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

SAFETY EVALUATION REPORT INPUT

FOR THE JAMES A. FITZPATRICK NUCLEAR POWER PLANT

SAFETY PARAMETER DISPLAY SYSTEM

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 to control room operators to aid them in rapidly and reliably determining the safety status of the plant. NUREG-037, 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. The results from the staff's review are to be published in a Safety Evaluation Report (SER).

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 analysis, the Director of the Office of Nuclear Reactor Regulation may require or direct the licensee to cease implementation.

2.0 SUMMARY

The staff reviewed the Power Authority of the State of New York (PASNY) SPDS Safety Analysis for the FitzPatrick Plant and additional information submitted on November 1, 1985. Based on the results of the review, we conclude that no serious safety questions are posed by the proposed SPDs, and therefore, implementation of the SPDS may continue.

The licensee evaluated the design and function of the SPDS to determine if unreviewed safety questions are involved. Based on the results of the evaluation, the licensee determined that the SPDS does not involve an unreviewed safety question.

The staff was supported by Science Applications International Corporation (SAIC) in the performance of this review. SAIC prepared the Technical Evaluation Report (TER), Attachment 1 to the SER. The staff agrees with the technical positions and conclusions as presented in the TER.

3.0 EVALUATION

3.1 Background

On November 30, 1984 the Power Authority of the State of New York submitted a Safety Analysis on the SPDS (Reference 2). The staff reviewed the analysis and because of insufficient information, was unable to complete the review. A request for additional information (Reference 3) was forwarded to the licensee and the licensee's response (Reference 4) was evaluated by the staff. This safety evaluation describes the results of the staff's review of the material identified.

3.2 Description

The licensee's SPDS is computer based and consists of a single display page that is a module within a larger plant system called the Emergency and Plant Information Computer (EPIC). The EPIC provides a multicolor CRT-based interface with multiple fixed format graphic displays. These displays are arranged in a structured hierarchy for efficient operator access. The SPDS display consists of a presentation of critical plant variables and is intended to provide an overall status of plant safety functions. EPIC also allows for quick access to lower level displays, which provide more detailed information, but are not formally defined as part of the SPDS. The SPDS portion of the EPIC system has recently been installed and is functioning.

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 (CSFs).

In the staff's evaluation of the parameters selected by the licensee for display in the SPDS, we have considered the Boiling Water Reactor Owners' Group (BWROG) Emergency Procedure Guidelines (EPGs) as a principal technical source of parameters important to operational safety.

Based on the staff's review of the licensee's supporting analyses, and our observation that the selected variables appear to be consistent with the BWROG, we find the proposed list of variables to be generally acceptable. However, as noted in our request for additional information (Reference 3), the staff believes that the licensee must add certain variables in order to achieve the functions required for an acceptable SPDS. These variables are:

- Primary Containment Radiation
- Combustible Gas Concentration in Primary Containment
- Source Range Monitors

In its response to our request for additional information (Reference 4) the licensee argued that because these variables are not included in the presently approved EPG's, they need not be included on SPDS. The NRC staff does not agree.

Primary Containment Radiation is essential for monitoring the radioactivity control function because it provides containment radiation status under containment isolation conditions. The licensee has not adequately justified that its SPDS provides this function. Therefore, the staff requires that this variable or an equivalent variable (or set of variables) be added to the SPDS, or the licensee should provide further justification explaining why the variable is inappropriate for the FitzPatrick plant.

Reference to variables identified in the EPGs is not adequate justification for omitting variables on SPDS. The staff considers the EPG entry conditions to be a necessary but not sufficient set of variables with respect to SPDS functions.

Combustible Gas Concentration in Primary Containment is essential for monitoring containment conditions because of the potential for hydrogen deflagration. Therefore, the licensee should add these variables to the SPDS, or provide further justification why these variables are inappropriate for the FitzPatrick plant. As stated above, the staff does not accept the justification that variables not included as entry conditions to the EPGs may be omitted.

Source Range Monitors are essential for monitoring reactivity status during startup and shutdown. Control rod position is not equivalent because actual power level is still indeterminate when insertion is incomplete. Therefore, in order to provide a measure of reactivity covering the expected, normal power range down to and including zero power, the licensee should add source range monitors or an equivalent parameter, or further justify why this variable is inappropriate for the FitzPatrick plant.

A fourth parameter, containment isolation, was also requested by the staff in Reference 3. The licensee has committed in its letter of November 1, 1985 (Ref. 4) to add containment isolation status to its SPDS. The NRC staff concurs with this decision.

Based upon our review of the safety analysis and PASNY's response to our request for additional information, we confirm that the parameters selected for display do not pose a serious safety problem. However, they are not adequate to fully monitor the critical safety functions required by Supplement 1 to NUREG-0737. We recommend that primary containment radiation, combustible gas concentration, and source range monitors be added to the system for the reasons discussed above.

3.4 Display Data Validation

The staff evaluated the licensee's design to determine that means are provided in the display system to assure that the data displayed are valid. The licensee's November 1, 1985 submittal provided a description of the methods used to identify invalid data to the operator.

All analog inputs to the SPDS are checked for out-of-range conditions prior to display. Inputs found to be out of range are indicated on operational displays by question mark "????" in the value field. An input quality flag is also carried by the signal and utilized in algorithms which require the input. Digital signals also carry quality tags. These are set either manually or by program logic based on the analysis of other input signals. Other quality tags are provided to identify other possible conditions, e.g., manually entered data, removed from scan, inhibited alarm functions. These quality tags are identified to the operator and are readily apparent, thus reducing the potential for misuse of invalid data.

Based upon our review of the licensee's information on data validation, the staff confirms that methods have been provided to validate data and to identify invalid data to the SPDS user.

3.5 Human Factors Program

The staff evaluated the licensee's Safety Analysis for a commitment to a Human Factors Program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator.

PASNY described its Human Factors Program in its submittal of November 1, 1985. The SPDS design team at FitzPatrick is multidisciplinary and includes human factors engineers. Major activities include ergonomics review, operator feedback, and functional verification including man-in-the-loop testing.

Based on our review of the licensee's submittals (References 2&4), the staff confirms that human factors engineering was an integral part of the licensee's design process.

It appears that the licensee has satisfied the staff's concern noted in our request for additional information (Reference 3) regarding the requirement for continuous display. The license proposes to use visual and audible cues to alert the operator to changes in any SPDS parameters. Since no details were provided, the adequacy of this method will be confirmed during the staff's post-implementation audit.

3.6 Verification and Validation Program

In its letter of November 30, 1984 the licensee committed to applying a verification and validation (V+V) program to the design of the FitzPatrick SPDS. The program is based on the guidance of NSAC-39, "Verification and Validation for Safety Parameter Display System". The V+V program plan appears to be comprehensive and if properly implemented assure that the functional requirements of the SPDS will be reliably and effectively satisfied. The staff finds the proposed program acceptable and will confirm that it has been properly implemented during the staff's post-implementation audit.

3.7 Electrical and Electronic Isolation

The licensee's safety analysis report did not address the requirement that 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 was forwarded to the licensee by letter dated June 17, 1985 (Reference 3). The requested information was received by letter dated November 1, 1985 (Reference 4). Additional information was also received on April 15, 1987 (Reference 5).

The installation of the SPDS/EPIC system at FitzPatrick created two Class 1E to non-Class 1E interfaces. The first interface is between the Class 1E Data Acquisition System (DAS) and the non-class 1E SPDS/EPIC computer. The second interface is between the Class 1E DAS and the non-class 1E uninterruptible power supply (UPS), which supplies AC power to the DAS. The same UPS also supplies AC power to the SPDS/EPIC system computer.

In the first interface, the integrity of the Class 1E system is ensured by the use of fiber-optic cables for the transmission of data between the DAS and the SPDS/EPIC computer.

The fiber-optic cables are unique isolators in that they possess inherent characteristics that are not found in other types of electrical isolators normally used in nuclear power plants. The construction of the fiber-optic cable is such that the cable contains no electrically conductive material. The fiber-optic cables have an isolation capability that is four to seven times greater than dry air. The voltage breakdown rating of a typical fiber-optic cable is on the order of 250 KV per meter.

Another desirable trait of the fiber-optic cable is that a fault at either end of the data link might destroy the modem but will not propagate over the fiber-optic cable. For example, one of the tests that must be performed to qualify an isolator is the application of the maximum credible fault (voltage, current) to the output of the device to verify that the fault does not propagate or degrade the input (Class 1E) side. This postulated failure does not affect fiber-optic cable, as the electrical energy resulting from the fault will not propogate through the optical fiber. Another characteristic of the fiber-optic cable is its nonsusceptibility to the coupling of crosstalk and electromagnetic interference (EMI). Ground loop problems inherent with copper cables are also eliminated.

The second interface involves the use of non-Class 1E power supplies to Class 1E equipment. Though the use of non-Class 1E UPS is acceptable to the staff for this application, the integrity of the Class 1E station power and DAS must be protected from faults in the UPS.

At FitzPatrick, the licensee protected the interface by using Class 1E circuit breakers that trip on the abnormal voltage conditions that could originate within the non-Class 1E UPS. The abnormal voltage conditions have been determined to be an undervoltage of 108 VAC and overvoltage of 132 VAC. The pass/fail criteria states that the circuit breakers shall trip within two cycles of the voltage fault conditions.

The results of the circuit breaker tests showed that the circuit breaker survived the application of the faults and operated within two cycles. The circuit breakers are located in a mild environment and are qualified to IEEE Standards 323 and 344.

In addition to the circuit breakers, the DAS power supplies have surge protection that meets the requirements of IEEE Standard 472 and also utilize input transformers. These transformers offer the DAS protection from electrostatic coupling, EMI, common mode voltage, and crosstalk.

Based on the above information, the staff concludes that the isolation devices, fiber-optic cables and Class 1E circuit breakers, are qualified isolators and are acceptable for interfacing the SPDS with Class 1E systems.

4.0 Conclusion

The NRC staff reviewed the Power Authority of the State of New York SPDS Safety Analysis for FitzPatrick to confirm: the adequacy of the variables selected to be displayed to monitor critical safety functions; that means are provided to assure that the data displayed are valid; that the displayed information can be readily perceived and comprehended so as not to mislead the operator; and 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 may continue. However, in order to fully satisfy the requirements in Supplement 1 to NUREG-0737, the staff requires that the FitzPatrick SPDS design be modified to include containment radiation, combustible gas concentration in containment, and source range monitors. The staff will consider further justification or the inclusion of other variables which provide the same functions.

The conclusion 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 or when sufficient information is available for the staff to make such a determination.

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. PASNY Letter dated November 30, 1984, C. A. McNeil, Jr. (PASNY) to D. B. Vassallo (NRC), JPN-84-79 regarding SPDS Safety Analysis.

3. NRC Letter dated June 17, 1985 from D. B. Vassallo, NRC, to J. C. Brons, PASNY, Request Additional Information Regarding SPDS/EPIC.

4. PASNY Letter dated November 1, 1985, from J. C. Brons (PASNY), to D. B. Vassallo, NRC, Response to Request for Additional Information Regarding SPDS/EPIC.

5. Letter dated April 15, 1987, from J. C. Brons (PASNY) to USNRG, "Additional Information Regarding Qualification of Safety Parameter Display System Electrical Breakers."

6. NUREG-0800, Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants, Section 18.2, Rev. 0, Safety Parameter Display System (SPDS), Appendix A to SRP Section 18.2, NRC November 1984.

ATTACHMENT 1

TECHNICAL EVALUATION
FOR
NEW YORK POWER AUTHORITY'S
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
SAFETY PARAMETER DISPLAY SYSTEM
SUPPLEMENTAL SAFETY ANALYSIS REPORT SUBMITTAL

INTRODUCTION

The New York Power Authority (NYPA) has submitted a Safety Parameter Display System (SPDS) Safety Analysis Report (Reference 1) dated November 30, 1984 to the Nuclear Regulatory Commission (NRC) which was reviewed by the staff. The staff review resulted in a Request for Additional Information (Reference 2) dated November 1, 1985 that contained a set of five questions. NYPA responses to the staff's questions were submitted to NRC in Reference 3. Science Applications International Corporation, as technical assistance contractor to the NRC, using guidance provided in NUREG-0800 (Reference 4), has reviewed the supplemental SPDS safety analysis submittal responses for:

Question 2 - Human Factors Program
Question 3 - Data Validation
Question 4 - Parameter Selection

The results of the review of three questions are provided below, following a brief summary of the review team's conclusions. Question 1 pertaining to electrical isolation, and question 5 pertaining to unreviewed safety questions were however, not included in this review.

SUMMARY

The review team concluded, based on review of NYPA responses to the three questions, that no serious safety questions were identified. The review team did, however, identify two concerns. First, with regard to human factors, there is a concern that the SPDS will not be continuously displayed. Second, with regard to parameter selection, there is a concern that containment radiation, containment hydrogen, and source range indication are not included on the SPDS.

EVALUATION

This report discusses SAIC's review of the responses to questions 2 through 4 of Reference 3 and presents its results and conclusions regarding the SPDS.

Question 2: Human Factors Program

In the Request for Additional Information, the staff requested that NYPA provide a description of the display system, its human factors design, and the methods used and results from a human factors program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator.

The licensee states that the FitzPatrick SPDS is being designed under a human factors program which includes ergonomic review and participation by the plant operators in the SPDS display design. Following the design, a man-in-the-loop simulation process will be used to validate the display and evaluate the interface hardware (keyboard, trackball) in realistic scenarios with the operator.

The SPDS display consists of a single display screen which presents all of the SPDS parameters dynamically updated within a static representation of key plant components (reactor vessel, drywell, suppression pool, reactor building). The value of each parameter is backlighted in colors which depict the alarm state. Green represents normal while red indicates an Emergency Operating Procedures entry condition has been met. Yellow indicates "caution" for secondary containment area temperature and radiation levels. A change of state is accompanied by audible alarms in the terminals.

NYPA does not plan to display the single SPDS display continuously in the control room. Audible and visual cues will be used to alert the operator to a change in status of any SPDS parameter. It is estimated that approximately 2 seconds will elapse from the time a request for the SPDS display is made (via dedicated function key) until the display is available.

Based on the response, the review team concludes that the FitzPatrick SPDS is designed under a structured human factors program to ensure that the displayed information can be readily perceived and comprehended in a manner which will not mislead the operator.

Question 3: Data Validation

In the Request for Additional Information, the staff requested that NYPA describe the method used to validate data displayed in the SPDS. Also NYPA was asked to describe how invalid data is defined by the operator.

Quality tags for analog and digital signals as well as analog and digital composed points are assigned to the data, based on the status of input signals or input arguments. These quality tags are identified to the operator so that data quality is readily apparent. Data which has been manually entered and points removed from scan are identified on the display. The review team concludes that the FitzPatrick SPDS has been designed to ensure that the displayed data is valid or the operator is alerted to invalid data.

Question 4: Parameter Selection

The staff review of the FitzPatrick SPDS identified four parameters which were omitted and requested justification. The parameters were:

Primary containment radiation
Primary containment isolation status
Primary containment hydrogen concentration
Source Range Monitors

Primary containment radiation will not be included in the SPDS display by NYPA although they have included this parameter on a lower-level Emergency and Plant Information Computer (EPIC) display which is not part of the SPDS. The justification of NYPA for omitting this parameter is that an accident condition will be detected by other variables before containment radiation and that the Emergency Procedure Guidelines (EPGs) do not require containment radiation as an entry condition. This justification is not

adequate in that the SPDS is not simply an alarm system but is required to aid operators in continuously monitoring plant status with respect to five critical safety functions, one of which is radioactivity control. Containment radiation is an important indicator of radioactivity control during the course of an accident and should be present on the SPDS display. The fact that it is available on lower-level EPIC displays in the system should indicate that a change to include it on the SPDS can be readily instituted.

NYPA has agreed to include a summary of primary containment isolation status on the SPDS display. Indications of both the requirement for isolation and the satisfactory or unsatisfactory occurrence of isolation will be available. The review team concludes that this addition will meet the requirement for inclusion of containment isolation information on the SPDS.

The licensee has not agreed that inclusion of primary containment combustible gas in the SPDS display is warranted since the EPGs do not include these variables as a primary factor. Regardless of the EPG requirement, however, it is the review team's judgment that containment hydrogen concentration should be included as it is a major indicator in containment integrity due to the potential for hydrogen explosion. EPGs are not necessarily a sufficient basis for selection of SPDS display parameters.

Finally, the licensee has also stated that the source range nuclear instrumentation information is not going to be included on the SPDS display primarily due to the fact that the EPGs do not require this parameter to be monitored. It is the review team's judgment that the licensee's position is inadequate.

CONCLUSIONS

The review team evaluated New York Power Authority's response to NRC request for additional information regarding the FitzPatrick nuclear power plant SPDS by using the guidance provided in NUREG-0800. The review team concluded that the licensee will incorporate human factors in the design, will ensure data validation, and has selected a useful set of parameters for displaying the critical safety functions.

The review team, however, also identified two concerns which are listed below.

1. NYPA's method for ensuring continuous display of the critical display of the critical safety functions may not be adequate.

2. NYPA justifications for not including containment hydrogen concentration, containment radiation, and source range nuclear monitors are not adequate.

REFERENCES

1. NYPA Letter dated November 30, 1984, C.A. McNeill, Jr. (NYPA) D.B. Vasallao, (NRC), JPN-84-79 regarding SPDS Safety Analysis.

2. Letter D.B. Vassallo, NRC, to J.C. Brons, NYPA, June 17, 1985, Request for Additional Information Regarding SPDS/EPIC.

3. Letter J.C. Brons, NYPA, to D.B. Vassallo, NRC, November 1, 1985, Response to Request for Additional Information Regarding SPDS/EPIC.

4. NUREG-0800, Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants, Section 18.2, Rev. 0, Safety Parameter Display System (SPDS), Appendix A to SRP Section 18.2, NRC, November 1984.

Document Name:
JAMES A. FITZPATRICK NP

Requestor's ID:
GOSS

Author's Name:
HAbelson

Document Comments:
James A. FitzPatrick Nuclear Power Plant (TAC. No. 51240)

March 18, 1988

Docket No. 50-333

Mr. John C. Brons
Executive Vice President, Nuclear Generation
Power Authority of the State
of New York
123 Main Street
White Plains, New York 10601

Dear Mr. Brons:

SUBJECT: SAFETY PARAMETER DISPLAY SYSTEM (SPDS)

RE: James A. FitzPatrick Nuclear Power Plant (TAC NO. 51240)

DISTRUBTION
Docket File
NRC PDR
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SVarga
BBoger
CVogan
HAbelson
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EJordan
JJohnson
ACRS(10)

The enclosed Safety Evaluation Report (SER) documents our review of your November 1, 1985 response to our request for information dated June 17, 1985 concerning the FitzPatrick SPDS. The SER, and accompanying Technical Evaluation Report (TER) prepared by our contractor SAIC, indicate that no serious safety questions have been identified with your SPDS design. Therefore, full implementation of the system, which is already installed and operational, should continue.

Our review, however, does indicate that you provided inadequate justification for not including three parameters in your SPDS design which are considered necessary by the staff to meet the requirements of Supplement 1 to NUREG-0737. Specifically, these parameters are containment radiation, combustible gas concentration in containment, and source range monitor inputs. We, therefore, request that your SPDS be modified to include these parameters (or equivalent parameters which provide the same function), or alternatively, that you provide further justification for your present position.

The reporting and/or recordkeeping requirements of this letter affect fewer than ten respondents; therefore, OMB clearance is not required under PL 96-511.

Sincerely,

Harvey I. Abelson, Project Manager
Project Directorate I-1
Division of Reactor Projects, I/II

Enclosures:
As stated

cc: See next page

PDI-1	PDI-1	PDI-1
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3/17/88	3/15/88	3/15/88

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2.0 SUMMARY

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The licensee evaluated the design and function of the SPDS to determine if unreviewed safety questions are involved. Based on the results of the evaluation, the licensee determined that the SPDS does not involve an unreviewed safety question.

The staff was supported by Science Applications International Corporation (SAIC) in the performance of this review. SAIC prepared the Technical Evaluation Report (TER), Attachment 1 to the SER. The staff agrees with the technical positions and conclusions as presented in the TER.

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(iv) Radioactivity control

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

In the staff's evaluation of the parameters selected by the licensee for display in the SPDS, we have considered the Boiling Water Reactor Owners' Group (BWROG) Emergency Procedure Guidelines (EPGs) as a principal technical source of parameters important to operational safety.

Based on the staff's review of the licensee's supporting analyses, and our observation that the selected variables appear to be consistent with the BWROG, we find the proposed list of variables to be generally acceptable. However, as noted in our request for additional information (Reference 3), the staff believes that the licensee must add certain variables in order to achieve the functions required for an acceptable SPDS. These variables are:

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- Source Range Monitors

In its response to our request for additional information (Reference 4) the licensee argued that because these variables are not included in the presently approved EPG's, they need not be included on SPDS. The NRC staff does not agree.

Primary Containment Radiation is essential for monitoring the radioactivity control function because it provides containment radiation status under containment isolation conditions. The licensee has not adequately justified that its SPDS provides this function. Therefore, the staff requires that this variable or an equivalent variable (or set of variables) be added to the SPDS, or the licensee should provide further justification explaining why the variable is inappropriate for the FitzPatrick plant.

Reference to variables identified in the EPGs is not adequate justification for omitting variables on SPDS. The staff considers the EPG entry conditions to be a necessary but not sufficient set of variables with respect to SPDS functions.

Combustible Gas Concentration in Primary Containment is essential for monitoring containment conditions because of the potential for hydrogen deflagration. Therefore, the licensee should add these variables to the SPDS, or provide further justification why these variables are inapproporiate for the FitzPatrick plant. As stated above, the staff does not accept the justification that variables not included as entry conditions to the EPGs may be omitted.

Source Range Monitors are essential fo, monitoring reactivity status during startup and shutdown. Control rod position is not equivalent because actual power level is still indeterminate when insertion is incomplete. Therefore, in order to provide a measure of reactivity covering the expected, normal power range down to and including zero power, the licensee should add source range monitors or an equivalent parameter, or further justify why this variable is inappropriate for the FitzPatrick plant.

A fourth parameter, containment isolation, was also requested by the staff in Reference 3. The licensee has committed in its letter of November 1, 1985 (Ref. 4) to add containment isolation status to its SPDS. The NRC staff concurs with this decision.

Based upon our review of the safety analysis and PASNY's response to our request for additional information, we confirm that the parameters selected for display do not pose a serious safety problem. However, they are not adequate to fully monitor the critical safety functions required by Supplement 1 to NUREG-0737. We recommend that primary containment radiation, combustible gas concentration, and source range monitors be added to the system for the reasons discussed above.

3.4 Display Data Validation

The staff evaluated the licensee's design to determine that means are provided in the display system to assure that the data displayed are valid. The licensee's November 1, 1985 submittal provided a description of the methods used to identify invalid data to the operator.

All analog inputs to the SPDS are checked for out-of-range conditions prior to display. Inputs found to be out of range are indicated on operational displays by question mark "????" in the value field. An input quality flag is also carried by the signal and utilized in algorithms which require the input. Digital signals also carry quality tags. These are set either manually or by program logic based on the analysis of other input signals. Other quality tags are provided to identify other possible conditions, e.g., manually entered data, removed from scan, inhibited alarm functions. These quality tags are identified to the operator and are readily apparent, thus reducing the potential for misuse of invalid data.

Based upon our review of the licensee's information on data validation, the staff confirms that methods have been provided to validate data and to identify invalid data to the SPDS user.

3.5 Human Factors Program

The staff evaluated the licensee's Safety Analysis for a commitment to a Human Factors Program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator.

PASNY described its Human Factors Program in its submittal of November 1, 1985. The SPDS design team at FitzPatrick is multidisciplinary and includes human factors engineers. Major activities include ergonomics review, operator feedback, and functional verification including man-in-the-loop testing.

Based on our review of the licensee's submittals (References 2&4), the staff confirms that human factors engineering was an integral part of the licensee's design process.

It appears that the licensee has satisfied the staff's concern noted in our request for additional information (Reference 3) regarding the requirement for continuous display. The license proposes to use visual and audible cues to alert the operator to changes in any SPDS parameters. Since no details were provided, the adequacy of this method will be confirmed during the staff's post-implementation audit.

3.6 Verification and Validation Program

In its letter of November 30, 1984 the licensee committed to applying a verification and validation (V+V) program to the design of the FitzPatrick SPDS. The program is based on the guidance of NSAC-39, "Verification and Validation for Safety Parameter Display System". The V+V program plan appears to be comprehensive and if properly implemented assure that the functional requirements of the SPDS will be reliably and effectively satisfied. The staff finds the proposed program acceptable and will confirm that it has been properly implemented during the staff's post-implementation audit.

3.7 Electrical and Electronic Isolation

The licensee's safety analysis report did not address the requirement that 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 was forwarded to the licensee by letter dated June 17, 1985 (Reference 3). The requested information was received by letter dated November 1, 1985 (Reference 4). Additional information was also received on April 15, 1987 (Reference 5).

The installation of the SPDS/EPIC system at FitzPatrick created two Class 1E to non-Class 1E interfaces. The first interface is between the Class 1E Data Acquisition System (DAS) and the non-class 1E SPDS/EPIC computer. The second interface is between the Class 1E DAS and the non-class 1E uninterruptible power supply (UPS), which supplies AC power to the DAS. The same UPS also supplies AC power to the SPDS/EPIC system computer.

In the first interface, the integrity of the Class 1E system is ensured by the use of fiber-optic cables for the transmission of data between the DAS and the SPDS/EPIC computer.

The fiber-optic cables are unique isolators in that they possess inherent characteristics that are not found in other types of electrical isolators normally used in nuclear power plants. The construction of the fiber-optic cable is such that the cable contains no electrically conductive material. The fiber-optic cables have an isolation capability that is four to seven times greater than dry air. The voltage breakdown rating of a typical fiber-optic cable is on the order of 250 KV per meter.

Another desirable trait of the fiber-optic cable is that a fault at either end of the data link might destroy the modem but will not propagate over the fiber-optic cable. For example, one of the tests that must be performed to qualify an isolator is the application of the maximum credible fault (voltage, current) to the output of the device to verify that the fault does not propagate or degrade the input (Class 1E) side. This postulated failure does not affect fiber-optic cable, as the electrical energy resulting from the fault will not propogate through the optical fiber. Another characteristic of the fiber-optic cable is its nonsusceptibility to the coupling of crosstalk and electromagnetic interference (EMI). Ground loop problems inherent with copper cables are also eliminated.

The second interface involves the use of non-Class 1E power supplies to Class 1E equipment. Though the use of non-Class 1E UPS is acceptable to the staff for this application, the integrity of the Class 1E station power and DAS must be protected from faults in the UPS.

At FitzPatrick, the licensee protected the interface by using Class 1E circuit breakers that trip on the abnormal voltage conditions that could originate within the non-Class 1E UPS. The abnormal voltage conditions have been determined to be an undervoltage of 108 VAC and overvoltage of 132 VAC. The pass/fail criteria states that the circuit breakers shall trip within two cycles of the voltage fault conditions.

The results of the circuit breaker tests showed that the circuit breaker survived the application of the faults and operated within two cycles. The circuit breakers are located in a mild environment and are qualified to IEEE Standards 323 and 344.

In addition to the circuit breakers, the DAS power supplies have surge protection that meets the requirements of IEEE Standard 472 and also utilize input transformers. These transformers offer the DAS protection from electrostatic coupling, EMI, common mode voltage, and crosstalk.

Based on the above information, the staff concludes that the isolation devices, fiber-optic cables and Class 1E circuit breakers, are qualified isolators and are acceptable for interfacing the SPDS with Class 1E systems.

4.0 Conclusion

The NRC staff reviewed the Power Authority of the State of New York SPDS Safety Analysis for FitzPatrick to confirm: the adequacy of the variables selected to be displayed to monitor critical safety functions; that means are provided to assure that the data displayed are valid; that the displayed information can be readily perceived and comprehended so as not to mislead the operator; and 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 may continue. However, in order to fully satisfy the requirements in Supplement 1 to NUREG-0737, the staff requires that the FitzPatrick SPDS design be modified to include containment radiation, combustible gas concentration in containment, and source range monitors. The staff will consider further justification or the inclusion of other variables which provide the same functions.

The conclusion 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 or when sufficient information is available for the staff to make such a determination.

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. PASNY Letter dated November 30, 1984, C. A. McNeil, Jr. (PASNY) to D. B. Vassallo (NRC), JPN-84-79 regarding SPDS Safety Analysis.

3. NRC Letter dated June 17, 1985 from D. B. Vassallo, NRC, to J. C. Brons, PASNY, Request Additional Information Regarding SPDS/EPIC.

4. PASNY Letter dated November 1, 1985, from J. C. Brons (PASNY), to D. B. Vassallo, NRC, Response to Request for Additional Information Regarding SPDS/EPIC.

5. Letter dated April 15, 1987, from J. C. Brons (PASNY) to USNRG, "Additional Information Regarding Qualification of Safety Parameter Display System Electrical Breakers."

6. NUREG-0800, Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants, Section 18.2, Rev. 0, Safety Parameter Display System (SPDS), Appendix A to SRP Section 18.2, NRC November 1984.

ATTACHMENT 1

TECHNICAL EVALUATION
FOR
NEW YORK POWER AUTHORITY'S
JAMES A. FITZPATRICK NUCLEAR POWER PLANT
SAFETY PARAMETER DISPLAY SYSTEM
SUPPLEMENTAL SAFETY ANALYSIS REPORT SUBMITTAL

INTRODUCTION

The New York Power Authority (NYPA) has submitted a Safety Parameter Display System (SPDS) Safety Analysis Report (Reference 1) dated November 30, 1984 to the Nuclear Regulatory Commission (NRC) which was reviewed by the staff. The staff review resulted in a Request for Additional Information (Reference 2) dated November 1, 1985 that contained a set of five questions. NYPA responses to the staff's questions were submitted to NRC in Reference 3. Science Applications International Corporation, as technical assistance contractor to the NRC, using guidance provided in NUREG-0800 (Reference 4), has reviewed the supplemental SPDS safety analysis submittal responses for:

Question 2 - Human Factors Program
Question 3 - Data Validation
Question 4 - Parameter Selection

The results of the review of three questions are provided below, following a brief summary of the review team's conclusions. Question 1 pertaining to electrical isolation, and question 5 pertaining to unreviewed safety questions were however, not included in this review.

SUMMARY

The review team concluded, based on review of NYPA responses to the three questions, that no serious safety questions were identified. The review team did, however, identify two concerns. First, with regard to human factors, there is a concern that the SPDS will not be continuously displayed. Second, with regard to parameter selection, there is a concern that containment radiation, containment hydrogen, and source range indication are not included on the SPDS.

EVALUATION

This report discusses SAIC's review of the responses to questions 2 through 4 of Reference 3 and presents its results and conclusions regarding the SPDS.

Question 2: Human Factors Program

In the Request for Additional Information, the staff requested that NYPA provide a description of the display system, its human factors design, and the methods used and results from a human factors program to ensure that the displayed information can be readily perceived and comprehended so as not to mislead the operator.

The licensee states that the FitzPatrick SPDS is being designed under a human factors program which includes ergonomic review and participation by the plant operators in the SPDS display design. Following the design, a man-in-the-loop simulation process will be used to validate the display and evaluate the interface hardware (keyboard, trackball) in realistic scenarios with the operator.

The SPDS display consists of a single display screen which presents all of the SPDS parameters dynamically updated within a static representation of key plant components (reactor vessel, drywell, suppression pool, reactor building). The value of each parameter is backlighted in colors which depict the alarm state. Green represents normal while red indicates an Emergency Operating Procedures entry condition has been met. Yellow indicates "caution" for secondary containment area temperature and radiation levels. A change of state is accompanied by audible alarms in the terminals.

NYPA does not plan to display the single SPDS display continuously in the control room. Audible and visual cues will be used to alert the operator to a change in status of any SPDS parameter. It is estimated that approximately 2 seconds will elapse from the time a request for the SPDS display is made (via dedicated function key) until the display is available.

Based on the response, the review team concludes that the FitzPatrick SPDS is designed under a structured human factors program to ensure that the displayed information can be readily perceived and comprehended in a manner which will not mislead the operator.

Question 3: Data Validation

In the Request for Additional Information, the staff requested that NYPA describe the method used to validate data displayed in the SPDS. Also NYPA was asked to describe how invalid data is defined by the operator.

Quality tags for analog and digital signals as well as analog and digital composed points are assigned to the data, based on the status of input signals or input arguments. These quality tags are identified to the operator so that data quality is readily apparent. Data which has been manually entered and points removed from scan are identified on the display. The review team concludes that the FitzPatrick SPDS has been designed to ensure that the displayed data is valid or the operator is alerted to invalid data.

Question 4: Parameter Selection

The staff review of the FitzPatrick SPDS identified four parameters which were omitted and requested justification. The parameters were:

Primary containment radiation
Primary containment isolation status
Primary containment hydrogen concentration
Source Range Monitors

Primary containment radiation will not be included in the SPDS display by NYPA although they have included this parameter on a lower-level Emergency and Plant Information Computer (EPIC) display which is not part of the SPDS. The justification of NYPA for omitting this parameter is that an accident condition will be detected by other variables before containment radiation and that the Emergency Procedure Guidelines (EPGs) do not require containment radiation as an entry condition. This justification is not

adequate in that the SPDS is not simply an alarm system but is required to aid operators in continuously monitoring plant status with respect to five critical safety functions, one of which is radioactivity control. Containment radiation is an important indicator of radioactivity control during the course of an accident and should be present on the SPDS display. The fact that it is available on lower-level EPIC displays in the system should indicate that a change to include it on the SPDS can be readily instituted.

NYPA has agreed to include a summary of primary containment isolation status on the SPDS display. Indications of both the requirement for isolation and the satisfactory or unsatisfactory occurrence of isolation will be available. The review team concludes that this addition will meet the requirement for inclusion of containment isolation information on the SPDS.

The licensee has not agreed that inclusion of primary containment combustible gas in the SPDS display is warranted since the EPGs do not include these variables as a primary factor. Regardless of the EPG requirement, however, it is the review team's judgment that containment hydrogen concentration should be included as it is a major indicator in containment integrity due to the potential for hydrogen explosion. EPGs are not necessarily a sufficient basis for selection of SPDS display parameters.

Finally, the licensee has also stated that the source range nuclear instrumentation information is not going to be included on the SPDS display primarily due to the fact that the EPGs do not require this parameter to be monitored. It is the review team's judgment that the licensee's position is inadequate.

CONCLUSIONS

The review team evaluated New York Power Authority's response to NRC request for additional information regarding the FitzPatrick nuclear power plant SPDS by using the guidance provided in NUREG-0800. The review team concluded that the licensee will incorporate human factors in the design, will ensure data validation, and has selected a useful set of parameters for displaying the critical safety functions.

The review team, however, also identified two concerns which are listed below.

1. NYPA's method for ensuring continuous display of the critical display of the critical safety functions may not be adequate.

2. NYPA justifications for not including containment hydrogen concentration, containment radiation, and source range nuclear monitors are not adequate.

REFERENCES

1. NYPA Letter dated November 30, 1984, C.A. McNeill, Jr. (NYPA) D.B. Vasallao, (NRC), JPN-84-79 regarding SPDS Safety Analysis.

2. Letter D.B. Vassallo, NRC, to J.C. Brons, NYPA, June 17, 1985, Request for Additional Information Regarding SPDS/EPIC.

3. Letter J.C. Brons, NYPA, to D.B. Vassallo, NRC, November 1, 1985, Response to Request for Additional Information Regarding SPDS/EPIC.

4. NUREG-0800, Standard Review Plan for Review of Safety Analysis Reports for Nuclear Power Plants, Section 18.2, Rev. 0, Safety Parameter Display System (SPDS), Appendix A to SRP Section 18.2, NRC, November 1984.