) to NRC Operating Reactors Branch (Dominic B. Vasallo, Chief), "Single Loop Operation," dated October 25, 1983.
6. Code of Federal Regulations, Title 10, Part 50, Appendix A, "General Design Criteria for Nuclear Power Plants," 1981.
7. IEEE Std 279-1971, "Criteria for Protection Systems for Nuclear Power Generating Stations," dated 1971.

## DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government thereof, and shall not be used for advertising or product endorsement purposes.

Printed in the United States of America  
Available from  
National Technical Information Service  
U.S. Department of Commerce  
5235 Port Royal Road  
Springfield, VA 22161  
Price: Printed Copy \$      ; Microfiche \$4.50

| Page Range | Domestic<br>Price | Page Range          | Domestic<br>Price |
|------------|-------------------|---------------------|-------------------|
| 001-025    | \$ 7.00           | 326-350             | \$ 26.50          |
| 026-050    | 8.50              | 351-375             | 28.00             |
| 051-075    | 10.00             | 376-400             | 29.50             |
| 076-100    | 11.50             | 401-426             | 31.00             |
| 101-125    | 13.00             | 427-450             | 32.50             |
| 126-150    | 14.50             | 451-475             | 34.00             |
| 151-175    | 16.00             | 476-500             | 35.50             |
| 176-200    | 17.50             | 501-525             | 37.00             |
| 201-225    | 19.00             | 526-550             | 38.50             |
| 226-250    | 20.50             | 551-575             | 40.00             |
| 251-275    | 22.00             | 576-600             | 41.50             |
| 276-300    | 23.50             | 601-up <sup>1</sup> |                   |
| 301-325    | 25.00             |                     |                   |

<sup>1</sup>Add 1.50 for each additional 25 page increment, or portion thereof from 601 pages up.



*Technical Information Department* - Lawrence Livermore Laboratory  
University of California - Livermore, California 94550