Docket Nos.: STN 50-482
and STN 50-483

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Gentlemen:

Subject: Results of Pre-Implementation Audit of Callaway and Wolf Creek Control Room

As a result of the review of the SNUPPS Detailed Control Room Design Review (DCRDR) Summary Report dated February 2, 1984 and its on-site pre-implementation audit conducted at Callaway and Wolf Creek during the week of February 27, 1984, the staff has prepared the enclosed report which presents the results of its evaluation. As indicated in the evaluation, the staff has concluded that SNUPPS has performed a review that satisfies the requirements of Supplement 1 to NUREG-0737 except in the areas of task analysis, verification that improvements will provide corrections without introducing new human engineering discrepancies, and coordination of the DCRDR with other improvement programs.

Because this issue will be a five-percent condition in the Callaway License, please provide your summary report addressing the staff comments by June 29, 1984. If you cannot meet this schedule, please advise the project managers within one week of the date of this letter.

Any discussion of the enclosed report should be directed to the appropriate project manager.

Sincerely,

ORIGINAL SIGNED BY:

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Enclosure: As stated

cc: See next page

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NUCLEAR REGULATORY COMMISSION

PRE-IMPLEMENTATION AUDIT

OF THE

DETAILED CONTROL ROOM DESIGN REVIEW

FOR

CALLAWAY AND WOLF CREEK PLANTS

This report documents the findings of the NRC staff and its consultant, Science Applications, Inc. (SAI), during the pre-implementation audit of the Detailed Control Room Design Review (DCRDR) being conducted by the Standardized Nuclear Unit Power Plant System (SNUPPS) for Union Electric Company's (UE) Callaway Plant and Kansas Gas and Electric Company's (KG&E) Wolf Creek Plant. The basis for the decision to conduct a pre-implementation audit was the review of the DCRDR Program Plan for Callaway and Wolf Creek (Reference 1), the large number of items previously unreviewed during the Preliminary Design Assessment (PDA), and the results of the NRC review of the SNUPPS responses to human engineering discrepancies in the control rooms (Reference 2). The results of the DCRDR Program Plan review were documented in SAI's report to the NRC (Reference 3) and the NRC's comments to SNUPPS (Reference 4). The requirements set forth in NUREG-0737, Supplement 1, "Requirements for Emergency Response Capability," December 1982 (Reference 9) served as the basis of the Program Plan and Summary Report evaluations and also the pre-implementation audit. The purpose of the audit was twofold: (1) to resolve the remaining PDA items prior to the planned upcoming fuel loading at the Callaway Plant and (2) to provide SNUPPS with feedback on their DCRDR approach and their responses to the Human Engineering Findings (HEFs) that were identified.

The human engineering review of the Callaway and Wolf Creek control rooms was started by SNUPPS in mid-1980. Since the Callaway and Wolf Creek control rooms are of a standardized design, except for certain site-specific panels, the review is applicable to both. The site-specific panels were reviewed on a plant-specific basis. The initial control room survey work performed in 1980 and 1981 was based on NUREG/CR-1580 and is referred to as the Preliminary Design Assessment (PDA). The remainder of the control room survey work, including a Supplementary Survey (SS) and an Auxiliary Shutdown Panel (ASP) review, were completed by January, 1984. However, the environmental aspects of the control room were not surveyed until April 1984, due to the incomplete state of the control room equipment and furnishings.

BACKGROUND

Licensees and applicants for operating licenses are required to conduct a Detailed Control Room Design Review. The objective is to "... improve the ability of nuclear power plant control room operators to prevent accidents or cope with accidents if they occur by improving the information provided to them" (NUREG-0660, Item I.D). The need to conduct a DCRDR was confirmed in

NUREG-0737 and in Supplement 1 to NUREG-0737. DCRDR requirements in Supplement 1 to NUREG-0737 requires each applicant or licensee to conduct their DCRDR on a schedule negotiated with the NRC. Guidelines for conducting a DCRDR are provided in NUREG-0700 while criteria for the NRC's evaluation of a DCRDR are contained in NUREG-0801. (The NUREG documents cited are listed as References 11 and 12).

A DCRDR is to be conducted according to the licensee's own program plan (which must be submitted to the NRC); according to NUREG-0700 it should include four phases: (1) planning, (2) review, (3) assessment, and (4) reporting. The product of the last phase is a summary report which must include an outline of proposed control room changes, proposed schedules for implementation, and justification for leaving partially or completely uncorrected any human engineering discrepancies (HEDs) with safety significance. Upon receipt of the summary report and prior to implementation of proposed changes, the NRC must prepare a Safety Evaluation Report (SER) indicating the acceptability of the DCRDR (not just the summary report). The NRC's evaluation encompasses all documentation as well as briefings, discussions, and audits if any were conducted.

The DCRDR requirements as stated in Supplement 1 to NUREG-0737 can be summarized in the form of the nine specific elements listed below:

1. Establishment of a qualified multidisciplinary review team.

2. Use of function and task analyses to identify control room operator tasks and information and control requirements during emergency operations.

3. A comparison of display and control requirements with a control room inventory.

4. A control room survey to identify deviations from accepted human factors principles.

5. Assessment of human engineering discrepancies (HEDs) to determine which HEDs are significant and should be corrected.

6. Selection of design improvements that will correct those discrepancies.

7. Verification that selected design improvements will provide the necessary correction.

8. Verification that improvements can be introduced in the control room without creating any unacceptable human engineering discrepancies.

9. Coordination of control room improvements with changes resulting from other improvement programs such as SPDS, operator training, new instrumentation (Reg. Guide 1.97, Rev. 2) and upgraded emergency operating procedures.

PLANNING PHASE

The NRC's HFEB staff concluded from their review of the SNUPPS DCRDR Program Plan that although the plan addresses some of the elements comprising the DCRDR, it is incomplete and does not address some of the elements in sufficient detail to establish how the element will be accomplished. The NRC suggested that a meeting be held with SNUPPS and utility representatives to clarify certain aspects of the DCRDR. On October 25, 1983, the NRC met with representatives of SNUPPS, Union Electric Company, and Kansas Gas and Electric Company to discuss the methodologies for accomplishing each of the nine elements. SNUPPS produced a revised program plan November 28, 1983, incorporating the comments made during the meeting (Reference 6). The summary report provides additional information and sample forms documenting the methodologies (and results) of the DCRDR activities over and above that provided by the revised program plan.

1. Qualification and Structure of the DCRDR Team.

The concerns expressed after the review of the original SNUPPS DCRDR program plan consisted of the following:

- The qualifications of the human factors contractor and other engineering and training personnel,
- The involvement of the human factors consultant in the DCRDR,
- The level of involvement of each of the disciplines participating in the DCRDR for each DCRDR task, and
- The organization of management for the DCRDR.

Through discussions with SNUPPS and utility personnel and review of supplemental documentation submitted to the NRC by SNUPPS these concerns were addressed and for the most part were met. The personnel involved in the DCRDR do appear to possess the qualifications and related experience necessary for performing a satisfactory DCRDR. With the exception of the level of involvement of the human factors consultant in the System Function Review and Task Analysis (SFR&TA), the remaining personnel and their level of involvement in the various DCRDR tasks appear to be sufficient. The human factors consultant, who is an integral and somewhat pivotal member of a DCRDR review team, participated approximately one-half week in the SFR&TA. While a low level of involvement of an experienced human factors engineer does not necessarily preclude the accomplishment of a successful task analysis, it is our experience that human factors engineering input is highly valuable, especially throughout the planning and performance of the task analysis.

In the revised program plan and the summary report, SNUPPS described the Technical Committee as the entity responsible for design decisions. We expressed our concern for how well informed and familiar the Technical Committee members were with the DCRDR, especially for the HED producing tasks since they were responsible for the design decisions. SNUPPS addressed our

concern by stating that the utility management, who comprised the Technical Committee, delegated the authority for design decision to the DCRDR Project Team which is familiar with, and responsible for, the day-to-day conduct of the DCRDR. Nevertheless, SNUPPS stated that feedback is still provided to management on the DCRDR.

In summary, the SNUPPS DCRDR management structure and the qualifications of the personnel involved in the DCRDR appear to be adequate. Except for human factors engineering involvement in the SFR&TA, all disciplines or personnel participating in the DCRDR appear to have been sufficiently involved.

REVIEW PHASE

The activities included in SNUPPS' Review Phase are:

1. Operating Experience Review
2. System Function Review and Task Analysis
3. Control Room Inventory
4. Control Room Survey
5. Verification of Task Performance Capabilities
6. Validation of Control Room Functions

Activities two through five address specific DCRDR requirements contained in NUREG-0737, Supplement 1. Since the verification and validation activities are so closely tied to the System Function Review and Task Analysis, these two activities will be discussed under the Function and Task Analysis requirement heading.

1. Operating Experience Review

Due to the incomplete state of construction of the Wolf Creek and Callaway plants at the time this activity was conducted, SNUPPS factored in operating experience into the DCRDR in these ways: (1) feedback provided by prospective operators from the Wolf Creek and Callaway Plants who had training on the SNUPPS simulator, (2) use of industry experience obtained through involvement of SNUPPS personnel in the Westinghouse Owners Group (WOG) activities, and (3) use of the Callaway simulator for the WOG emergency procedure validation program.

Two activities appear to have been performed to take advantage of the experience gained by the prospective operators from the SNUPPS plants and the experience gained by other owners of Westinghouse plants. These activities are the SNUPPS Operating Personnel Survey and the review of historical documentation from other, similar plants.

The SNUPPS Operating Personnel Survey was performed as part of the Preliminary Design Assessment (PDA) effort. The prospective operators from the SNUPPS plants who had training on the SNUPPS simulators were given questionnaires and were interviewed regarding their evaluations of control room design features. The results of the questionnaires and interviews were documented observations of specific problems with the control room design. These observations were used as feedback to the findings produced from other

PDA activities (e.g., control room survey) and were used as direct input in the development of design improvements.

The SNUPPS review team reviewed and is reviewing on a continual basis historical documentation of other, similar plants. The review of LERs and other documentation will be continuous rather than on a one-time basis so that UE and KG&E will be continuously aware of the implications to their plants of occurrences from other, similar plants.

SNUPPS recognizes the value of operating experience input in the DCRDR and although this is not a requirement of NUREG-0737, Supplement 1, they appear to have performed a review of operating experience which will provide valuable insights and feedback for other DCRDR and PDA activities.

FUNCTION AND TASK ANALYSIS

The SNUPPS System Function Review and Task Analysis (SFR&TA) was based on the generic Emergency Response Guidelines (ERGs) developed by the Westinghouse Owners' Group (WOG). The WOG ERGs essentially identify the event-related and symptom-related emergency procedures and the associated system/subsystems, system and operator functions, operator tasks, and a generic list of instruments and controls. Based upon the presentations made by WOG representatives on task analysis on March 29, 1984, the NRC concluded that Revision 1 of the WOG ERGs and background documents do provide an adequate basis for generically identifying information and control needs.

Owners of Westinghouse PWRs can tailor this generic set of information and control needs to their own plant-specific task analysis. Since the SNUPPS Callaway Simulator was used in the development of the ERGs and the SNUPPS emergency operating procedures closely follow the ERGs, the identification and description of operator tasks resulting from this effort is directly applicable to the Callaway control room. The effort identified 141 categories of "monitoring tasks (instrumentation)" and 119 categories of "operational tasks (controls)." This is a comprehensive list of unique task categories in that many of the categories are applicable to more than one procedure.

The SNUPPS plant-specific part of the analysis began by reviewing the nature of each task description. Of 141 monitoring tasks identified, 124 were determined to be "digital" (discrete) in nature and 109 of the operational tasks were determined to be "digital." A digital monitoring task requires the operator to make a "yes" or "no" determination from an indication. The Summary Report provides three examples of what is meant by a "digital" monitoring task. The third example, "Whether a flow meter is indicating other than zero flow," raises some doubt as to the purpose, objectivity and method of the task analysis performed, along with concern regarding the multidisciplinary makeup of the review team. This task example already assumes a specific display which, from an information requirements point of view, may not be very satisfactory for displaying the binary condition of flow versus no flow. If the human factors discipline was involved in the analysis, a task described in this manner should have been questioned.

In a control context, a "digital" task may require the operator to turn equipment on or off or to reposition a valve or breaker. Once the operational tasks were identified as "digital", the Summary Report seems to indicate no further task analysis was conducted. The staff's concern is that different types of similar components often have very different operating characteristics. For example air-operated and motor-operated valves cycle at extremely different rates. Some controls combine mode selection with operation (e.g., CLOSE, AUTO, OPEN) and these requirements should be defined through task analysis. Different control types are needed for different purposes (e.g., some controls used detented positioning while others are spring loaded momentary contact). Task analysis provides the means to define the control characteristics required by the operator in the context of the system being controlled. During the on-site audit the staff saw indications (i.e., labeling) that some consideration was given to control characteristics, but not from a requirements basis and not documented.

The capability of performing digital tasks was evaluated only in the verification process by addressing these two questions: (1) Is the instrument or control properly located in the control room, and (2) Is the design of the control or instrument in accordance with human engineering principles? As reflected by these two questions, the capability of performing digital tasks was evaluated, not in the sense of whether or not the information and control characteristics required for the operator to perform the tasks were present in the instrument or control, but only in the sense of whether or not the instruments and controls already in the control room are suitably located and designed according to basic principles.

The capability of performing "non-digital" (continuous) tasks was evaluated in greater detail. The design characteristics of instruments involved in "non-digital" tasks were evaluated against a set of information or specifications drawn from plant emergency procedures, the control room inventory, the FSAR, and the specifications for individual displays. In addition, the ranges of some instruments specified in the WOG ERG documents were verified with the ranges specified in Reg. Guide 1.97. This set of information or specifications was listed in tables which served as the working documents in this portion of the verification effort (see Appendices B and F of the Summary Report). SNUPPS stated that the values for the required precision are tabulations based on the judgment of the reviewers.

We have several concerns about the approach taken by SNUPPS to define the required design characteristics of instruments involved in "non-digital" tasks. These are: (1) The use of plant-specific documentation to identify the design requirements, (2) the apparent inconsistency of certain requirements identified in Appendices B and F of the Summary Report, and (3) the apparent lack of analysis to determine the required characteristics of displays and controls.

Due to the use of plant-specific documentation to identify some of the design requirements against which the plant-specific instrumentation will be compared, the verification of instrument suitability may actually be a check for instrument design deviation from plant specifications. The verification of instrument suitability should be based on an analysis of the required

design characteristics which is performed independently of documentation describing plant-specific instruments and controls. SNUPPS has not clarified how design requirements were determined for the plant-specific documents. SNUPPS' partial reliance upon plant-specific documentation may have decreased the validity of the verification of instrument suitability.

Appendix B of the Summary Report provides an example Task Analysis and Verification worksheet for one monitored parameter, containment pressure. It is unclear how the required values of range and precision were determined and what the precision value means. The report provides no explanation of the process but the worksheet appears to contain errors. The last task indicates a need for the operator to know if the pressure is greater or less than 60 psig. The listed display range requirement is "0-60+". If the task statement is correct, then the required display range is incorrect. Based on the display precision required of ± 2.5 (psig), the required range should be 57.5 to 62.5 psig since the task is asking for a discrete indication.

Appendix F contains a summary of the requirements and characteristics of the 17 monitored parameters identified in the ERGs. It is equally unclear how the values in this appendix were obtained since, in the one example of containment pressure, the task analysis worksheet and the table in Appendix F differ as shown below:

Appendix B

Required "display range":	0-30 psig
Actual "display range":	0-60 psig
Required "display precision':	±0.5 psi
Actual "display precision":	±0.25 psi (analog)

Appendix F

Required "range & units":	0-60 psig
Actual "instr. charstics.":	0-70 psig
Required "precision of display:	±2 psi
Actual "instr. charstics.":	±0.25 psi (analog)

SNUPPS should document an explanation for this apparent inconsistency and all other inconsistencies between the work sheets and Appendix F of the Summary Report.

An example of a "non-digital" (monitoring) task provided in the Summary Report by SNUPPS is one in which the operator is required to "...take action based on the value of reactor coolant system wide range pressure." As in the case of instruments involved in "digital" tasks, the example demonstrates that SNUPPS has made an a priori assumption that wide range is needed rather than one of several specific values of reactor coolant system pressure. Once again SNUPPS has apparently accepted instrument design without performing a prior analysis of information requirements.

The data sheets of Appendix B, applicable to operational tasks requiring the operator to exercise some form of modulating (continuous) control,

provide no useful information regarding the analysis to determine control characteristic requirements. The data sheet includes only checks in the "suffice" column indicating that what exists in the control room is satisfactory. The basis for "suffice" is unclear. The remainder of the data sheets reviewed during the meeting of March 9, 1984 provided no further evidence that a requirements analysis was conducted. The staff expected to see control characteristics (e.g., gain, response requirements, transfer function, and frequency of use) described for each control.

Although the verification of the suitability of instruments involved in "non-digital" tasks was based upon some set of pre-defined design requirements, this was not the case for the verification of the suitability of controls involved in "non-digital" tasks. The verification of the suitability of controls involved in the "non-digital" tasks was apparently performed without any prior definition of design characteristics. The result of such a methodology may have been a verification of control suitability that was less than fully objective. As stated earlier, the verification of the ability to perform control tasks was accomplished by performing these tasks on the Callaway simulator. The concern here is lack of objectivity through the natural tendency to uncritically accept, as suitable, that which already exists in the control room.

SNUPPS performed two separate validations of control room functions. The first effort consisted of analyzing the video-taped walk-throughs of various procedures performed at the SNUPPS simulator at Zion. The findings from this analysis were incorporated as part of the PDA findings.

The second effort consisted of analyzing the video-taped walk-throughs of the entire set of 41 WOG ERGs at the Callaway simulator. This validation effort appears to have been focused primarily on validating the WOG ERGs. In addition, SNUPPS took the opportunity of analyzing the video tapes to evaluate control room instrument and control consistency with the procedures, operator workload, and workstation flow or traffic. The six HEFs produced from this second validation effort reflect an adequate evaluation.

In summary, the points below were made concerning SNUPPS' SFR&TA and verification and validation efforts. The inadequacies in the SNUPPS SFR&TA may reflect the low level of human factors involvement in this effort.

1. No analysis was conducted to define the required characteristics of "digital" (discrete) controls or displays.

2. Due to the use of plant-specific documentation to identify some of the design requirements against which plant-specific instrumentation was compared, the verification of instrument suitability may not have been completely valid.

3. Based on the SFR&TA writeup, examples of continuous monitoring and modulating control tasks, and the sample Task Analysis and Verification worksheet it is unclear what analysis, if any, was conducted to determine the information and control characteristics required by operators to accomplish their tasks.

4. There appears to be inconsistency in the requirements specified for certain parameters in Appendices B and F of the Summary Report.

5. SNUPPS' validation of control room functions appears to have been adequately performed.

Based on the review of the Summary Report, the on-site audit and meetings, and the meeting of March 29, 1984 with members of the WOG in which the ERG development program was discussed and the limitations were described, the following information is needed from SNUPPS:

- A description of how the design requirements were determined for the plant-specific documentation that was used to identify the design characteristics against which plant-specific instrumentation was compared.

- For each instrument and control used to implement the EOPs, provide an auditable record of how the needed instrument and control characteristics were determined. These characteristics should be derived through the task analysis process from the information and control needs identified in the background documentation of the ERG or from plant-specific information.

In addition, SNUPPS should provide documentation which would serve to clarify the points made above. The information provided by SNUPPS should serve as its final response and input to our evaluation of the SFR&TA.

3. Control Room Inventory

The inventory of controls and displays in the control room that is used in the DCRDR consists of plant design drawings and specifications. The drawings of the control room panel arrangement and the individual panel control/display arrangement include labels, mimic lines, and demarcation lines which identify the displays and controls by coded identification number, plant system, and function. The specifications, vendor manuals, etc., describe individual controls and displays. These drawings and specifications were developed prior to changes in the control room resulting from the DCRDR and PDA and are continuously updated to reflect changes in the control room design.

The control room inventory was used in the initial portion of the verification of task performance capabilities. According to SNUPPS, the verification effort was initially done using the control room inventory and then later done using the Callaway simulator. However the inventory was used, the requirement in NUREG-0737, Supplement 1 calls for a comparison of information and control requirements with the control room inventory to identify missing controls and displays. The comparison, which was carried out in the verification effort, is described in the previous section. In itself, the inventory of controls and displays appears to be comprehensive and should have provided adequate support to the DCRDR as an information source.

4. Control Room Survey

As mentioned previously, the control room survey work was initiated in 1980 using NUREG/CR-1580 as the source of evaluation criteria. This survey work was completed in 1981 and is referred to as the Preliminary Design Assessment (PDA). After the issuance of NUREG-0700, SNUPPS performed a Supplementary Survey (SS) of the control room in late 1983, to ensure that all criteria in NUREG-0700 which was not considered in the PDA was applied to the control room. In addition to surveying the control room, SNUPPS performed a review of the Auxiliary Shutdown Panel (ASP) in late 1983 using NUREG-0700 as guidance. The results of these survey activities are documented in the summary report as Human Engineering Findings (HEFs). The environmental survey was performed in April 1984 and the findings will be documented in a supplement to the DCRDR summary report.

The audit of the control room survey work consisted primarily of a post-implementation examination of the as-built improvements responding to the specific HEFs found during the PDA. In addition, the audit team assessed the resolution (corrective action and schedule) of the HEFs that resulted from the review of the ASP and the SS. A summarization of the results of the audit for the PDA, ASP, and SS is given below. Specific comments on the ASP and SS can be found in Appendix A.

Preliminary Design Assessment

The open items from the NRC audit of the PDA which was performed in July, 1981 were discussed with the SNUPPS DCRDR Team and all items were determined to be adequately resolved. The items for which corrective action was complete, were verified by direct examination in the control room. The schedule for all items not fully implemented was examined and determined to require completion of the corrective action prior to exceeding five percent power operation.

Supplementary Survey

Appendix D of the DCRDR summary report listed the HEFs and SNUPPS' responses resulting from the SS. The HEFs from each of the nine sections of the SS were examined by the audit team in the control room. With the exception of the one finding in the Annunciator Warning System section, the resolution of the findings in the SS was finalized and determined to be acceptable. The resolution of the finding in the Annunciator Warning System section will be determined after the environmental sound survey has been completed.

Auxiliary Shutdown Panel Review

Appendix E of the DCRDR summary report lists the HEFs and SNUPPS' responses resulting from the ASP review. The HEFs from the nine sections of the ASP review were examined by the audit team at the ASP. With the exception of two findings in the Control Room Workspace section, the resolution of the findings in the ASP review was finalized

and determined to be acceptable. Resolution of finding 1.5 is pending further evaluation by SNUPPS and utility personnel. The resolution of finding 1.1 as documented in SLNRC 84-0048 was determined to be unacceptable. Comments related to these two findings are presented in Appendix A of this report.

In general, the control room survey work performed during the PDA, SS, and ASP review activities is comprehensive and has met the requirement in Supplement 1 to NUREG-0737 for "a control room survey to identify deviations from accepted human factors principles." In the context of this task, we believe the SNUPPS review team has demonstrated their sincere interest in resolving the HEFs identified and improving the operability of the Callaway and Wolf Creek control rooms.

ASSESSMENT AND IMPLEMENTATION PHASE

1. Assessment of HEFs

SNUPPS had originally developed an assessment or prioritization scheme which assigned one of seven different priorities to an HEF. These priority assignments for the most part reflected the significance of the HEF in terms of safety, reliability, or operator performance. Priorities were also to be assigned to HEFs which would be corrected without further assessment or were found to have been acceptable by human factors criteria. This priority assignment was to be one of the following four criteria considered by SNUPPS when resolutions to HEFs were being developed.

- Priority, which indicates the safety significance of the HEF,
- Difficulty of backfitting changes, e.g., availability of space on control panels, class IE separation requirements, etc.,
- Complexity of change, e.g., straight-forward change versus significant redesign, and
- Impact on schedules for construction, startup and operation.

However, SNUPPS stated that the prioritization scheme did not really assume dominance in the HEF resolution and implementation scheduling processes. The approach SNUPPS took in resolving HEFs was to fix as many HEFs as they could regardless of the assigned priority. So although an assessment or prioritization process was carried out for the large majority of HEFs produced from the PDA and DCRDR, it did not serve very often as a criteria for the HEF resolution or selection of design improvement process. We believe that SNUPPS has met the requirement of NUREG-0737, Supplement 1 regarding assessment of HEFs.

2. Selection of Design Improvement

As can be seen from reading the summarization of the audit findings for resolution of HEFs generated from the Supplemental Survey and the Auxiliary Shutdown Panel review (Appendix A), the backfits selected were found to be

generally acceptable. Several HEFs from the control room survey still remain to be resolved. A total of seven HEFs were identified from the other SNUPPS HEF-producing activities. The one HEF produced from the verification of task performance capabilities and the six HEFs from the validation of control room functions appear to be adequately resolved.

Except for the pending resolution of several HEFs, all HEFs identified in the PDA and thus far in the DCRDR appear to have been satisfactorily resolved. Analysis of the data collected from the environmental surveys may or may not produce HEFs. Any HEFs that are identified from this analysis will be reviewed by the NRC as will proposed resolutions and implementation schedules. We believe that SNUPPS has met this NUREG-0737, Supplement 1 requirement.

3. Schedules for Implementing HEF Corrections

Due to the handling of HEFs on an individual basis rather than fixing backfitting schedules to groups of HEFs, an overall evaluation of these schedules could not be made. Nevertheless, SNUPPS and utility personnel appear to be sincerely interested in accomplishing the changes in the control room in an expeditious manner. Most will be accomplished prior to loading fuel and a few prior to exceeding five percent power operation. Only those that require long lead time parts or more detailed design effort will be accomplished prior to startup from the first refueling outage.

4. Verification that Improvements Will Provide the Necessary Corrections Without Introducing New HEFs

SNUPPS states in its summary report that prior to the implementation of the design improvements, proposed redesigns are reviewed to determine that (1) the selected design improvements will provide the necessary correction and (2) the design improvement does not introduce new HEFs (p. 2-3). The procedure for this review begins with an evaluation of the redesign against the HEF and the recommended resolution (if provided). SNUPPS evaluates changes involving "significant" redesign by "usually" depicting them on a full-scale mock-up or full-scale drawings of the control boards. Several concerns we have over the use of the words "significant" and "usually" by SNUPPS in their summary report are: (1) how SNUPPS defines "significant redesign, (2) whether or not any changes not defined as "significant" are verified on the mock-up or drawings, and (3) whether or not the word "usually" means in this context that some significant changes have not been verified on the mock-up or drawings. The implications here are for the comprehensiveness and systematism of SNUPPS' approach to verifying HEF corrective changes. The HEF correction verification process also includes the performance of walk-throughs of selected procedures on either the full-scale mock-up, the simulator, or the control room after changes have been made.

We believe some kind of verification of HEF corrective changes was performed but do not feel assured that what was done was systematic or comprehensive. Although walk-throughs of procedures exercising the system or components that were redesigned is an excellent method for performing the

verification process, the procedures selected must exercise all changes in order for this walk-through verification to be valid. The documentation and limited discussion on this effort do not assure us that the procedure selection and walk-throughs were comprehensive. SNUPPS should provide additional detailed documentation on the methodology for the walk-through verification effort. The documentation in the summary report demonstrates that some but apparently not all redesigns are verified for correcting HEFs and ensuring the redesign does not introduce new HEFs. Therefore, we conclude that SNUPPS has not demonstrated the performance of a verification of HEF corrective changes which would meet the requirements set forth in NUREG-0737, Supplement 1.

5. Coordination of the DCRDR With Other Improvement Programs

SNUPPS appears to recognize that other improvement programs should be integrated with the DCRDR. SNUPPS addressed our concerns for ensuring that these other programs were integrated with the DCRDR by briefly describing the nature of the integration of the DCRDR with the following programs: (1) the Safety Parameter Display System (SPDS), (2) the Emergency Operating Procedure (EOP) upgrade, (3) training, and (4) the Reg. Guide 1.97 instrumentation.

SNUPPS stated in the summary report that the task analysis considered the integration of the SPDS with the rest of the systems in the control room (p. 1-4, section 1.1.3). Also, the task analysis results were used to verify that the SPDS included all necessary parameters. SNUPPS states that in the course of its development by the WOG, the SPDS was reviewed from a human engineering standpoint. SNUPPS also states that "the locations of the CRTs and printers for the plant computer and SPDS have been selected by Utility Operations personnel in concert with the architect/engineer and utility and staff engineering personnel." This statement seems to indicate that there was no human engineering assistance provided in the selection of the location for the SPDS in the control room.

SNUPPS stated that the results of verification of task performance capabilities and the validation of control room functions will essentially serve as the DCRDR inputs to the EOP upgrade program. Of the seven HEFs identified from these activities, three from the validation effort appear to be possible inputs to the EOP upgrade program. Another activity that may be related to the SNUPPS EOP upgrade program, although it is not so indicated, is the performance of a walk-through of a full set of EOPs at the Callaway simulator (p. 1-4).

At Callaway, plant personnel involved in the DCRDR have participated in the Senior Reactor Operator License Training on the Callaway simulator. During this training period, changes already on the control boards and changes to be incorporated that were generated from the DCRDR were discussed with the entire training class.

The Training Department at Callaway was the primary reviewer of the EOPs which were used in a verification and validation process of the procedures and the control boards. The same will be true for Wolf Creek when the verification and validation process is performed there. During these

reviews, changes to the control boards are included in the procedures to assure sufficient information was available to operators for completion of assigned tasks.

SNUPPS states that due to"...the relatively advanced state of the SNUPPS design relative to operating PWRs, the modifications in response to Reg. Guide 1.97 have been relatively minor. The instrumentation for post-accident monitoring was reviewed as part of the primary review of the control boards." Included in this review by SNUPPS were controls and displays associated with post-TMI modifications.

In summary, SNUPPS appears to be integrating the DCRDR with operator training rather well. The integration of the Reg. Guide 1.97 instrumentation with the DCRDR seems to have been handled sufficiently. Except for the apparent lack of human engineering assistance in selecting a location for the SPDS in the control room, SNUPPS appears to have used all the relevant inputs from the DCRDR and elsewhere (WOG) in developing their SPDS. SNUPPS needs to provide evidence that human engineering principles relative to SPDS/CRT location were considered in the selection of the SPDS location. In addition, the responsible entity in management and their mechanism or approach to coordinating/integrating all the improvement programs should be identified. With the contingency that our concerns in these areas are met, we believe that SNUPPS has fulfilled this coordination requirement of NUREG-0737, Supplement 1.

CONCLUSIONS AND RECOMMENDATIONS

Throughout the audit SNUPPS and utility personnel were found to be very helpful in providing information and assistance when needed by the NRC audit team. We believe this is an extension of their interest in not only meeting the NRC requirements for the DCRDR but also in improving the overall operability of the Callaway and Wolf Creek control rooms. Several DCRDR activities reflect this interest by SNUPPS and the utilities. The control room survey activities including the review of the Auxiliary Shutdown Panel were found to be quite comprehensive. SNUPPS' and the utilities' attentiveness and interest towards properly resolving the HEFs identified from the DCRDR and PDA is noteworthy. Although the Operating Experience Review was not a required activity, SNUPPS found it as a valuable form of feedback to the other DCRDR activities.

Although the activities mentioned above were found to have been performed quite adequately, there were other activities in the DCRDR program about which concerns were raised. The most notable of these activities was the SNUPPS task analysis to determine information and control requirements and the use of the WOG ERG development program as the basis for the SNUPPS task analysis. The low level of involvement of a human factors engineer in the development and performance of the SNUPPS SFR&TA may or may not have had a negative impact upon the outcome of these activities. The poor documentation of these activities at the plant specific level have made evaluation extremely difficult. In order for the WOG ERG development program to form a valid basis for these SNUPPS activities, SNUPPS must be able to demonstrate how they used the generic information and control requirements in the development of their plant-specific requirements. Other elements or

activities of the DCRDR we have concerns for are the verification of HEF corrections and the coordination of the DCRDR with the SPDS and EOP upgrade programs.

We understand that SNUPPS will be submitting a supplement to the summary report consisting of the environmental survey results and further detailed descriptions of several HEF resolutions for the Supplementary Survey and the Auxiliary Shutdown Panel review. At that time an evaluation will be performed on the results of these surveys and the proposed resolutions of any HEFs found.

Based on our evaluation of the SNUPPS DCRDR, we conclude that SNUPPS has met the requirements of NUREG-0737, Supplement 1, with the exception of the areas listed below. Our acceptance of these areas as meeting the requirements of NUREG-0737, Supplement 1 will depend on SNUPPS' response to the comments given in this report.

- Function and Task Analysis
  - The analysis of control requirements for controls involved in "digital" tasks.
  - The analysis of information requirements for instruments involved in "non-digital" tasks.
  - The analysis of control requirements for controls involved in "non-digital" tasks.
- Verification that Improvements Will Provide the Necessary Corrections Without Introducing New HEFs; the methodology for redesign verification.
- Coordination of the DCRDR With Other Improvement Programs
  - Human factors consideration in the selection of the SPDS location.
  - The management entity and approach to coordinating/integrating all the improvement programs.

REFERENCES

1. Detailed Control Room Design Review Program Plan for the Standardized Nuclear Unit Power Plant System (SNUPPS), attachment to letter from N.A. Petrick, SNUPPS, to H.R. Denton, NRC, dated June 30, 1983.

2. Human Factors Engineering Branch Control Room Design Review Technical Evaluation Report for Standardized Nuclear Unit Power Plant System (SNUPPS), attachment to memorandum from V.A. Moore, NRC, to B.J. Youngblood, NRC, dated June 22, 1983.

3. DCRDR Program Plan Evaluation for Wolf Creek Generating Station and Callaway Plant, Unit 1, Science Applications, Inc., September 23, 1983.

4. NRC Staff comments on Detailed Control Room Design Review Program Plan for SNUPPS, attachment to Memorandum from W.T. Russell, NRC, to T.M. Novak, NRC, dated September 26, 1983.

5. Detailed Control Room Design Review Summary Report for the Standardized Nuclear Unit Power Plant System (SNUPPS), February 2, 1984.

6. Detailed Control Room Design Review Program Plan for the Standardized Nuclear Unit Power Plant System (SNUPPS), attachment to letter from N.A. Petrick, SNUPPS, to H.R. Denton, NRC, dated November 28, 1983.

7. NUREG-0660, Vol. 1, "NRC Action Plan Developed as a Result of the TMI-2 Accident," USNRC, Washington, D.C., May 1980, Rev. 1, August 1980.

8. NUREG-0737, "Requirements for Emergency Response Capability," USNRC, Washington, D.C., November 1980.

9. NUREG-0737, Supplement 1, "Requirements for Emergency Response Capability," USNRC, Washington, D.C., December 1982, transmitted to reactor licensees via Generic Letter 82-33, December 17, 1982.

10. NUREG/CR-1580, "Human Engineering Guide to Control Room Evaluation," USNRC, Washington, D.C., July 1980.

11. NUREG-0700, "Guidelines for Control Room Design Reviews," USNRC, Washington, D.C., September, 1981.

12. NUREG-0801, "Evaluation Criteria for Detailed Control Room Design Reviews," USNRC, Washington, D.C., October 1981, draft report.

13. Letter 84-0048 from N.A. Petrick, SNUPPS, to H.R. Denton, NRC, dated March 21, 1984, submitting Callaway implementation schedule for resolutions to SS and ASP findings (Attachment 1) and additional comments made during the NRC audit (Attachment 2).

APPENDIX A

Summarization of Audit Findings for Resolutions of HEFs Generated From the Supplemental Survey and the Auxiliary Shutdown Panel Review

Supplementary Survey

Each of the nine sub-elements of the Supplementary Survey were examined by the NRC audit team with the following assessment of the prescribed findings:

1. Control Room Workspace

   The corrective action and schedule for the resolution of the one finding in this area were determined to be acceptable.

2. Communications

   The corrective action and schedule for the resolution of the eight findings in this area were determined to be acceptable.

3. Annunciator Warning System

   The resolution of the one finding in this area had not been determined pending the completion of the environmental sound survey scheduled for April 1984.

4. Controls

   The corrective action and schedule for the resolution of the six findings in this area were determined to be acceptable. Specific comments related to existing findings/responses were as follows:

   Finding 3 - During the examination of the annunciator reset controls which had been modified to prevent inadvertent operation by recessing the reset and test buttons, the operator was unable to test or reset the annunciators from three of the operating stations. The reviewers verified that appropriate maintenance requests had been initiated to correct this situation.

   Finding 4 - The response in the DCRDR Summary Report indicated that a missing escutcheon plate was to be replaced. Effective corrective action had been taken by the installation of a label instead of the replacement of the escutcheon plate.

5. Displays

   The corrective action and schedule for the resolution of the twenty-one findings in this area were determined to be acceptable. Specific comments related to existing findings/responses were as follows:

   Finding 16 - During the examination of the Hagan controllers that were modified to indicate CLOSED on the left with indicator movement to the right for indication of the CLOSED position, the reviewers observed that the actual operation of the knob which controlled valve position was different for each controller as a

function of the fail-safe position of the valve being operated. In order to retain the convention of CLOSED being indicated to the left and OPEN being indicated to the right, the difference in the direction of knob was determined to be an inherent feature of the system design. Hagan controllers that operate fail-closed valves require that the knob be turned clockwise to open the valve while Hagan controllers that operate fail-open valves require that the knob be turned counter-clockwise to open the valve. In Reference 13, SNUPPS indicated that an enhancement will be added prior to exceeding five percent power operation in the form of a label indicating the proper direction for turning the knob to the OPEN position.

Finding 19 - Discussions with SNUPPS personnel revealed that several months will be required to procure and install the proper recorder paper that corresponds to the scales unique to each individual recorder. The bulk of the recorder paper will be installed prior to exceeding five percent power operation. In the interim, paper with 0 to 100% scales will be used in any recorder that does not have the proper paper installed. In all cases, each recorder will have paper installed and will be properly annotated to indicate time and date by the control room personnel.

6. Labels and Location Aids

The reviewers found the mimics on panels RL017 and RL018 to be acceptable. In addition, the maintenance tag out system for each utility was reviewed and found to be acceptable. No findings were detected in this section.

7. Process Computer

The corrective action and schedule for the resolution of the eighteen findings in this area were determined to be acceptable. Specific comments related to existing findings/responses were as follows:

Finding 10 and Finding 11 - These findings were related to the status feedback to the operator of the computer system operation in the form of messages and cursor indication. The responses in the DCRDR Summary Report were not reflective of the actual operating configuration of the computer system. Discussions with facility personnel indicated that the responses would be revised to reflect the actual operating configuration of the computer system which was determined to be acceptable.

Finding 18 - The reviewers observed the operation of the alarm printer and determined that the last line of print was slightly obscured from the operators view. Facility personnel determined that the replacement of the ribbon and the cleaning of the plastic cover would significantly improve the readability of the last printed line. The NRC audit team concurred with this corrective action.

8. Panel Layouts

The corrective action and schedule for the resolution of the five findings in this area were determined to be acceptable.

9. Control/Display Integration

The corrective action and schedule for the resolution of the one finding in this area were determined to be acceptable. Observations by the reviewers determined that the scale of the reactor vessel level meter was different between facilities. At Callaway the meter scale went to 120 percent while at Wolf Creek the meter scale went to 110 percent. SNUPPS states this difference will be resolved by changing Wolf Creek's meter scale to the correct scale of 120 percent.

In addition to the specific findings described in the SS, the NRC audit team identified three areas related to facility displays that should be addressed and corrective action specified. These items were as follows:

Steam Flow and Feed Flow Indicators - The indicators at the Callaway facility were found to have typed labels for scale markings that were difficult to read and were installed as a result of data determined during hot functional testing. Facility personnel indicated that a work plan had been prepared to correct the scale markings and the corrective action would be complete approximately one week following receipt of the new scales. At the Wolf Creek facility the scales of these meters had not been changed since hot functional testing remains to be accomplished.

High Pressure Turbine First Stage Pressure - These indicators were found to be different between the two facilities. Wolf Creek had meters which indicated from zero to 800 psig while Callaway had meters which read from zero to 900 psig. The meters at Callaway as a result of the rescaling had minor divisions with values of 22.5 psig. This made it very difficult to read the meter without computation by the operator. SNUPPS personnel indicated that the difference between the facilities would be evaluated and a scale selected to improve the readability.

Reactor Coolant Pump Seal Flow - These meters located on panel RL002, were observed to have a non-linear scale configuration that placed the normal operating value for reactor coolant seal flow in the lower 20 percent of the meters indicating range. The SNUPPS personnel indicated that an evaluation would be made to determine if the scales could be reconfigured to more accurately display the anticipated seal flow near its operating value. This evaluation would be applicable to both Callaway and Wolf Creek. Resolution of this issue will be noted by SNUPPS in the supplement to the Summary Report.

Auxiliary Shutdown Panel Review

Each of the nine sub-elements of the review were examined by the NRC audit team with the following assessment of the prescribed findings.

1. Control Room Workspace

The corrective action and schedule for the resolution of four of the six findings in this area were determined to be acceptable. Additional evaluation by SNUPPS and utility personnel is required to determine the resolutions to the following findings:

Finding 1 - The need to place a fire door within the operating area for the panels has resulted in the loss of operating room for the operator at the panels. Additionally at the Callaway facility a door box support bracket and conduit interfere with the operator when standing in front of panel 118B. The fire door (not installed at either facility at the time of the onsite audit) will interfere with the operator when standing in front of Panel 118A. In Reference 13, SNUPPS indicates that the hinge for Union Electric's fire door will be located approximately 12 inches out from the adjacent wall. Additional evaluations by SNUPPS and utility personnel will be necessary to resolve this potential problem. SNUPPS and utility personnel should seek a way to hang the fire door closer to the wall so that it is flush to the wall and out of the way of the operator. SNUPPS has indicated that the conduit and bracket will be removed prior to fuel load.

Finding 5 - The top row of displays on panel 118A and B were examined and determined to be approximately nine inches higher than NUREG-0700 recommends. The affected displays include steam generator level indication, reactor coolant system temperature indication and pressure indication. These displays are utilized during the operation of the panel by the operator and should be readable by personnel representing the fifth percentile in height and taller. The reading of the displays was also hampered by the area limitation described in Finding 1 and poor lighting in the area. Additional evaluations by SNUPPS and utility personnel will determine permanent resolution prior to exceeding five percent power operation. In the interim, a stool will be provided as a temporary solution.

The corrective action and schedule for resolution of the twenty-seven findings in the following areas were determined to be acceptable:

2. Communications

3. Annunciator Warning Systems

4. Controls

5. Visual Displays

6. Labels and Location Aids

7. Process Computers

8. Panel Layout

9. Control-Display Integration