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March 28, 1984

Mr. Harold R. Denton, Director
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U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Attention: Ms. E. G. Adensam, Chief
Licensing Branch No. 4

Subject: Duke Power Company
Catawba Nuclear Station
Docket Nos. 50-413 and 50-414

Dear Sir:

Please find attached five copies of Revision 4 to the Duke Power Company Response to Supplement 1 to NUREG-0737 for Catawba Nuclear Station. This document was originally submitted as an enclosure to my letter of April 14, 1983.

In accordance with the previously submitted schedule for Catawba Nuclear Station, the attachment includes the Duke Control Room Review Supplemental Report for Unit 2 (including environmental survey results for both units) and the Safety Parameter Display System Safety Analysis. This completes the response to Supplement 1 to NUREG-0737 for Catawba.

Instructions for inserting Revision 4 into the Catawba document are included as part of the attachment.

Very truly yours,

H.B. Tucker /-TR

Hal B. Tucker

JSW:scs

Attachments

A003
1/1

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DUKE POWER COMPANY
CATAWBA NUCLEAR STATION

Response to Supplement 1 to NUREG-0737
Document Revision Transmittal

Revision Number 4

Instructions

Revise Volume 1 as described below:

Remove Page i Table of Contents, Revision 2	Insert Page i Table of Contents, Revision 4
Remove Page ii Table of Contents, Revision 2	Insert Page ii Table of Contents, Revision 4
Remove Page iii Table of Contents, Revision 2	Insert Page iii Table of Contents, Revision 4
	Insert Page iv Table of Contents Revision 4
	Insert New Section 3.5 Control Room Review Supplemental Report, Unit 2 and Tab 3.5

Revise Volume 2 as described below:

Remove Page i Table of Contents, Revision 2	Insert Page i Table of Contents, Revision 4
Remove Page ii Table of Contents, Revision 2	Insert Page ii Table of Contents, Revision 4
Remove Page iii Table of Contents, Revision 2	Insert Page iii Table of Contents, Revision 4
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Duke Power Company

Catawba Nuclear Station
Control Room Review
Supplement to Final Report
Unit 2

Revision 4

Table of Contents

Foreword

The Final Report of the Duke Power Control Room Review together with the supplement for Catawba Unit 1 and this companion Supplement for Catawba Unit 2 constitutes the complete "Summary Report" as required by Supplement 1 to NUREG-0737.

1.0 Introduction

This Supplement to the Duke Power Control Room Review - Final Report describes the Assessment Phase results for the review of Catawba Nuclear Station, Unit 2. It also describes certain plant-specific items from the Review Phase of the Catawba 2 review and presents an implementation priority schedule for HED solutions.

2.0 Summary of Plant-specific Review Phase Activities

2.1 Control Room Survey

An environmental survey of the Catawba Control Room and the Unit 1 Auxiliary Shutdown Panel Area was conducted in accordance with the Control Room Survey Methodology as described in the Final Report. Due to the construction status of Catawba 2, an environmental survey of the Unit 2 Auxiliary Shutdown Area was not completed. Since the Unit 1 and Unit 2 Auxiliary Shutdown Areas are very similar in design, the HED solutions implemented on Unit 1 will also be implemented on Unit 2. As a final check, the Unit 2 Auxiliary Shutdown Area environmental conditions will be verified during final testing of the Unit.

2.2 Unit 1/Unit 2 Difference Evaluation

The Catawba Control Room is a two unit Control Room containing the main control boards for both Unit 1 and 2 in a "horseshoe" arrangement. The same type of components are used on each control board, and the arrangement of the system controls is essentially identical.

Because of the similarity between the Unit 1 and Unit 2 control boards, the Task Analysis and Control Room Survey activities were conducted for Unit 1. HEDs identified during these review activities also applied to Unit 2 unless a specific difference in the units existed. A component by component comparison of the units was performed to identify any existing differences. Where differences were identified, a Survey or Task Analysis evaluation, as appropriate, was conducted to identify additional specific HEDs on Unit 2. In addition, in a few cases where there was a minor unit difference and the Unit 2 approach was determined to be the better approach, HEDs were identified for Unit 1.

2.3 Operating Experience Review (OER)

The OER was conducted on a station basis by BioTechnology in accordance with the methodology described in the Final Report and included both Unit 1 and Unit 2. In addition to specific areas concerning control board and Control Room design and arrangement, the interviews and questionnaires also covered the use of procedures, training, station staffing, and general station operation, among other areas. OER comments in areas beyond the scope of the Control Room Review were documented and transmitted to the attention of station management. The Review Team requested station management to review these comments and initiate appropriate action if required.

2.4 Post Accident Monitoring Instrumentation Assessment

An evaluation of the existing plant instrumentation with respect to the requirements of Regulatory Guide 1.97 was conducted by the Design Engineering Department. HEDs identified during this evaluation were reviewed and assessed in the Control Room Review. These HEDs apply to both Unit 1 and Unit 2.

3.0 Summary of Assessment Activities

3.1 Overview

The objectives of the Assessment Phase of the Control Room Review were to:

- o Determine the importance of each HED to plant operation
- o Develop feasible solutions and estimate solution costs
- o Select cost-effective improvements to the Control Room

<u>Significance Evaluation</u>

Of prime importance in the Assessment Phase was the task of establishing the significance of an HED as it relates to the performance of the intended operating task. The significance evaluation considered a combination of factors including the potential for operator error, the potential for error detection and recovery, and the consequence of the error to plant operation and safety. This process established a relative significance for an HED. It was recognized early that not all HEDs would require this formal significance evaluation and a selective screening process was developed.

HEDs were reviewed to determine the following:

1) Is the HED a deficiency?

2) Due to its unique nature, does the HED require individual study and assessment?

3) Can the HED be resolved with surface enhancements?

4) Should the HED be resolved to maintain consistency with control room conventions or standards?

5) Is the HED part of a larger or generic HED or a duplicate from another review effort?

6) Is the HED deficiency so minor that no physical change is needed and the only action required is to establish operator awareness through training?

7) Is the HED in the process of resolution with an existing design change?

All HEDs not initially categorized in the screening activity were processed through the significance evaluation activity. The final disposition of significance evaluation of an HED was based primarily on the judgement of the Assessment Team composed of three Senior Reactor Operators, three Mechanical/Nuclear Engineers, two Electrical Engineers, and one Human Factors Specialist. The process was systematically applied through the use of work place procedures, and standard evaluation forms.

Solution Development

HEDs determined to be deficiencies were selected for resolution through physical control room modifications, surface enhancements to control boards, recommendations for procedure revisions, or additional training as appropriate. Three solution teams, each consisting of one operator and one engineer, were assisted by engineers from Design Engineering and Human Factors Specialists from BioTechnology in developing integrated solutions on a control board basis. For each control board, all HED solutions (both physical changes and surface enhancements) were reviewed to assure that no additional human factors deficiencies were created while solving HEDs, and to assess the impact of these corrections on operating crew effectiveness and system safety.

HED solutions were evaluated for the feasibility of implementation by examining the as-built status of the control boards for any physical restraints of installation, and by discussing proposed solutions with systems engineering personnel in the Electrical and Mechanical Divisions of Design Engineering. Proposed solutions were cost estimated by a standard menu of cost estimate information developed by the Review Team. HEDs with more complex solutions, such as the installation of new equipment or modification of existing equipment to provide signal sources, the processing of new signals, and cabling necessary to provide those signals to the Control Room, were separately cost estimated on an individual basis with assistance from the Design Engineering Department.

Selection of Cost-effective Improvements

A ratio of HED significance to solution cost was calculated for HEDs with an assigned significance. This ratio, similar to a benefit/cost evaluation, provided a relative ranking of HEDs from most cost-effective to least cost-effective. The Review Team reviewed the range of this ratio as an aid in determining which solutions represented cost-effective improvements to the Control Room.

HEDs without assigned significance, such as HEDs with surface enhancement solutions or HEDs with solutions required to maintain Control Room conventions, were subjectively reviewed as to cost-effectiveness by the Review Team to aid in the selection of cost-effective improvements.

All HEDs where solutions were not judged to be cost-effective were reviewed in an effort to determine if alternative solutions existed. Possible alternatives included revised physical solutions, more emphasis on surface enhancement techniques, the use of procedures or training awareness, or some combination of these areas. Where an applicable alternative solution was selected, the HED was assigned to the appropriate category. Where no applicable alternative solution was identified, the HED was documented as such.

3.2 Summary of Results

Table 3-1 summarizes the results of the Assessment Phase. The number of HEDs in each of the final disposition categories for the HEDs which were identified in

The Unit 1/Unit 2 Difference Evaluation, the Unit Environmental Survey and the Post Accident Monitoring Assessment is shown.

Appendix A contains a listing of HEDs to be solved by surface enhancement techniques.

Appendix B contains a listing of HEDs in the physical change category.

4.0 Implementation Schedule

An implementation schedule was developed after an extensive review of the HED solutions recommended for implementation. Following the requirements of Supplement 1 to NUREG-0737, this review carefully considered the significance of each HED, including the contribution of the HED solution to the reduction of risk and enhancement in the safety of operation, the difficulty of installing the HED solutions, the need for rewriting operating procedures and retraining of operators, and the coordination of HED solution changes with changes resulting from other post TMI improvement programs such as the SPDS, operator training, new instrumentation from Reg. Guide 1.97, Rev. 2, and upgraded emergency procedures.

The integration of the changes resulting from each of the NUREG-0737,Supplement 1 improvement efforts, as well as, the scheduling and coordination of individual HED solution changes is a complex and demanding scheduling effort which requires cognizance of the inter-relationships between each of the improvement areas, operator training requirements, and the plant status required for the implementation of each change.

The Duke Control Room Review Team, comprised of engineering personnel, Senior Reactor Operators from each of the three Duke nuclear stations and human factors specialists, carefully assessed the significance of each HED, developed HED solutions, and determined the implementation priority of recommended solutions. The schedule was developed following a policy of scheduling the completion of the more significant HEDs first, consistent with the practical constraints of installation such as design/installation time, material procurement, and the coordination with training and procedures. An arbitrary policy of first completing minor changes with little significance was <u>not</u> followed; rather, emphasis was placed on completing the more significant changes first and coordinating all changes with plant operation and Operator training.

Since most HED solutions cannot be installed while systems are energized such as during unit operation or testing and since a considerable amount of planning is necessary to complete the design/engineering and material procurement requirements to install a HED solution, as well as to complete the necessary Operator training and procedure changes, the Duke Control Room Review Team used the initial fuel loading and first refueling outage dates as implementation milestones. A detailed schedule for both the installation of HED solutions and the necessary front end work to support the implementation of each solution was developed. HED solutions were prioritized and assigned to one of the following categories:

I. HED solutions to be completed before fuel load.

II. HED solutions to be completed before the end of the first refueling outage.

A commitment schedule for the completion of HED solutions is shown in Appendix C.

Table 3-1
Catawba Nuclear Station
Control Room Review
HED Assessment Disposition

Unit 1 HEDs	Unit 2 HEDs	PAM Assess. HEDs	Disposition Category
0	0	0	HEDs with assigned significance points
3	0	3	HEDs violating Control Room Conventions
3	5	0	HEDs requiring Surface Enhancement
1	2	0	HEDs requiring Special Evaluation
1	3	3	Non-deficiencies
7	7	0	Duplicate/Supporting HEDs
0	2	0	Management Attention HEDs
0	0	0	HEDs already resolved through NSM process
15	19	6	Total

Appendix A

Catawba Nuclear Station

Control Room Review

<u>Surface Enhancement Solution HEDs</u>

Revision 4

The following Unit 1 HEDs (C-1-0536, C-1-0538, and C-1-0541) were identified in the Unit 1/Unit 2 Difference Evaluation. HEDs C-1-0536 and C-1-0541 will apply to both Unit 1 and Unit 2. C-1-0538 will apply to Unit 1 only.

In addition to HED C-1-0536, C-1-0541, and the additional specific Unit 2 HEDs described in this Appendix, the Unit 1 Surface Enhancement Solution HEDs described in Appendix A of the Control Room Review, Supplement to Final Report, Catawba Nuclear Station, Unit 1 will also apply to Catawba Unit 2.

HED ERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
-1-0536	SCM	9/13/83	GEN			NAMEPLATE	HFS ES8.8	LABELS AND LOCATION AIDS

:SCRIPTION:
THE ATTACHED NAMEPLATES SHOW DIFFERENT ENGRAVINGS FOR UNIT1 AND UNIT 2. THEY SHOULD MATCH IN FORMAT WITH ONLY THE "1"S AND "2"S BEING THE DIFFERENCE

:COMMENDATION:
ENGRAVE UNIT 1 LIKE UNIT 2.

DISPOSITION SUENH DESCRIPTION: REENGRAVE NAMEPLATES TO MAKE U1 &U2 MATCH

-1-0538	SCM	9/13/83	NS	1MC11 NS3		METER	HFS PS5.8	VISUAL DISPLAYS

ESCRIPTION:
NS3A&B SCALES ARE LINEAR BUT THE PROCESS SIGNAL IS NONLINEAR. (UNIT 2 SCALES ARE NON-LINEAR)
SCALE: 0-4000 GPM "NS PMP DISCH FLOW"

ECOMMENDATION:
DETERMINE IF LINEAR SCALE IS REQUIRED. IF SO, ADD SQ ROOT EXTR TO PROCESS; IF NOT, INSTALL NON-LINEAR SCALE.

DISPOSITION SUENH DESCRIPTION: REPLACE SCALES WITH SQ RT SCALES

-1-0541	SCM	9/14/83	NC	1MC5 NC3A		METER	HFS PS6.1	VISUAL DISPLAYS

ESCRIPTION:
NC3A DOES NOT HAVE UNITS ON ITS SCALE PLATE. UNITS SHOULD BE "OF".

ECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: ADD UNITS " F" TO SCALE PLATE

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
C-2-0436	SCM	9/12/83	NC	2MC10 NC83		CH-E30 SWITCH	HFS PS4.2	CONTROLS

DESCRIPTION:
PUSHBUTTONS FOR OIL LIFT PUMPS ARE ENGRAVED "START", "TRIP" RATHER THAN "ON", "OFF" WHICH VIOLATES DUKE CONVENTION. DEVICE #S INCLUDE: NC 83,84,85,86,100,101,102,103.

RECOMMENDATION:
REENGRAVE "ON" AND "OFF"

DISPOSITION SUENH DESCRIPTION: REPLACE PRESENT BUTTONS WITH "ON" & "OFF" BUTT

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
C-2-0438	SCM	9/12/83	RN	2MC11 RN33		CH-E30 SWITCH	HFS PS6.2	CONTROLS

DESCRIPTION:
SOME RN VALVES HAVE CONTROLS ON UNIT 2 THAT ARE ALSO ON UNIT 1. THE VALVE # IS STARTED WITH A "1" SO THESE VALVES ARE NOT DESTINGUISHED FROM OTHER VALVES ON UNIT 1. DEVICES ARE ATTACHED.

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: INSTALL LABEL BEHIND SHARED RN NAMEPLATES

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
C-2-0439	SCM	9/12/83	WL	2MC11 W20B		METER	HFS PS5.1	VISUAL DISPLAYS

DESCRIPTION:
ENGINEERING UNITS ARE NOT LOCATED ON THE SCALE PLATE ON W20B AND W20C.

RECOMMENDATION:
UNITS SHOULD BE ADDED: W20B- F; W20C-PSIG.

DISPOSITION SUENH DESCRIPTION: ADD UNITS TO SCALES

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
C-2-0440	SCM	9/13/83	KC	2MC07 ND3		NAMEPLATE	HFS PS6.2	LABELS AND LOCATION AIDS

DESCRIPTION:
THE NAMEPLATE FOR METERS ND 3A AND ND 3B DO NOTUSE THE UNIT 2 DESIGNATION IN NAMING ND HX A OR B. A "2A" OR "2B" SHOULD BE USED.

RECOMMENDATION:

DISPOSITION SUENH DESCRIPTION: REENGRAVE NAMEPLATE

HED SERIAL NO.	ORIG	DATE	PLANT SYSTEM	CNTL BOARD CNTL DEVICE	PHOTO ID INSTR.	COMPONENT TYPE	HED SOURCE	PROBLEM AREA
C-2-0443	SCM	9/14/83	RN	2MC11 RN80		LABELS	HFS ES8.8	LABELS AND LOCATION AIDS

DESCRIPTION:
LABEL IN MIMIC IS ARRANGED DIFFERENTLY ON UNIT 2 THAN ON UNIT 1. SEE ATTACHED SKETCH.

RECOMMENDATION:
MAKE UNIT 2 LIKE UNIT 1.

DISPOSITION SUENH DESCRIPTION: REVISE RN MIMIC LABEL

Appendix B

Catawba Nuclear Station

Control Room Review

<u>Physical Change Solution HEDs</u>

The following Unit 1 HEDs (C-1-0537, C-1-0539, C-1-0542, C-1-0654, C-1-0655, C-1-0656, and C-1-0701) were identified during the Unit 1/Unit 2 Difference Evaluation, the Post Accident Monitoring Instrumentation Assessment, and the Environmental Survey of the Catawba Control Room and Unit 1 Auxiliary Shutdown Panel Area. These HEDs will apply to both Unit 1 and Unit 2.

In addition to these HEDs and the additional specific Unit 2 HEDs described in this Appendix, the Unit 1 Physical Solution HEDs described in Appendix B of the Control Room Review, Supplement to Final Report, Catawba Nuclear Station, Unit 1 will also apply to Catawba Unit 2.

HED No. C-1-0537

Problem Description:

The scales on meters NC43A and NC43B (NC Hot Leg L/R Press) do not match.

Solution Description:

Delete duplicate meter NC43A (NCP5141).

HED No. C-1-0539

Problem Description:

Linear scales are provided on meters W3A and W3B but process signal is non-linear.

Solution Description:

Add square root extractor to process signal loop.

HED No. C-1-0542

Problem Description:

Present T-avg/T-ref Deviation meter is provided for load following. No deviation meter is provided for rod control (Deviation is shown on recorder).

Solution Description:

Move present deviation meter to location near Turbine Control Panel. Add new deviation meter from Rod Control System in existing meter location.

HED No.

Problem Description:

Solution Description:

HED No. C-1-0654
Problem Description:

The range (50°F to 300°F) for W meter VX252 for the Pressurizer Relief Tank does not meet the recommended RG 1.97 range.

Solution Description:

Provide 50-350°F scale for PRT temperature meter.

HED No. C-1-0655
Problem Description:

Present scale of 40°F to 200°F does not meet RG 1.97 recommendations.

Solution Description:

Provide 40-400°F scale for cont. temperature meters.

HED No. C-1-0656
Problem Description:

Present scale of 40°F to 200°F does not meet RG 1.97 recommendations.

Solution Description:

Revise OAC cont. temperature to 40-400°F.

HED No. C-1-0701
Problem Description:

The normal AC and emergency lighting in the Auxiliary Shutdown Panel does not meet recommended guidelines for illumination, uniformity, and glare.

Solution Description:

Improve the lighting in this area.

HED No. C-2-0153
Problem Description:

Normal and Emergency lighting in some areas of the Control Room does not meet recommended guidelines.

Solution Description:

Provide improved normal and emergency lighting in these areas.

HED No. C-2-0442
Problem Description:

There are some differences between the Unit 1 and Unit 2 annunciators.

Solution Description:

Combine 2AD18 and 2AD19 (HVAC Annunciators) into one annunciator. Implement remaining Unit 1 annunciator changes on Unit 2.

HED No.
Problem Description:

Solution Description:

HED No.
Problem Description:

Solution Description:

Appendix C

Catawba Nuclear Station

Control Room Review

Implementation Priority Schedule

Revision 4

Catawba Nuclear Station, Unit 2
HED Solution Implementation
Commitment Schedule

Considering the magnitude of the changes required to implement all HED solutions, and the complex coordination required for the installation of each HED solution with all NUREG 0737 Supplement 1 activities and the station modifications already scheduled, a commitment schedule with some degree of flexibility is required. The following commitment schedule summarizes the priority schedules developed by the Duke Control Room Review Team into percentages of the total HEDs to be corrected by the end of each milestone.

	Milestone	% HED Solution Completion
I.	Fuel loading	55
II.	By the end of the first refueling outage	45

Revision 4

Catawba Nuclear Station, Unit 1
HED Solution Implementation
Commitment Schedule

The additional HEDs identified for Catawba Unit 1 during the Unit 1/Unit 2 Difference Evaluation, the Environmental Survey, and the Post Accident Monitoring Instrumentation Assessment are scheduled for completion prior to the end of the first refueling outage for Unit 1. The following HEDs are included:

C-1-0536	C-1-0539	C-1-0654	C-1-0701
C-1-0537	C-1-0541	C-1-0655	
C-1-0538	C-1-0542	C-1-0656	

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4 SAFETY PARAMETER DISPLAY SYSTEM

4.0 INTRODUCTION

This document describes the implementation plans for the installation of Safety Parameter Display Systems at Catawba. The approaches taken by Duke Power Company in providing these systems are consistent with the long-standing practice of utilizing in-house capabilities. This includes the use of technical and operations expertise in formulating the design of the SPDS as well as integrating the SPDS into existing highly reliable and well-developed plant data systems.

The SPDS systems described in the following meet the intent of the guidance documents NUREG-0737, Supplement 1 and was developed considering the guidance of the NUTAC Guidelines for an effective SPDS implementation program, NSAC/39, NUREG-0696, and other related documents.

4.1 IMPLEMENTATION PLAN

4.1.1 GENERAL SCHEDULE CONSIDERATIONS

The Safety Parameter Display System is being developed in an integrated manner with other activities associated with the overall emergency response capabilities being developed in response to NUREG-0737, Supplement 1.

As in the case with other emergency response capabilities activities, the SPDS system will be developed within Duke Power Company. By utilizing this in-house capability, many years of design, operating and maintenance experience will be incorporated into the SPDS design and implementation.

The SPDS design, development and implementation will be scheduled to take advantage of knowledge gained from the various elements of the Control Room Review and the development of the symptom oriented emergency procedures.

Further, the design of the SPDS will be an interactive process with input from various disciplines in both the development and testing phases. The validation and verification as well as on-line testing will be performed prior to the final installation of the SPDS to ensure an effective SPDS is provided to the operating crew. Results from V&V, on-line testing, CRR Task Analysis, Human Factors Review, and related activities will be evaluated and incorporated as needed prior to finalizing the SPDS design.

4.1.2 TRAINING

Control Room operators, shift supervisors, and shift technical advisors will receive training on the use of the SPDS. This training will be performed in conjunction with the operator training on the new Symptom Oriented Emergency Procedures.

This training will include the SPDS logic and its relationship to the emergency procedures. The panel functions and methods of calling up and interpreting supporting displays will be covered. The verification of SPDS indications using hardwired and other control room indications will be provided. Invalid or indeterminate SPDS indications (due to failed plant inputs) will be identified to the operator. Visual aids in the form of slides representing SPDS and supporting displays will be used.

In addition, appropriate instrument and electrical personnel at the station will receive training on the maintenance of the SPDS and field inputs. Training records will be maintained on those required to receive training.

4.1.2.1 Training Schedule Considerations

It is expected that the SPDS will be fully developed and tested prior to initiating training of operating crews and prior to final installation. Further, since the SPDS will provide the operator with information pertinent to the new symptom oriented emergency procedures, operator training for the SPDS will be performed in conjunction with training on the symptom oriented emergency procedures.

4.1.3 MANAGEMENT

The management of the SPDS project will be under the direction of the Control Room Review Steering Committee. Lead responsibility for the SPDS project was initially designated to be the Manager of Engineering Services of the Steam Production Department. After the initiation of this project, two major re-organizations occurred. This resulted in the Manager of Production Technical Services of the Production Support Department assuming lead responsibility for this project.

In this capacity, the SPDS Project Leader is responsible for the overall coordination and scheduling of the SPDS project. Under his direction, a number of other groups will design, review, and/or implement the SPDS systems.

A complete set of documentation related to the SPDS will be maintained by the SPDS Project Leader.

Design documents, software codes, system descriptions, V&V documents, and user documentation will be reviewed and approved and controlled consistent with established procedures for these classes of documentation. Revisions to these documents will also be controlled, reviewed and approved prior to use.

4.1.4 ROLE AND MISSION SPECIFICATION

The role and mission of the SPDS is to aid the Control Room Operating Crew in monitoring the status of the critical safety functions. The primary objective of the SPDS is to provide the operating crew with an overview of the safety status of the plant and how well the critical safety functions are being maintained.

The critical safety functions are defined by the generic Emergency Response Guidelines (ERG's) developed by the Westinghouse Owners Group. In the case of Catawba, the Emergency Procedure Guidelines identify the following critical safety functions:

- Subcriticality
- Core Cooling
- Heat Sink
- Integrity
- Containment
- Inventory

4.1.5 LOCATION OF THE SPDS

The SPDS will enable the operator to quickly assess the safety status without taking any manual actions from his normal operating positions. Further, the SPDS will be readily viewable from a wide area in the Control Room to enable shift technical advisors and shift supervisors to readily determine the safety status of each of the critical safety functions. The SPDS displays will also be available to the Technical Support Center personnel. The SPDS will be integrated into the plant control room without adding clutter and confusion. Further, a new and different man-machine interface will be avoided.

4.1.6 SPDS AVAILABILITY

The SPDS will be reliable and readily available to the operator during normal operation and during emergency operating conditions. It is not required during stable shutdown conditions nor during refueling outages.

It is not essential that the SPDS be operational for plant operations personnel to determine the safety status of the plant or to execute any of the symptom oriented emergency procedures since adequate instrumentation, instructions and training will be provided independent of the SPDS.

The plant operating crew will be trained and procedures will be in place to enable them to monitor the critical safety function status both with and without the SPDS. Further, this training and these procedures will require the operating crew to verify SPDS indications using reliable control board indicators prior to taking any corrective actions.

4.1.7 VALIDATION AND VERIFICATION

A component (SPDS) level Validation and Verification Program will be developed considering the guidance contained in the NUTAC Guidelines and NSAC/39. The V&V of the SPDS will be performed by the Design Engineering Department providing an independent review since the SPDS design will be developed by the Nuclear Production and Production Support Departments.

Further, a Human Factors Review and a Task Analysis will be performed of the SPDS and supporting displays by the Control Room Review Team to validate the SPDS as part of the total operating system.

4.2 SYSTEM DESCRIPTION

This section describes the design of the Safety Parameter Display System, Human Factors considerations and includes a description of the Operator Aid Computer (OAC) Systems.

4.2.1 HUMAN FACTORS CONSIDERATIONS

The Safety Parameter Display System will be designed with appropriate Human Engineering Factors incorporated.

4.2.1.1 Viewability

The SPDS will be implemented on the Operator Aid Computer System which has three color graphic CRT's located on each unit's main control board. In this location, these CRT's are readily viewable from all normal operating positions. The six color blocks, one for each critical safety function will be continuously displayed on the bottom of the alarm video. The alarm video is centrally located on the main control board. The dimensions of the color blocks are such that they are easily viewable from any position within the main control area of the Control Room. Since the color blocks will always be positioned in the same relative locations on the CRT, it will be easy for the operator, STA and shift supervisor to readily determine the status of any of the six critical safety functions.

The supporting displays for the SPDS will be available to the operator on demand on the other two videos located on the main control board. The man-machine interface used by the operators to call up the supporting displays is the same as he normally uses to call up system graphics, display menus, and other OAC programs. This man-machine interface is thoroughly familiar to the operators through their normal operation of the plant.

4.2.1.2 Information Hierarchy/Highlighting

4.2.1.3 SPDS

The Safety Parameter Display System will consist of logic based on the Westinghouse Owners Group decision trees which are part of the symptom oriented emergency procedures. This logic drives the six CSF color blocks.

4.2.1.4 Other Information

The SPDS is described above, other supporting information is provided through a variety of normally available control room tools. Supporting CRT displays will be provided which will allow the operator to call up displays that duplicate each of the decision trees. The alarmed path through the tree will be highlighted and will indicate the appropriate emergency procedure to implement.

Decision trees not in alarm will indicate that the critical safety function is satisfied.

Further, an additional level of detail will be available to the operator. He can determine the plant field inputs which have resulted in the logic generating an alarm, such as "NR level in SG A less than 5%", "Pressurizer level channel A less than 17%", etc.

In addition, the remaining OAC features such as system schematics, input display lists, trend recording, alarms, etc., will be available for the operator's use as needed.

4.2.1.5 Man-Machine Interfaces

The Operator Aid Computer System Man Machine interfaces have been developed over the past 20 years and takes advantage of the feedback from operators over this period of time. Control panels are conveniently placed on the lower control board below each CRT. Panel functions are designed to minimize the number of key strokes required of the operator consistent with the urgency of his needs.

Response to the operator's commands by the OAC's is nearly instantaneous with displays completed within two seconds.

4.2.2 DESIGN CONTROL

The SPDS logic design is the responsibility of the Nuclear Production Department's Instrument and Electrical Section. This logic was based upon the

Westinghouse Decision Trees. Inputs were selected to provide the information required to drive this logic.

The Design of the Catawba SPDS Systems will use the SPDS being developed for McGuire since both plants contain nearly identical Westinghouse NSSS Systems and Support Systems.

An independent validation and verification program will be performed by the Design Engineering Department (see Section 4.1.7).

4.2.3 RELIABILITY AND AVAILABILITY

As can be seen on the chart below, availability of the OAC systems at McGuire and Oconee has exceeded 99% when OAC downtime during unit outages is excluded. The reliability of the Catawba OAC's is expected to be similar to the McGuire OAC's since they are nearly identical.

Each OAC is fed by a dedicated static inverter which normally receives its power from DC batteries. Upon inverter, DC batteries or charger failure, a static transfer switch provides regulated AC power from two independent sources.

ANNUAL AVERAGE ADJUSTED SYSTEM AVAILABILITY*

	1980	1981	1982	Average Adjusted Availability*
McGuire 1	N/A	99.27%	99.38%	99.3%
Oconee 1	99.20%	99.75%	99.83%	99.6%
Oconee 2	99.82%	99.54%	99.80%	99.7%
Oconee 3	99.43%	99.74%	99.67%	99.6%

* = DOWNTIME DURING GENERATING UNIT OUTAGE NOT INCLUDED

4.2.4 OPERATOR AID COMPUTER SYSTEM

The Operator Aid Computer Systems at Catawba are Model 4400 Honeywell Corporation with 64K CPU memory and a one million word bulk core memory system. Rotating and tape bulk systems are not used due to their relatively slow memory access times and susceptibility to mechanical failures.

4.2.4.1 Color Videos

A compliment of five 19" color CRT's are driven by an AYDIN 5205-C color graphic video Display Generator. Three CRT's are located on the main control boards and have the following functions.

- Alarm Video - Dedicated to displaying plant alarms. Digital inputs are scanned every 400 milliseconds and are alarmed immediately upon detection. Analog values are scanned every 30 seconds and checked for high and/or low alarms as well as rate of change as appropriate. SPDS critical safety function status blocks will be permanently displayed on the bottom lines of the alarm video.

- Utility Video - The utility video is also located on the main control board. An alpha/numeric keyboard is provided to enable the operator to select any display or program available in the OAC. Twelve chart recorder pens are operator assignable from the utility and monitor videos. These 12 pens are located on the main control board in four-three pen recorders. Operator can select high and low ranges for any of the inputs available in the OAC.

- Monitor Video - Same function as utility video above and includes its own keyboard similar to that described above. Panel buttons are also provided to allow the utility and monitor videos to display the contents of the alarm video in case of a failure of the alarm video.

Additional Videos

- Performance Video - The performance video is located in the Computer Room and serves several different users to avoid interfering with plant operators in the Control Room. It is used for plant records and performance, reactor engineering, programmers console, field input calibrations, etc. All OAC displays, programs and functions are available at this console including the capability to display the contents of the alarm video.

- Technical Support Center Video - This video is located in the Technical Support Center and has the same capabilities as the utility, monitor, and performance videos thereby making available the SPDS, supporting displays, alarm video information as well as access to all plant inputs to the OAC.

4.2.4.2 Typers and Printers

The following printers/typers are provided. An alarm typer is located in the Control Room which provides a hard copy of all alarms which appear on the alarm video. Also printed are status change messages such as pumps, motors, valves on/off open/closed, etc.

A utility typer is also provided in the Control Room. This typer allows the operator to print the output of a number of programs as well as any OAC input desired. Generation and plant logs are also typed out automatically each hour. The utility typer doubles as a backup to the alarm typer in case of failure.

A performance typer is located at the performance console in the Computer Room. Also, high speed line printers are available to type out large volumes of data from the OAC as needed.

4.2.4.3 Floppy Disc Drives

Magnetic floppy disc drives are also provided in the Computer Room for dumping copies of all OAC programs on a weekly basis in case of OAC program loss or damage. This allows the OAC to be restored to the latest version of system programs rapidly.

4.2.5 INSTALLATION AND TESTING

The SPDS will be thoroughly tested prior to being made available to the operator. This testing will include actual operation of the SPDS logic on the OAC for several weeks during startup, shutdown and normal operation. This testing will be transparent to the operators as the displays are inhibited from operating. However, an alarm summary table will be used to capture SPDS alarm changes as well as SPDS input parameter changes. This testing has been completed on the original version of McGuire's SPDS logic and was very useful in verifying the proper functioning of the SPDS as well as revealing some discrepancies primarily resulting to dynamic plant conditions. The results from these tests will be incorporated into a revision of the SPDS logic.

4.2.6 MAINTENANCE

Since the SPDS is being installed in the existing OAC Systems, the maintenance functions are already well defined and organized and demonstrated by the high availability of these computers.

4.2.6.1 Central Process Computer Group

Briefly, a Central Process Computer Group is responsible for generating and maintaining all application software. Further, this group provides hardware support and maintains a central set of spare parts for the OAC's. This group is responsible for the overall functioning of these systems including the implementation of factory recommended alterations and enhancements. Vendor support is also available when needed.

4.2.6.2 Station Maintenance Personnel

The Instrument and Electrical Section at the station is responsible for day to day hardware maintenance and preventative maintenance of the OAC Systems. Back up maintenance and spare parts support is generally available in less than four hours from the Central Process Computer Group located in Charlotte. The station also maintains a supply of normally required spare parts.

4.2.6.3 Availability Reports

Availability of the OAC's is monitored routinely. Additionally, procedures will be implemented to monitor SPDS logic and input performance to assure high availability of this function with periodic reviews of alarm summary tables.

4.3 SPDS SAFETY ANALYSIS

4.3.1 INTRODUCTION

A safety analysis review has been performed in order to verify the technical correctness and completeness of the McGuire and Catawba SPDS design. This independent review consisted of a series of detailed comment summaries which were provided to the SPDS designers at each phase of the design process. As a result of the review, the generic decision trees developed by the Westinghouse Owner's Group (WOG) have been slightly modified. These modifications have been incorporated within the SPDS logic and also in the emergency procedures referenced by the SPDS. The bases for the SPDS design, a comparison with the generic Owner's Group methodology, and the conclusions of the safety analysis review are discussed in the following sections.

4.3.2 OVERVIEW AND BASES

The SPDS is structured around the monitoring of the six critical safety functions and status trees specified in the Westinghouse Owner's Group Emergency Response Guidelines (ERGs) dated September 1, 1983. In order of decreasing severity these functions are: Subcriticality, Core Cooling, Heat Sink, Integrity, Containment, and Inventory. This set of critical safety functions and the corresponding status trees have undergone an exhaustive review within Westinghouse and the Owner's Group. The September 1, 1983, Revision 1 version, which is the bases of the McGuire/Catawba SPDS, also includes recommendations based on the NRC review of the ERGs. The NRC review culminated in the issuance of an SER dated June 1, 1983.

A Duke Power Company program was undertaken to convert the generic Emergency Response Guidelines into plant specific Emergency Procedure Guidelines. This program resulted in the identification of three modifications to the generic critical safety function status trees, each of which is included in the SPDS logic. Each modification can be considered as an enhancement of the generic version which remains consistent with the overall intent of the ERGs.

Modification #1: The generic status tree for Subcriticality is only valid following a reactor trip, since during normal operation the first branch point is "Power >5%", and a "yes" answer directs the operator to the "Response to Nuclear Power Generation/ATWS" procedure. In order for the SPDS to provide a meaningful unalarmed indication for all critical safety functions during normal power operation, a new first branch point in Subcriticality, "Reactor Trip Required", has been added. A "no" answer to this first decision point is appropriate during normal operation, and a valid unalarmed condition is indicated. A "yes" answer leads to the "Power >5%" branch point for continuation of the generic post-trip logic.

Modification #2: The generic status tree for Integrity has been revised to alarm on high Reactor Coolant System pressure. The alarm setpoint has been selected to indicate a high pressure condition that is well in excess of normal post-trip conditions. The alarm is useful with respect to alerting an overpressure condition and reduces the potential for challenging the pressurizer code safety valves.

Modification #3: The generic status tree for Containment has been revised to include monitoring of the containment hydrogen concentration.

With the exception of the above modifications, the McGuire/Catawba SPDS logic is designed to monitor plant computer field inputs so as to generate alarm conditions consistent with the Owner's Group critical safety function status trees.

4.3.3 SUMMARY OF SPDS LOGIC

The SPDS logic monitors the indications of pertinent plant instrumentation for comparison with setpoints that are characteristic of degraded plant conditions. The logic is designed to provide the best representation possible for each of the decision points in each of the status trees. Since the decision points have been uniquely specified in the Owner's Group documentation, development of the logic was a relatively straightforward task. Plant specific setpoints have been developed which include applicable instrument error and the effects of a degraded instrument environment as required.

Recognizing that the WOG critical safety functions and status trees have been subjected to a thorough NRC review, and due to the relative simplicity of converting the status trees into a logic scheme, a detailed summary of the logic utilized in the McGuire/Catawba SPDS is not warranted.

4.3.4 CONCLUSIONS

The McGuire/Catawba SPDS has been subjected to a thorough and independent review to ensure that the logic design accomplished the intended critical safety function monitoring task. The SPDS is based on the Westinghouse Owner's Group critical safety functions and status trees released with the Emergency Response Guidelines, Revision 1, dated September 1, 1983. The plant specific logic includes three minor enhancements consistent with the overall intent of the generic version. The utilization of the SPDS has been verified to be fully integrated with the upgraded emergency procedures. The logic has been verified to be technically correct. The SPDS will enhance operator response to transient events by alerting the operator to symptoms of degraded plant conditions, and by automating the prioritization of subsequent operator actions.

This review was completed pursuant to 10CFR 50.59 and has been determined not to result in an unreviewed safety question. The proposed SPDS meets or exceeds the existing design criteria as described in the Final Safety Analysis Report.

4.4 CATAWBA SPDS STATUS

Below is the status of the Catawba SPDS as of February 1984. The Catawba SPDS design is currently being developed using the McGuire SPDS system and will emerge as a separate design.

An analysis of the Westinghouse generic Emergency Response Guidelines (ERG's) resulted in the initial design basis and definition of the SPDS which was developed and approved in May, 1982.

In June, 1982, the Westinghouse Decision Trees which define the status of the six critical safety functions contained in the Westinghouse ERG's were defined in "and/or" logic arrays and OAC inputs were selected to drive this logic.

This logic was coded into software and installed on McGuire Unit 2 OAC in July, 1982 where the logic was tested to assure proper operation. At this time, the display presentations were reviewed and approved.

The Validation and Verification Plan was developed by the Design Engineering Department providing an independent analysis of the SPDS design and software developed by the Steam Production Department. This V&V process was then applied to the initial SPDS software. At this time, the SPDS software was installed on the McGuire Unit One OAC with the SPDS display inhibited. An alarm summary table was used to store all SPDS alarms and related SPDS field input alarms. This allowed a dynamic testing of the SPDS logic during normal unit maneuvers, start-ups and shutdowns.

In November, 1982, concepts for the supporting displays were developed which would provide methods for the operators to investigate the causes for SPDS alarms.

In January, 1983, revised Westinghouse Decision Trees (dated 9/1/82), results from Dynamic Testing, and information from the V&V Program were incorporated in a revised version of the SPDS logic.

This revised logic was installed on the OAC and V&V reinitiated in February, 1983. Alternative supporting displays were reviewed and design selected in March, 1983.

Additional revisions to the Westinghouse Emergency Response Guidelines were received in July 1983 which resulted in additional revisions to the SPDS logic and software. The Nuclear Production Department Reactor Safety Section performed numerous reviews and provided many suggestions on improving the SPDS design.

The supporting display system was developed and a Human Factors review was completed in October 1983 by the Control Room Review Team. Their comments were incorporated into the final SPDS design. A review of the Shift Technical Advisor function was also confirmed and a determination made to provide an additional CRT and keyboard for use by the STA. This CRT will be installed on the operators desk in the "horse shoe" area of the control room.

Training information was developed and provided to the Catawba operators in November 1983.

The software for the Catawba SPDS and supporting displays will be completed in March 1984. The final V&V is also in progress at this time and will be completed during March/

The SPDS should be installed and functional on schedule.