Docket Nos. 50-498
and 50-499

MAR 12 1987

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HWalker

Applicant: Houston Lighting and Power Company

Facility: South Texas Project, Units 1 and 2

SUBJECT: SUMMARY OF MEETINGS AND AUDITS ON ELECTRICAL INSTRUMENTATION AND CONTROL SYSTEMS, EQUIPMENT QUALIFICATION, SPDS AND CONTROL ROOM DESIGN REVIEW SUBJECT

The NRC staff conducted a series of audits on January 28, 29 and 30, 1987 at the South Texas Project site. The members of the NRC staff who performed the audit were S. H. Weiss (Section Leader), J. L. Mauck, O. P. Chopra, S. N. Saba, H. Walker and consultants. The staff members mentioned belong to the Electrical Instrumentation and Control Systems Branch in the Division of PWR Licensing-A of the Office of Nuclear Reactor Regulations.

Discussion:

The reports of the audits conducted are provided as Enclosures to this meeting summary. Each enclosure is addressed individually as follows:

Enclosure 1: This enclosure discusses the audit aspects related to the review reported in Chapter 7 of the SER (NUREG-0781). Under the section entitled "Findings", 14 items are listed, separated into two parts. The first part of nine items indicated specific actions requested of the applicant and documentation to confirm completion of the actions. The second part has five items on which the applicant is requested to make submittals for review by the staff. The staff recognizes that on at least one of these (No. 3 of the second group) a submittal has been received and is under review.

Enclosure 2: This enclosure describes the audit relative to installation of safety-related electrical systems and equipment as described in Chapter 8 of the SER. The results of the audit are presented as "Comments". Some of the comments indicate actions requested of the applicant. The applicant is expected to take the actions requested or provide justification for not doing so.

Subsequent to the audit, the staff met with the applicant on March 10, 1987 to discuss progress in the resolution of the audit items. At this meeting, the staff was informed that the applicant was taking credit for the use of a single fuse (Class 1E) in two instances as an isolation device in the Essential Cooling Water (ECW) control system. This practice is contrary to staff guidelines that are discussed in Regulatory Guide 1.75 and IEEE Standard 384-1974. The staff expects justification or corrective action to resolve this concern.

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Subsequent to the audit and during the South Texas Technical Specification review, the staff discovered that the offsite power circuits for South Texas plant are not electrically independent. The control power for all 13kv breakers that provide offsite power to the plant is from a single battery. This design is inconsistent with SRP Section 8.2.1 which requires that the control power to these breakers be from different batteries. The staff expects justification or corrective action to resolve this concern.

Enclosure 3: This enclosure addresses the audit of the Safety Parameter Display System. The discussion of the audit is presented in terms of Supplement 1 to NUREG-0737 and Section 18.2 of NUREG-0800. The applicant is expected to respond to the discussion by taking the indicated actions or providing justification for not doing so.

Enclosure 4: This enclosure relates to the audit of the equipment qualification files. The files audited are indicated and it is mentioned that staff guidance on duration of qualification was not met in some instances. A subsequent meeting was held on February 10, 1987 at which the applicant committed to provide additional information to justify conformance to the staff guidance. The safety evaluation on equipment qualification will be published separately.

In addition to the above, the audit activity resulted in the applicant making one commitment to submit additional information on the Detail Control Room Design Review. The items which would be addressed in the additional information related to completion of actions currently under way.

-S-

N. P. Kadambi, Project Manager
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Enclosures:
As stated

cc: See next page

NPK

PAD#5: PKadambi:jch 3/12/87

SGW EICSB: FR FRosa 3/12/87

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ENCLOSURE 1

PAEI TRIP REPORT
SITE VISIT - SOUTH TEXAS PROJECT
JANUARY 28, 29, AND 30, 1987

INTRODUCTION AND SUMMARY

On January 28, 29, and 30, 1987, the Electrical, Instrumentation & Control Systems Branch (PAEI) conducted a site visit at the South Texas Project. The primary purpose of the site visit was to verify that the installation of electrical instrumentation and control equipment conformed to applicable design criteria regarding physical separation between redundant safety related circuits, and between safety related and non-safety related circuits (see Section 7.1.4.4 of the South Texas SER, NUREG-0781). In addition, the South Texas design was reviewed to verify that the actual installation of instrumentation and control systems was consistent with the staff's understanding of the design based on the review of electrical schematic/elementary diagrams and Chapter 7 (Instrumentation & Controls) of the FSAR. Additional areas of review included control room indication and annunciation, remote shutdown panels, instrument sensing lines, instrument racks, and capability for testing.

The pertinent results of the PAEI site visit are provided in the "Findings" section below. This section is divided into two parts. The first part consists of concerns whose resolutions should be verified by the applicant and the second part consists of concerns that are to be resolved by the NRR staff.

FINDINGS:

In general, the physical arrangement and installation of electrical, instrumentation, and control equipment appeared to be in accordance with the applicable design criteria. However, specific concerns along with their potential resolution, were identified by the staff.

We require the applicant to verify that the proper actions have been taken to resolve the following concerns that were noted during the staff site audit.

(1) During the turbine stop valve circuit trace it was noted that the wiring exiting conduit A1EHZ5C6382 was not permanently installed. Before start-up, the applicant should verify that the wiring to all of the turbine stop valves is permanently installed and meets the applicable separation criteria.

(2) For both trains (R and S), the applicant has not provided acceptable separation for the logic input wiring to the SSPS. By analysis the applicant has stated that 1" separation will be maintained between the sil-temped input cables. The cabling in both digital input enclosures should be routed so that this 1" separation is maintained. In addition the red logic input cable for train S should be sil-temped as required by the South Texas separation criteria. The applicant should verify that these actions are completed.

(3) During the staff audit of the control room panels, numerous instances were noted where the stated criteria for separation within panels were not followed. The applicant should verify that the areas where separation concerns were noted are corrected. The panels where the separation criteria were not met are as follows:

(a) Panel 2 - Group C (yellow) is not separated from Group A (red)

(b) Panel 3 - Group N,M (black) not separated from Group B (blue) and Group C (yellow).

(c) Panel 4 - Numerous examples were seen where Group N,M (black) was in contact with Class 1E Divisional conduits.

(d) Panel 6 - Group N,M (black) not separated from Group B (blue); Group N,M (black) wiring in contact with Class 1E divisional conduits.

(4) During the staff audit, we noted that Group B (blue) and Group A (red) wiring was tied directly to Non Class 1E conduits. The applicant should verify that acceptable separation is maintained within ODPS enclosure, APC-B, Protection Set III.

(5) The Group D (white) cable spreading room does not meet the applicable separation criteria in that D1XE2CTSA1 (white) was not adequately separated from N1XE2 CXYA- (black). The applicant provided documentation that acknowledged this separation problem and stated that corrective action would be taken. The completion of this corrective action should be verified by the applicant.

(6) The Group B (blue) cable spreading room does not meet the applicable separation criteria in that a Group C (yellow) cable was not adequately separated from a Group N,M (black) tray. The applicant provided documentation that acknowledged this separation problem and stated that corrective action would be taken. The completion of this corrective action should be verified by the applicant.

(7) In its review of the remote shutdown panel, the staff noted a separation concern within Bay 2 of the remote shutdown panel (RSP). Group C (yellow) and Group A (red) wiring did not meet the 6" separation criterion. The applicant should verify that the separation criterion utilized within RSP Bay 2 is acceptable.

(8) In its review of the Group D (white) converter room, the staff noted two instances where conduit containing one white cable was routed with four black cables. The applicant provided documentation that stated the black cables were actually Group D (white) cables. The applicant should provide identification in accordance with Section 8.3.1.3 of the FSAR for these black cables (e.g., they should be color coded as Group C cables at the entrance of the enclosure). This identification should be verified by the applicant.

(9) The staff noted that flammable gas taps existed in the Group A (red) cable spreading room. The applicant stated that these gas taps were temporary and would be removed before fuel load. The removal of these gas taps should be verified by the applicant.

We believe that the resolution of the following concerns that were identified during the site audit should be pursued by PAEI. Therefore, PAEI will take followup action for these concerns and report its findings in a supplement to the SER.

(1) The staff identified separation concerns within the Solid State Protection System (SSPS). The concerns identified are as follows:

(a) Synchronization cables (503 and 504) that are routed between train R and train S do not meet the separation criteria specified in Westinghouse documentation. According to this documentation, these cables, orange and green, should meet the separation criteria specified in Section 8.3.1.4.4.5 of the South Texas FSAR. Furthermore, the cables should be identified according to Section 8.3.1.3 of the FSAR.

(b) Non-Class 1E multiplexer cables in both train R and train S of the SSPS cabinets are bundled with the respective divisional cabling. This lack of separation continues as the non-safety and divisional cables exit the cabinets (top exit). After several feet, the non-Class 1E cabling enters a non-Class 1E tray and the divisional cabling enters safety-related conduits and trays. The licensee should (1) provide an analysis that justifies the lack of separation within the SSPS cabinets between the non-Class 1E multiplexer cables and the train R and Train S cabling, (2) reroute the non-1E cabling upon exiting the SSPS cabinets so that it meets the separation criteria stated in Section 8.3.1.4.4.5 of the FSAR, and (3) perform a tray analysis for the non-1E multiplexer cable and provide the voltage levels and current carrying capacity for the worst case fault cable routed in this tray.

(2) During its review of control room Panel 3 (Diesel) the staff noted the utilization of isolation devices that have not been previously reviewed. These isolation devices are being used to isolate safety-related ESF instrumentation buses from non-Class 1E loads. The isolation devices in question are manufactured by Magnetic and Struthers-Dunn. The applicant should provide information regarding the utilization of these isolation devices and provide the required responses to a previously transmitted question regarding isolation devices. In addition, the applicant should review the South Texas instrument bus scheme and provide the information noted above for all other types of isolation devices being utilized for non-Class 1E loads on the Class 1E instrument buses.

(3) The 6" separation criterion was not met within the ODPS system cabinets. The applicant has submitted an analysis to justify this lack of 6" separation. This report is presently under staff review and the results of this review will be reported in a supplement to the SER.

(4) During its review of the SSPS enclosures, the staff noted several instances where Group NM (black) cabling was separated by less than 6" from Divisional train R (orange) and S (green) cabling. In several instances the black cabling was actually bundled (touching) with the orange and green cabling.

The applicant should provide the analysis that allows this less than 6" separation and, in some areas, the less than 1" separation. If this cannot be provided, then the applicant should implement separation criteria according to Section 8.5.1.4.4.5 of the FSAR.

(5) The applicant should provide the final documentation that shows the Sil-Temp implementation program. This documentation should show (1) the areas where Sil-Temp was used, (2) the minimum separation allowed for these areas, (3) the type Sil-Temp utilized (e.g., wrap, sleeve) and (4) the areas when the Sil-Temp has been over-wrapped with a water resistant tape.

ENCLOSURE 2

SOUTH TEXAS SITE VISIT SUMMARY

We conducted an audit drawing review and site visit at the South Texas plant to assure that the installation of safety-related electrical systems and equipment were implemented in accordance with the design described and criteria specified in the Final Safety Analysis Report.

A. Plant Walk Through

The following areas were observed:

1. Control Room
2. Cable Runs and Cable Spreading Area
3. Vital Instrumentation and Control Power Supply Installation
4. ESF Systems and Pump Rooms
5. Electrical Penetration areas
6. Battery and Battery Charger rooms
7. Switchgear rooms
8. Diesel Generator rooms
9. Turbine Building
10. Reactor Building
11. Auxiliary Shutdown panel
12. Switchyard

B. Comments

1. In general, we verified that separation between the redundant divisions or between the Class 1E and non-Class 1E circuits is maintained and barriers are provided where separation is marginal. Where the above could not be accomplished, the applicant instituted a test program conducted by Wyle Laboratories to provide justification for lesser separation distances. The test program methodology and the test results will be submitted by the applicant in the near future. These test results will be reviewed and evaluated by the staff and reported in a supplement to the South Texas safety evaluation report.

2. As part of the in-plant observation, we traced power cable routes for two redundant Residual Heat Removal pumps from switchgear to the pump installations. It was demonstrated that the minimum separation requirements had been met for the two RHR pumps.

3. The implementation of identification and color coding schemes for safety-related circuits and equipment was observed. We found that many safety-related pumps were not identified (for the selected systems observed). We require the applicant to identify the above pumps and to check other electrical equipment to assure this condition does not exist elsewhere in the plant.

4. As part of our walk-thru of the containment penetration areas, we found that many low power cable penetration splices were inadequately installed in that both ends of the splices were not properly sealed. The deficiency in the installation of cable splices could result in failure of Class 1E equipment essential to the safe operation and shutdown of the plant. The potential failures which could occur include electrical short circuits, localized circuit overheating and circuit discontinuities. Therefore, we require the applicant to develop a program to inspect all splices located inside and outside containment for connecting field wiring to the electrical penetration conductor. If the cable splices are determined to be improperly installed, the applicant should initiate replacement of such splices.

5. Our walk thru of the ESF pump rooms revealed that the separation between heat tracing circuits and RTD circuits does not meet the recommendations of R.G. 1.75 at South Texas plant. The applicant informed us that RTD circuits (non-Class 1E) are low energy circuits and do not pose any threat to heat tracing (Class 1E) circuits. However, we will require the applicant to perform an analysis, substantiated by a test, to demonstrate that the existing separation between above circuits is adequate.

6. Our walk thru of the battery rooms revealed that the pilot cells were not identified and that the markings on the pilot cells were not labelled

as "Maximum" and "Minimum." In addition, there was no 1/4" marking above the maximum level indication mark on the pilot cells. Per plant technical specifications (TS) requirements, at least once per 7 days, the applicant is required to verify that the electrolyte level for each pilot cell is $>$ minimum level indication mark, and $\angle$1/4" above maximum level indication mark. It is not clear how TS requirements are going to be met if the pilot cells are without these markings. Therefore, we will require the applicant to identify and mark the pilot cells properly for each Class 1E battery.

7. Our review of the control circuitry of the active and passive safety related valves revealed that if the power to these valves is locked out, redundant valve position indication is not provided for such valves. This is inconsistent with the requirements of BTP #18. Therefore, we require the applicant to either provide redundant valve position indication for these valves or justify the present design.

8. Our review of the circuits for penetration protection revealed that, for certain control circuits, primary and back up protection is not provided. We require the applicant to either provide primary and backup protection for these control circuits or justify the present design.

ENCLOSURE 3

MEETING MINUTES
SPDS AUDIT
SOUTH TEXAS PROJECT
JANUARY 28-29,1987

1.0 INTRODUCTION

On January 28 and 29, 1987, the NRC conducted an audit of the Houston Lighting & Power (HL&P) Company Safety Parameter Display System (SPDS) design for the South Texas Project (STP). The Audit Team examined the STP Verification and Validation (V&V) program, and reviewed the operation of the SPDS. Thus, the audit specifically addressed the points of a Design Verification Audit and a Design Validation Audit as described by Section 18.2 of NUREG-0800. The Audit Team was composed of individuals from the Nuclear Regulatory Commission (NRC) Division of Nuclear Reactor Regulation and from the Lawrence Livermore National Laboratory, acting as consultants to the NRC. These meeting minutes summarize the information gathered by the NRC Audit Team through discussions with HL&P personnel and review of project documentation. This summary discusses the information gathered with respect to each of the specific SPDS requirements of Supplement 1 to NUREG-0737 and the V&V recommendations of Section 18.2 to NUREG-0800.

2.0 DISCUSSION OF SPDS DESIGN FEATURES

2.1 " THE SPDS SHOULD PROVIDE A CONCISE DISPLAY..."

The STP SPDS function is provided by fourteen displays on the Emergency Response Facility Data Acquisition and Display System (ERFDADS). Safety function status boxes show the status for each of the six plant critical safety functions (CSFs). These status boxes are located in the bottom left-hand corner of all SPDS displays. The safety status boxes change color to indicate a change in CSF status. The user can also select one of two top-level overview displays. These displays give a graphical representation of plant safety functions in the form of deviation bar graphs. The length of the bar for a given CSF represents the relative degree by which the most deviant parameter associated with that CSF deviates from the normal condition. There are two distinct types of displays available at each level in the SPDS: 1) Normal Safety Functions displays which represent CSF status prior to reactor trip, and 2) Critical Safety Functions displays which represent CSF status after reactor trip.

2.2 "THE SPDS SHOULD ... DISPLAY ... CRITICAL PLANT VARIABLES.."

The STP SPDS parameters were selected by the following process. First STP performed a task analysis based upon the Westinghouse Owners Group (WOG) Emergency Response Guidelines ERGs) identified variables needed to implement these guidelines. Next review of the Optimal Recovery Guidelines (ORGs) identified variables the operator needs to perform diagnosis, take preplanned manually controlled actions, and take actions necessary to reach and maintain a controlled condition. Critical Safety Function Status Trees were then reviewed to assess what variables are needed for the operator to determine whether a Functional Restoration Guideline (FRG) should be implemented. Additionally, a review of the FRGs identified the variables the operator needs to restore or maintain CSFs.

The selection process used to determine normal CSF parameters was similar to the process described above. Operational personnel were also involved in the selection process of SPDS variables. Table 1 of this document contains a list of the STP SPDS parameters.

A number of specific Audit Team questions were discussed. The audit team noted that Plant Vent Radiation and Main Steam Line Radiation are not used in the determination of Critical Safety Function status following a reactor trip. Therefore, the STP SPDS does not continuously display information from which the status of the Radiation Control CSF status con be determined.

2.3 " THE SPDS SHOULD ... AID THEM (OPERATORS) IN RAPIDLY DETERMINING THE SAFETY STATUS OF THE PLANT..."

During the audit discussions, HL&P stated that SPDS displays can be called up within 2 seconds. The NRC Audit Team noted that a very short interval elapses between a operator command and the beginning of display generation. However, completion of some displays required as long as 30 seconds. HL&P indicated that the long display generation time may have resulted from system development activities that were being conducted during the audit.

HL&P also stated that data updates to displays occurred every 5 seconds. HL&P further indicated that data update and recalculation rates are user-selectable with a password control system. There did not appear to be any formal administrative control to prevent selection of inappropriate update rates.

All numerical displays present the data to the nearest unit. Plot displays have a resolution of approximately 1-2% span.

SPDS parameters are received from the Qualified Display

Processing System (QDPS) and from field inputs via remote Data Acquisition Systems (DAS). Sensor data fed into the DAS is checked to confirm the data is within the instrument's calibrated operating range. Additionally, the DAS CPUs perform an operability test on each SPDS input every scan cycle. A quality tag based upon these initial tests is assigned to the input data. Non-redundant inputs are treated as good data if the input passes the operability and range check. Non-redundant inputs that fail either check are considered bad data. Redundant inputs also receive an interchannel comparision validity check. If all inputs have passed the operability and range checking, and all inputs are within a predetermined percentage of the average of the inputs, then the average of all inputs is used. This value is considered good data. If one or more inputs did not pass the operability and range check, the remaining redundant inputs are subject to the interchannel comparison test. The average of the remaining inputs is used as the parameter value if the interchannel comparison criterion is met. In this case the parameter value is flagged as poor. Whenever the interchannel comparison criterion is not met, the input most different from the average is deleted and the interchannel comparison test is repeated. If the validity criterion is met, the new average is used as the parameter value. This value is flagged as poor. If at least two redundant inputs did not pass the operability and range checks, or at least two redundant inputs do not pass the interchannel comparison test, then the value for the parameter is considered bad. Bad data are not used in the determination of CSF status. If only bad data are available for a given CSF, then the CSF status indication is displayed as blue to indicate that status is unknown. On lower level displays, the numerical parameter values are appended with the letter P to indicate poor data, the letter B to indicate bad data, or the letter S to indicate a manually- input value. Numerical bar charts are color-coded dark blue to indicate bad data, and light blue to indicate manually-input data.

Data input to the SPDS via the QDPS receive similar data validity checking. Each of the two redundant QDPS channels sends a single synthesized value of SPDS parameters to the ERFDADS. Each parameter value has an associated quality flag. The ERFDADS applies data validity checking to inputs from QDPS as if they were redundant instrument channel inputs.

At the time of the audit, parameter range check and interchannel comparison acceptance criteria were not yet selected. HL&P indicated that the acceptance criteria and the interchannel comparison algorithms will be consistent with those used by the Qualified Display Processing System. Therefore, the QDPS and SPDS will display consistent information. The interchannel comparison acceptance criteria will be based upon calculated instrument loop accuracy under severe environment conditions.

The operator is able to determine if the system is inoperable by noting that the screen clock has stopped or the system cursor has stopped blinking. All input signals from the field are fed into redundant DASs which in turn have redundant host processors. The on-line system has a complete standby backup. The standby constantly monitors the on-line system. If the on-line system fails, the backup system automatically comes on line. The system has an Uninterruptable Power Supply (UPS) that has a two-hour rating. In addition the TSC diesel backs up ERFDADS power.

In terms of system security there are keylocks on hardware cabinets. Software system security is maintained by password protection. The STP computer support staff maintains administrative control of all passwords. Software changes can only be made at the system operations console. In, addition the system logs console location and time for all failed attempts to access the computer system. Draft procedures for control of software modifications and database changes were examined by the NRC Audit Team. The draft software modification procedure included appropriate provisions for review and testing of changes. The draft database change procedure did not address the need for independent verification that proposed changes are technically correct.

2.4 "THE PRINCIPLE PURPOSE AND FUNCTION OF THE SPDS IS TO AID THE CONTROL ROOM PERSONNEL DURING ABNORMAL AND EMERGENCY CONDITIONS IN DETERMINING THE SAFETY STATUS OF THE PLANT AND IN ACCESSING WHETHER ABNORMAL CONDITIONS WARRANT CORRECTIVE ACTIONS BY CONTROL ROOM OPERATORS TO AVOID A DEGRADED CORE."

The STP SPDS top-level normal safety function displays provide a bar chart to indicate relative value of each of six normal safety functions. The normal safety function mid-level displays provide numerical indication of parameter as well as 30 minute historical trends.

The top-level Critical Safety Function display provides the operator with a vertical bar chart for each safety function. The individual bar's length indicates the degree of deviation from normal, with respect to warning and alarm limits, for each function. These bars are normally pink, but turn dark blue if all input parameters for the specific function are bad. Safety Status boxes are included in these top-level displays. They are color coded to reflect CSF status (i.e., red-unsafe, green-normal, blue-invalid).

All SPDS critical mid-level displays contain the status indicator boxes. However, there is not a consistently applied indication that individual parameters have deviated from normal.

The NRC Audit Team observed an STP operations staff member perform a walkthrough of one of the EOPs. The use of ERFDADS and QDPS display information appeared well-integrated into the

Emergency Operating Procedures.

2.5 "(THE) SPDS (SHALL BE) LOCATED CONVENIENT TO THE CONTROL ROOM OPERATORS."

The STP SPDS displays and controls location and readability were reviewed by HL&P against NUREG-0700 guidelines.

There are three-thirteen inch SPDS displays, with full keyboards, located at the operators consoles. In addition, there are three nineteen-inch SPDS displays, with function button keyboards, located on the main control boards.

2.6 "THE SPDS SHALL CONTINUOUSLY DISPLAY INFORMATION FROM WHICH THE SAFETY STATUS OF THE PLANT... CAN...BE ASSESSED..."

As previously described, the STP SPDS indicates CSF status on safety status boxes. The NRC Audit Team observed that as one traverses through the different levels of ERFDADS displays, the status boxes disappear. In addition, the NRC Audit Team noted that following a reactor trip the SPDS does not continuously display the information necessary to assess the status of the Radiation Control System.

2.7 "THE SPDS SHALL BE SUITABLY ISOLATED FROM ELECTRICAL OR ELECTRONIC INTERFERENCE WITH EQUIPMENT AND SENSORS THAT ARE IN USE FOR SAFETY SYSTEMS."

Test data for this item has been submitted to the NRC. This item was not within the scope of this review.

2.8 "PROCEDURES WHICH DESCRIBE THE TIMELY AND CORRECT SAFETY STATUS ASSESSMENT WHEN THE SPDS IS AND IS NOT AVAILABLE WILL BE DEVELOPED BY THE LICENSEE IN PARALLEL WITH SPDS. FURTHERMORE, OPERATORS SHOULD BE TRAINED TO RESPOND TO ACCIDENT CONDITIONS BOTH WITH AND WITHOUT THE SPDS AVAILABLE."

STP operators are trained to use procedures which support use of the ERFDADS, QDPS, SPDS, and control boards. Operators are trained to use the ERFDADS, QDPS, and control boards when the SPDS is not available. As mentioned previously, the use of ERFDADS is well-integrated into the EOPs.

2.9 "THE SPDS DISPLAY SHALL BE DESIGNED TO INCORPORATE ACCEPTED HUMAN FACTORS PRINCIPLES SO THAT DISPLAYED INFORMATION CAN BE READILY PERCEIVED AND COMPREHENDED BY SPDS USERS."

The SPDS system design at STP used pre-established human factors guidelines derived from NUREG-0700 and the STP Control Design Review Criteria Report. Appendix A of the STP Safety Analysis Report contains the guidelines used. Included in the human factors design considerations were such items as standardization of color coding and symbols for all displays. Human Factors principles were incorporated into the STP SPDS design. However, the NRC Audit Team observed several deviations from good human factors practices. These items are:

- Color code meanings are considerably different in different applications. For example, on bar charts red indicates the parameter is in alarm, but on time history plots red identifies the channel that is being trended.

- Some displays appear to be unnecessarily cluttered. For example, the mid-level normal core cooling display has the average temperature display enclosed in a symbol that appears to contribute nothing to the understanding of the display.

- Label formats are not consistent from display to display.

- On some CRTs it is difficult to distinguish green from yellow. This is especially true when the user is near the display.

- In some cases, selection of lower level displays by placing the cursor over the point for which more information desired was possible only by precise positioning of the cursor.

- The SPDS function keys are poorly differentiated from other the keys used to call other ERFDADS functions.

- The SPDS function keys are gray with white lettering. The labels are already so dirty that they are hard to read.

- Parameter alarm limits are not consistently indicated on the mid-level displays. Thus, these displays cannot be used to monitor the margin between the current value and a alarm condition.

- The normal CSF status displays include alarm setpoints that may be mode-dependent. However, the status determination setpoints do not change with operating mode.
- The safety status box indicators are rather small. Consequently, they may be lost in the clutter on mid-level displays and non-SPDS ERFDADS displays.

3.0 DISCUSSION OF THE VERIFICATION AND VALIDATION PROGRAM

3.1 SYSTEMS REQUIREMENTS REVIEW

The basic requirements for the STP SPDS design are in a overall ERFDADS specification combined with ERFDADS input/output lists, and display design data packages. These materials were prepared by Bechtel Power Corporation for HL&P. These documents were subject to the normal Bechtel and HL&P review and approval procedures. However, it appears HL&P did not conduct a formal, documented review of the specification with respect to the SPDS requirements of Supplement 1 to NUREG-0737 and the guidance of Section 18.2 of NUREG-0800. HL&P indicated that an informal review of this nature was conducted as part of the development of presentations of SPDS capabilities. The NRC Audit Team reviewed the material developed by this informal review, but was unable to confirm that the informal review represented a rigorous and independent system requirements review.

3.2 DESIGN VERIFICATION REVIEW

The overall ERFDADS specification formed the basis for development of a system functional description and a software specification. These documents were prepared by the ERFDADS vendor, Energy Incorporated (EI). Included in these documents was a cross reference of the specific hardware and software requirements to the requirements of the overall ERFDADS specification. The system functional description was used to assemble a listing of off-the-shelf hardware needed to meet the ERFDADS system requirements and system design documents. The software specification formed the basis for development of ERFDADS computer code.

The development of functional description, software specification, design documents, and computer code included independent reviews, as specified by EI's Quality Assurance (QA) program. Code development also included performance of software module acceptance testing. EI formed a Verification and Validation Committee made up of senior staff members who were independent of the software and hardware design. This V&V

committee verified that the reviews and testing required by the QA program were conducted. The committee also performed spot check reviews of their own.

The V&V committee formally transmits their findings to STP, and a written resolution is required. The V&V committee then reviews the resolution of their findings. If the ERFDADS design team and the V&V committee cannot agree upon the resolution of a finding, the V&V committee may appeal directly to the South Texas Project management.

The NRC Audit Team selected sample SPDS requirements from the overall ERFDADS specification for review. The team verified that the ERFDADS specification/system functional description cross reference and that the ERFDADS specification/software specification cross reference addressed the sample requirements. The Audit Team confirmed that the selected requirements were addressed in the functional description or in the software specification. The Audit Team also examined software design and verification documents for a sample ERFDADS SPDS function. This examination confirmed that appropriate verification reviews and tests were conducted as part of the development process.

3.3 VALIDATION TESTING

Integrated hardware and software system testing was conducted at the vendor's site. This factory demonstration testing was performed in accordance with test procedures prepared by the system designers and reviewed by the V&V Committee. EI and HL&P personnel conducted the factory demonstration test under the direction of a test supervisor who was independent of the system design personnel. The V&V Committee audited the performance of the testing and the test results to verify that testing was in accordance with procedures, and to verify that the testing demonstrated that system performance is in accordance with the predefined acceptance criteria.

The NRC Audit Team examined the factory demonstration test procedure steps and results applicable to the sample ERFDADS requirements. This examination confirmed that the sample requirements were appropriately tested and that acceptable test results were obtained and documented. The Audit Team also sampled test discrepancies, confirmed that the sample discrepancies were appropriately resolved, and confirmed that retesting validated the changes made to correct the discrepancies.

HL&P had not conducted and did not have plans to conduct man-in-the-loop testing to confirm the useability of the SPDS in the context of the STP control room, operator training, and operating procedures.

3.4 FIELD VERIFICATION

The HL&P startup group performed field verification testing of the as-installed system. This testing was performed according to site acceptance test procedures prepared by EI and reviewed by the EI V&V committee. Existing STP startup test procedures applicable to plant startup in general controlled the conduct of the field verification testing. Testing included simulation of all SPDS instrument inputs and verification that proper readings were obtained at the SPDS displays. HL&P intends to retest the system every two years by simulating inputs at the ERFDADS multiplexers and verifying proper response of the displays. Verification of proper reading of the ERFDADS/SPDS displays is also a requirement of the periodic instrument loop calibration procedures.

Table 1

STP SPDS Parameters

Safety Function	Normal Safety Function (Pre Reactor Trip)	Critical Safety Function * (Post Reactor Trip)
Subcriticality	Source Range Neutron Flux and Startup Rate	Neutron Flux - Extended Range (Upper Range)
	Intermediate Range Neutron Flux and Startup Rate	Neutron Flux - Extended Range (Lower Range)
	Power Range Neutron Flux	Neutron Flux - Extended Range - Startup Rate
Core Cooling	Max T_{cold} (Wide Range)	Reactor Vessel Water Level - Upper Head
	Max T_{hot} (Wide Range)	Reactor Vessel Water Level - Plenum
	Average Temperature (Narrow Range)	Subcooling Margin
	Delta Temperature (Narrow Range)	Core Exit Temperature
	Total RHR Flow	
Heat Sink	Steam Generator Level (Narrow Range)	Steam Generator Level (Narrow Range)
	Steam Flow/Feed Flow Differential	Steam Generator Pressure
	Steam Generator PORV Status	Total Aux. Feedwater Flow
	Steam Generator Safety Relief Valve Status	Aux. Feedwater Loop Flow
	Steam Generator Blowdown Radiation Level	
	Condenser Vacuum Pump Exhaust Radiation Level	
	Max Main Steamline Radiation Level	

Table 1 (Cont'd)

Integrity	Pressurizer Pressure Pressurizer PORV Status Pressurizer Safety Relief Valve Status RCS Pressure Reactor Vessel Head Vent Valve Status Reactor Containment Building Atmosphere Radiation Level (Noble Gas and Particulate)	T_{cold} in each Loop (Wide Range) T_{cold} Drop (in last hour) RCS Pressure RCS Pressure and Temperature versus Plant Operational Limits Display RCS Pressure and Temperature versus COMS Limits Display
Containment	Atmosphere Radiation Level Plant Vent Radiation Level Pressure (Normal Range) Temperature Isolation Status/Operability	Water Level (Wide Range) Hydrogen Concentration High Range Radiation Level Pressure (Normal Range and Extended Range)
Inventory	Pressurizer Level VCT Level Charging Flow Letdown Flow Seal Injection Flow	Reactor Vessel Water Level - Upper Head Reactor Vessel Water Level - Plenum Pressurizer Level

* Critical Safety Functions: as defined in the WOG ERGs and the STP EOPs.

ENCLOSURE 4

During the period of January 27 through January 30, 1987 the NRC staff and its consultants from EG&G Idaho audited the equipment qualification files of South Texas Project, Unit 1. The staff and its consultants audited a total of 11 files, and all files were for equipment located in a potentially harsh environment. As a result of the audit, the following are observations and comments made by the staff and its consultants at an exit interview held at the South Texas Project site on January 30, 1987 (List of attendees attached).

Prior to the audit it was discovered that some equipment at the South Texas Project is qualified for a post-accident period of only 30 days. Staff guidance typically provides that electrical equipment important to safety that is located in a potentially harsh environment (i.e., equipment within the scope of 10 CFR 50.49) be environmentally qualified for a period of 100 days after an accident. In some instances, regulatory guidance allows for post-accident qualification periods of substantially less than 100 days; in those instances, an applicant is expected to satisfy the post-accident time margin requirements specified in Position C.4 of Reg. Guide 1.89, Revision 1. The aforementioned staff guidance was discussed with the applicant at the time of the audit.

On February 10, 1987 representatives of the South Texas Project met with the staff in Bethesda Maryland to discuss the issue of post-accident qualification time period. As a result of that meeting the applicant committed to qualified equipment within the scope of 10 CFR 50.49 for a post accident period of 100 days. If there are instances where specific items of equipment cannot be qualified for the 100 day post accident time period, the applicant is expected to provide justification in accordance with the guidance provided in Position C.4 of Reg. Guide 1.89 Revision 1.

The following comments are specific to individual EQ files as indicated. However, the applicant must update all files to incorporate these comments where applicable.

Auxiliary System Motor EQCP No. 4000 (RHR)

The qualified post-accident operability period was less than the six months specified by the applicant. During the audit the specification was reviewed by the applicant and changed to 100 days post-accident. Documentation in this file does support post-accident qualification for 100 days, therefore the staff finds this acceptable.

Barton DP Indicating Switch Model 581A-0/199, EQCP No. 4335

Not qualified for the time period specified.

RDF Corp. RTD, EQCP No. ESE-6

This file was not audited. However, the applicant must establish a qualified life for this item.

Valco Solenoid Valve, EQCP No. 4026

Component ID number on valve does not agree with the number in the file. In addition, the elevation on the SCEW sheet should be corrected to agree with the elevation at which this item is installed.

In addition to the files noted above, the following were also audited.

Okonite 600V Power Cable, EQCP No. 4058
NTD International Flow Sensor and Connectors, EQCP No. 4376
FCI Sump Level Indicator, EQCP No. 4374
Rockbestor TC Extension Wire, EQCP No. 4103
Limitorque Valve Actuator, EQCP No. 4028
Namco Limit Switch, EQCP No. 4027
Veritrak Pressure Transmitter, EQCP No. ESE-1B
Garrett PORV, EQCP No. HE-9

ELECTRICAL/I&C/CRDR/EQ EXIT

Name	Organization
Jack Bailey	HL&P
Michael Powell	HL&P
D. R. Carpenter	USNRC/SRI
Martin Opee	Westinghouse
J. T. Westermeier	HL&P/PM
S. M. Dew	HL&P/DPM
Carl S. Weary	TU Electric
H. Lowell Magleby	NRC Consultant
Jerry L. Mauck	NRC
Om P. Chopra	NRC
S. H. Weiss	NRC
Harold Walker	NRC
Mike Trojovsky	INEL/NRC
Frank Matthewson	Bechtel Eng.
Rich Johnson	Bechtel Eng.
Jeff Phelps	HL&P Licensing
S. S. Talwar	HL&P Eng.
Mike Duke	HL&P Eng.
R. L. Parker	HL&P Eng.
Paul G. Trudel	Bechtel
Jim Hurley	Bechtel
R. A. Witthauer	Bechtel
Don Ashton	Bechtel
G. E. Tandy	HL&P Eng.
T. B. Dixit	HL&P Eng.
Nancy Ellis	Energy, Inc.
Wayne Harrison	HL&P
Sal F. Luna	Torrey Pines Technology
Tom H. Crawford	HL&P
Yvonne T. Williams	Bechtel
Scott Head	HL&P
Leonard R. Casella	HL&P
Geoffrey D. Purdon	HL&P
J. R. Molleda	HL&P