February 12, 1987

Docket No. 50-336

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Mr. Edward J. Mroczka, Senior Vice President
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Dear Mr. Mroczka:

We have completed our evaluation of the Millstone Unit 2 Safety Parameter Display System (SPDS) which is addressed by TMI Action Item I.D.2. As indicated in the enclosed Safety Evaluation, we conclude that no serious safety questions are posed by the proposed SPDS and, therefore, your implementation of the SPDS may continue. An SPDS implementation date of March 25, 1987 for full operability of the SPDS continues to be acceptable.

Sincerely,

/s/

D. H. Jaffe, Project Manager
PWR Project Directorate #8
Division of PWR Licensing-B

Enclosure:
As stated

cc w/enclosure:
See next page

PBD-8:	PBD-8:	PBD-8:
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Millstone Nuclear Power Station
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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

NORTHEAST NUCLEAR ENERGY COMPANY, ET AL.

MILLSTONE NUCLEAR POWER STATION, UNIT NO. 2

DOCKET NO. 50-336

SAFETY PARAMETER DISPLAY SYSTEM (TMI ITEM I.D.2)

1.0 INTRODUCTION

All holders of operating licenses issued by the Nuclear Regulatory Commission (licensees) and applicants for an operating license must provide a Safety Parameter Display System (SPDS) in the control room of their plant. The Commission-approved requirements for the SPDS are defined in Supplement 1 to NUREG-0737 (Reference 1).

The purpose of the SPDS is to provide a concise display of critical plant variables for control room operators to aid them in rapidly and reliably determining the safety status of the plant. NUREG-0737, Supplement 1, requires licensees and applicants to prepare a written safety analysis describing the basis on which the selected parameters are sufficient to assess the safety status of each identified function for a wide range of events, which include symptoms of severe accidents. Licensees and applicants shall also prepare an Implementation Plan for the SPDS, which contains schedules for design, development, installation, and full operation of the SPDS as well as a design Verification and Validation Plan. The Safety Analysis and the Implementation Plan are to be submitted to the NRC for staff review.

Prompt implementation of the SPDS in operating reactors is a design goal of prime importance. The review of human factors design of the SPDS for operating reactors called for in NUREG-0737, Supplement 1, is designed to avoid delays resulting from the time required for NRC staff review. The NRC staff will not review operating reactor SPDS designs for compliance with the requirements of Supplement 1 of NUREG-0737 prior to implementation unless a pre-implementation review has been specifically requested by licensees. The licensee's Safety Analysis and SPDS Implementation Plan will be reviewed by the NRC staff only to determine if a serious safety question is posed or if the analysis is seriously inadequate. The NRC staff review to accomplish this will be directed at (1) confirming the adequacy of the parameters selected to be displayed to detect critical safety functions, (2) confirming that means are provided to assure that the data displayed are valid, (3) confirming that the licensee has committed to a human factors program to ensure that the displayed information

can be readily perceived and comprehended so as not to mislead the operator, and (4) confirming that the SPDS will be suitably isolated from electrical and electronic interference with equipment and sensors that are used in safety systems. If, based on this review, the staff identifies serious safety questions or seriously inadequate analyses, the Director of IE or the Director of NRR may require or direct the licensee to cease implementation.

2.0 SUMMARY

The staff reviewed Northeast Utilities' SPDS Safety Analysis for Millstone Unit 2. Based on the results of the review, it is concluded that no serious safety questions are posed by the proposed SPDS, and therefore, implementation of the SPDS by the licensee may continue.

3.0 EVALUATION

3.1 Background

The staff evaluated Northeast Nuclear Energy Company's Safety Analysis Report (Reference 2) on the Millstone Unit 2 SPDS. The information contained in the analysis was insufficient for the staff to complete its evaluation. The staff generated a request for additional information, which was forwarded to the licensee. In a letter dated October 8, 1986, the licensee responded with the additional information needed by the staff to complete its review. The staff's evaluation of the Millstone 2 SPDS follows.

3.2 Description

The Millstone 2 SPDS is driven by the plant's process computer. The SPDS displays safety function information on colorgraphic terminals located in the control room. The SPDS monitors the status of the safety functions continuously. The primary users of the SPDS within the control room are the Shift Supervisor and the Supervising Control Operator.

The SPDS represents one part of an integrated emergency response capability. It will be consistent with the Emergency Operating Procedures (EOP's) and the Operators Training Program. For Millstone 2, the EOP's are based upon the Combustion Engineering Owners Group Emergency Procedure Guidelines.

In the safety analysis, the licensee states that the SPDS is being designed to complement the EOPs. It is not intended that the SPDS be necessary for EOP execution. The major use of the SPDS during emergency conditions will be to independently monitor the safety status of the plant and alert the operator if the safety function status degrades.

In doing this, it allows the operator to rapidly evaluate the safety functions. The SPDS has the capability to store monitored plant variables for the interval of 2 hours pre-event to 12 hours post-event.

The SPDS will be strictly a monitoring device. Therefore, it cannot affect any of the accidents analyzed in the FSAR nor can it affect any of the barriers between the nuclear fuel and the public. Based on this data, the licensee states that the SPDS will not increase the possibility of occurrence of any previously analyzed accident nor decrease the margin of safety as defined in the basis for any technical specification. The licensee also concludes that implementation of the SPDS will not constitute an unreviewed safety question as defined in 10 CFR 50.59.

3.3 Parameter Selection

Section 4.1f of Supplement 1 to NUREG-0737 states that:

The minimum information to be provided shall be sufficient to provide information to plant operators about:

(i) Reactivity control

(ii) Reactor core cooling and heat removal from the primary system

(iii) Reactor coolant system integrity

(iv) Radioactivity control

(v) Containment conditions

For review purposes, these five items have been designated as Critical Safety Functions.

The safety analysis states that by design, the SPDS safety functions and variables are those of the Millstone 2 EOP's. These EOP's are based on the generic Combustion Engineering EPG's, which have been previously accepted for implementation by the NRC (Reference 4). The staff requested the licensee to compare the Millstone 2 Safety Functions with the Critical Safety Functions defined in NUREG-0737, Supplement 1. The licensee's response (Reference 3) provided the following data:

Millstone 2 Safety Functions	NUREG-0737, Supplement 1 Critical Safety Functions
1) Reactivity Control	Reactivity Control

2) Reactor Coolant System Inventory Control	Reactor Core Cooling
3) Reactor Coolant System Pressure Control	Reactor Coolant System Integrity
4) Reactor Coolant System Heat Removal	Heat Removal from the Primary System
5) Containment Integrity	Containment Conditions and Radioactivity Control
6) Vital Auxiliaries	(no comparable CSF)

With the above data, the staff then proceeded to review the variables selected by the licensee for each of the Critical Safety Functions identified in NUREG-0737, Supplement 1. A list of the variables used for Safety Function monitoring, as identified by the licensee, is presented in Table I.

The staff reviewed the variables selected by the licensee for each of the Safety Functions. We found that the variables selected did provide the minimum information needed by an operator to evaluate the functions, but with one exception: steam generator radiation. In the safety analysis, the licensee states that steam generator radiation is not currently monitored at the plant. Subsequently, during a February 6, 1987 telephone conversation between D. H. Jaffe of NRC and E. Perkins of NNECo, Mr. Perkins confirmed that a steam generator radiation monitoring capability was installed during the recent refueling outage.

Based upon our review of the variables selected by the licensee for display in the SPDS, the staff confirms that the variables are adequate to evaluate the status of the critical safety functions required by the NRC.

3.4 Display Data Validation

Sensor signals used by the SPDS will undergo pass/fail processing, range limit checking, and signal validation before being used in the algorithms to determine the status of the safety functions. The quality of a parameter is indicated by its quality tag. All SPDS parameters, including derived variables, carry a three stage quality tag: validated, unvalidated, and invalid. The quality tags assigned by the signal validation algorithms are: a blank for valid data, a U for unvalid data, and an N for invalid data. These quality tags are displayed in magenta to the left of the parameter value.

The approach to signal validation in the Millstone 2 SPDS is based on the parity space concept for fault detection and isolation. The PARITY software module, which was developed at C.S. Draper Laboratory for nuclear plant applications, is adapted for use in the Millstone 2 plant process computer. The standard use of PARITY is to evaluate each plant parameter based on three to five redundant sensor signals, and to provide a composite best estimate of the parameter along with an indication of the quality of the estimate. Additional software was developed to make non-standard decisions, to revise the quality tag for each inconsistent sensor signal, and to estimate parameters having only two redundant sensor signals.

Some plant variables are represented by a single sensor signal. The only information items to determine validity of such signals are pass/fail processing (signal is in/out of scan) and limit checking data (in/out of range). The sensor signal is given a quality tag as follows: a blank for valid data if in scan and in range, a U for unvalid data if the signal is out of range, and an N if the signal is not in scan.

Based upon our review of the information on data validation provided by the licensee, the staff concludes that a comprehensive method is being used to validate data. Also, the staff confirms that means are provided to assure that the data displayed are valid.

3.5 Human Factors Program

The SPDS information may be displayed on any of the colorgraphic CRT's connected to the Integrated Computer System. This arrangement permits the control room operating crew to move freely around the control room and still have access to SPDS information.

The SPDS displays are arranged in a three-level hierarchy. Level I consists of an overview display for each of the seven Emergency Operating Procedures. Level II consists of the six Safety Function displays for each of the six safety functions. The six safety function status boxes are integral with every display page.

Each EOP has one Overview display, six Safety Function displays, and six Sensor Data displays associated with it. The human factors guidelines contained in NUREG-0835 were used in developing the display hierarchy.

To reduce the potential for clutter and other human engineering discrepancies, all SPDS displays were designed on colorgraphic display terminals. Each display was reviewed by a design team, which included a senior licensed operator, a human factors expert, and other operations-oriented personnel. The team would identify the need for change and the displays would be revised accordingly. This process was repeated until all team members agreed that each display met the needs of the operating crew.

Trend arrows and colorgraphic trend displays are used to display trend information. Eighteen predefined SPDS trend displays are available for use by the operating crew. The safety analysis states that the update rate for SPDS parameters being trended is consistent with the operator's information and control requirements derived from the control room design review. That is, the trend information provided by the SPDS will be consistent with the information provided by the control board instruments.

Based on the review of the information contained in the licensee's safety analysis, the staff confirms that human factors engineering was an integral part of the licensee's SPDS design process.

3.6 Verification and Validation Program

The licensee's safety analysis describes a Verification and Validation Program. The system functional requirements are the foundation on which the SPDS will be designed, built, installed, and accepted. The system design will be validated against the functional requirements. SPDS functional requirements will be verified against the criteria of Supplement 1 to NUREG-0737.

After verification of the functional and design requirements, other design documentation will be verified for accurate and complete translation of the requirements from various tasks in the design process to the subsequent tasks in the design process. Verification will include a correlation between the design features and the requirements.

SPDS validation will be conducted using a combination of the three levels listed below:

a. Factory Testing

SPDS software and hardware may be integrated for functional testing prior to site installation. Testing will be conducted for appropriate hardware, software, and system functions in accordance with a systematic test plan.

b. Installation and Acceptance Testing

After SPDS installation in the plant has been completed, functional testing will be performed to demonstrate correct operation of the installed SPDS hardware and software. End-to-end checkouts of all SPDS inputs and outputs will be performed. These checkouts will cover from sensor signal input to SPDS variable display.

c. Man-in-the-Loop Evaluation

Operations personnel, trained in EOP's, will review SPDS displays and interfaces. The objective of the evaluation will be to review the SPDS design as a potential aid to emergency response by operations personnel.

Based on the review of the information on the Verification and Validation Program, the staff confirms that an adequate program exists for the design and development of the SPDS.

3.7 Electrical and Electronic Isolation

The licensee's safety analysis report did not address the requirement that the SPDS must be isolated from equipment and sensors that are used in safety systems to prevent electrical and electronic interference. A request for additional information (RAI) (Reference 5) on the isolators was forwarded to the licensee. The licensee responded to the RAI by letter dated July 31, 1986 (Reference 6). The staff held several telephone conferences with the licensee to discuss the response. The discussions resulted in additional submittals from the licensee dated October 24, 1986 (Reference 7) and November 13, 1986 (Reference 8). Our review of the information contained in these submittals relative to the qualification of the isolators as acceptable interface devices between Class 1E safety-related instrumentation systems and the SPDS follows next.

The electrical isolation devices used at Millstone 2 are Foxboro Spec 200, Model N-2AO-VAI and Energy Incorporated (EI) Model 00993. The Foxboro isolator has been previously reviewed and approved by the staff (Reference 9).

The EI analog isolators use a Burr-Brown optical isolator for Class IE (input) to non-Class 1E (output) isolation. The isolators were subjected to functional tests and a common failure isolation test. The isolators successfully passed the functional tests.

The common failure isolation test verified the device's capability to isolate input when the output is faulted under various conditions. The output fault conditions included an output open circuit test, an output short circuit test, and the maximum credible fault (MCF) test. The MCF test was applied to the output in the transverse mode between the plus and minus terminals.

The MCF voltages and potential current analyzed for Millstone Unit 2 are 120 VAC and 125 VDC, both at a potential current of 20 amperes. The pass/fail acceptance criterion for the common failure isolation tests was that there shall be no measurable effect on the isolator's Class 1E input, as monitored with a digital oscilloscope upon the application of the MCF voltage to the non-Class 1E output of the isolator.

The isolators were subjected to MCF voltage tests of 140 VAC and 140 VDC with the current limited to 20 amperes. The isolators met the pass/fail criteria.

In addition to the tests previously mentioned, the isolators were qualified to IEEE-381-1977, "Standard Criteria for Type Tests of Class 1E Modules used in Nuclear Power Generating Stations." The isolators are located in a mild environment and, therefore, they do not come under the requirements of 10 CFR 50.49. The isolators comply with the seismic design bases for Millstone Unit 2.

Based on the staff's review of the licensee's submittals with respect to the Class 1E electrical isolation devices and on the prior review and acceptance of identical isolators at other plants, the staff concludes that these devices are qualified isolators acceptable for interfacing the SPDS with Class 1E systems. The staff also concludes that these isolation devices meet the Commission's requirements stated in NUREG-0737, Supplement 1.

3.8 Inadequate Core Cooling Instrumentation

The staff's safety evaluation of TMI Action Item II.F.2, Instrumentation for Detection of Inadequate Core Cooling, is presented in Reference 10. The safety evaluation identified an issue associated with inadequate core cooling instrumentation (ICCI) that was to be resolved with the SPDS review. This issue, as stated in Reference 10, is:

"The final ICCI display will be incorporated in the SPDS. Schedular and technical aspects of the SPDS are incorporated in its own review."

By letter dated December 23, 1986, the licensee provided the staff with information on how data from the inadequate core cooling instrumentation is incorporated in the SPDS (Reference 11). This letter contained copies of display formats of dedicated inadequate core cooling (ICC) displays as well as SPDS display formats that contained ICC data. Also, information on the keyboard by which both the SPDS and the ICC displays are accessed was presented.

The staff reviewed these display formats and confirmed that ICC data was incorporated into the SPDS displays; thus, this issue will be fully resolved when the SPDS becomes operational. A license condition for Operating License No. DPR-65 for Millstone Unit 2 states that the SPDS is required to be operational by March 25, 1987. The licensee states that the final displays will be in place at that time. This implementation date continues to be acceptable to the NRC staff.

4.0 CONCLUSION

The NRC staff reviewed Northeast Utilities' Millstone Unit 2's safety analysis to confirm the adequacy of the variables selected to be displayed to monitor critical safety functions, to confirm that means are provided to assure that the data displayed are valid, to confirm that the licensee has committed to a Human Factors Program, to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator, and to confirm that the SPDS is suitably isolated. Based on its review to date, the staff concludes that no serious safety questions are posed by the proposed SPDS and therefore, the implementation of the SPDS by the licensee may continue.

In a review of some of the display formats within the SPDS, the staff confirms that data from the inadequate core cooling instrumentation is displayed. The display of this data resolves a previous staff concern related to inadequate core cooling as described in our letter of August 28, 1986.

The conclusions that SPDS implementation may continue does not imply that the SPDS meets or will meet the requirements of Supplement 1 to NUREG-0737. Such confirmation can be made only after a post-implementation audit.

Licensees are required to inform the Commission, in writing, of any significant changes in the estimated completion schedule identified in the staff's safety evaluation and when the action has actually been completed.

An SPDS implementation date of March 25, 1987, for full operability of the SPDS continues to be acceptable.

5.0 REFERENCES

1. U.S. Nuclear Regulatory Commission, "Clarification of TMI Action Plan Requirements, Requirements For Emergency Response Capability," U.S. NRC Report NUREG-0737, Supplement 1, January 1983.

2. Letter from W.G. Council, Northeast Nuclear Energy Company, to J.R. Miller, NRC, Subject: Safety Parameter Display System Safety Analysis Report, dated March 25, 1985.

3. Letter from W.G. Council, Northeast Nuclear Energy Company, to A.C. Thadani, NRC, Subject: Safety Parameter Display System, dated October 8, 1986.

4. Safety Evaluation of "Emergency Procedure Guidelines," Generic Letter 83-23, dated July 29, 1983.

5. Letter from A.C. Thadani, NRC, to J.F. Opeka, Northeast Nuclear Energy Company, Subject: Request for Additional Information, SPDS, dated February 11, 1986.

6. Letter from J.F. Opeka, Northeast Nuclear Energy Company, to A.C. Thadani, NRC, Subject: Safety Parameter Display System, dated July 31, 1986.

7. Letter from J.F. Opeka, Northeast Nuclear Energy Company, to A.C. Thadani, NRC, Subject: Safety Parameter Display System, dated October 24, 1986.

8. Letter from J.F. Opeka, Northeast Nuclear Energy Company, to A.C. Thadani, NRC, Subject: Safety Parameter Display System, dated November 13, 1986.

9. Memorandum from F. Rosa, NRC, to W. Regan, NRC, Subject: Millstone 3 - Review of Isolation Devices that Interface with the SPDS, dated July 15, 1985.

Date: February 12, 1987

Principal Contributor:
L. Beltracchi

TABLE I
SPDS PROCESS VARIABLES

I. REACTIVITY CONTROL

1.	Reactor Power:	Power Range
		Wide Range Extended Range Fission Detector
2.	CEA Position	Dropped Rod Signal
3.	BAST Level	#1 #2
4.	Charging	Flow Pump Status
5.	SIS Flow	HPSI LPSI
6.	RWST Level	
7.	Reactor Trip	Trip Circuit Breakers Annunciator
8.	Cold Leg Temperature	Loop 1 Loop 2
		Loop 1 (wide range) Loop 2 (wide range)

II. INVENTORY CONTROL

1.	Pressurizer Level	
2.	Unheated Junction Thermocouples	Top 2 from each train
3.	Cold Leg Temperature	
4.	Hot Leg Temperature	Loop 1 Loop 2
		Loop 1 (wide range) Loop 2 (wide range)
5.	Incore Thermocouple	

6. Charging Flow

7. RWST Level

8. Pressurizer Pressure — High Range, Low Range, Wide Range

9. Reactor Vessel Level — Train 1, Train 2

10. Reactor Trip

III PRESSURE CONTROL

1. Pressurizer Pressure

2. Unheated Junction Thermocouple

3. Cold Leg Temperature

4. Hot Leg Temperature

5. Incore Thermocouple

6. Charging Flow

7. Reactor Trip

IV. REACTOR COOLANT SYSTEM HEAT REMOVAL

1. Hot Leg Temperature

2. Cold Leg Temperature

3. Steam Generator Level, SG1, SG2

4. CST Level

5. Incore Thermocouple

6. Charging Flow

7. Steam Generator Pressure, SG1, SG2

8. Pressurizer Pressure

9. PORV Acoustic Monitor, PORV 2-RC-402
PORV 2-RC-404

10. Reactor Trip

11. Main Feedwater Flow, SG1, SG2

12. Aux. Feedwater Flow, SG1, SG2

V. CONTAINMENT INTEGRITY

1. Containment Pressure, Narrow Range
   Wide Range

2. Containment Temperature

3. SG Blowdown Rad Monitor

4. Containment Area Rad Monitor

5. SJAE Rad Monitor

6. Stack Radiation Monitor, Wide Range, Unit 1, Unit 2

7. Containment Normal Sump Level

8. Containment Hydrogen Concentration

9. Main Steam Line #1 Rad Monitor

10. Atmospheric Dump Valve #1 Rad Monitor

11. Main Steam Line #2 Rad Monitor

VI. VITAL AUXILIARIES

1. Bus 24C Voltage

2. Bus 24D Voltage

3. Bus 201A Voltage

4. Bus 201B Voltage

5. Instrument Air Pressure