September 28, 1995

Mr. Nicholas J. Liparulo
Nuclear Safety and Regulatory Activities
Westinghouse Electric Corporation
P.O. Box 355
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SUBJECT: STATUS OF AP600 DRAFT SAFETY EVALUATION REPORT (DSER) OPEN ITEM RELATED TO REQUIREMENTS FOR THE SAFETY PARAMETER DISPLAY SYSTEM (SPDS)

Dear Mr. Liparulo:

The Nuclear Regulatory Commission (NRC) staff has recently completed review of revised request for additional information (RAI) response 620.48 (Revision 2 dated June 7, 1995). This response addresses the DSER open item related to the SPDS (Open Item 18.8.2.3-1). The SPDS review is included as part of Element 7 of the Human Factors Engineering Program Review Model. To facilitate communications and coordinate work effort with Westinghouse, a formal assessment has been enclosed detailing how the RAI response resolves this open item. This information is being provided to Westinghouse to ensure that a common understanding of issue closeout in the human factors engineering area is maintained.

If you have any questions regarding this matter, you can contact me at (301) 415-1141.

Sincerely,

original signed by:

William C. Huffman, Project Manager
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Office of Nuclear Reactor Regulation

Docket No. 52-003

Enclosure: DSER Open Item
Resolution of
AP600 SPDS Issues

cc w/enclosure:
See next page

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Docket No. 52-003
AP600

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AP600 DSER Open Item Resolution
SPDS Issues
(Part of Element 7 HSI Design)

To address the open item associated with the SPDS Issues of Element 7, Westinghouse has submitted a response (June 7, 1995) to RAI 620.48. Specifically, this document addresses Open Item 18.8.2.3-1. The results of the review are described in this document.

The following is an overview of the status of the results of the review.

Open Item (OITS #, DSER #)	Current Status
1362 18.8.2.3-1: SPDS Implementation Details	Action W
This open item is based on nine individual SPDS criteria. The status of each is:	
1. General SPDS Requirements	Action W & Action N
2. Rapid and concise display of safety parameters	Action W
3. Convenient display of safety parameters	Resolved (Action W)
4. Continuous display of safety parameters	Resolved (Action W)
5. High reliability	Resolved (Action W)
6. Isolation	Resolved (Action W)
7. Human factors engineering	Resolved (Action W)
8. Minimum information	Action W
9. Procedures and Training	Resolved (Action W)

Enclosure

Open Item 18.8.2.3-1: SPDS Implementation Details

1. GENERAL SPDS REQUIREMENTS

Criterion: The top-level requirements for SPDS are contained in 10 CFR 50.34 (f)(2)(iv). The detailed NRC criteria which follow were derived from NUREG-0737, Supplement 1.

DSER Evaluation: In SSAR Section 18.9.2.2.6, Westinghouse states that "the alarm system meets the requirements of the safety parameter display system (SPDS)." In the response to RAI 620.48 (Revision 0), Westinghouse states that in the AP600 control room, alarms will be better organized, have cause-effect relationships more clearly presented, and be fewer in number than is typical in current control rooms. Westinghouse concludes that this presentation, in combination with the analog information regarding plant processes provided by other control board CRT displays, satisfies the intent of the SPDS requirement.

In SSAR Section 1.9.3, item (2)(iv), Westinghouse states that alarms are grouped "by plant process or purpose, as directly related to the critical safety functions" and that the requirement for analog display of plant parameters is met by similarly grouped information available on graphic CRT displays.

The staff acknowledges that the implementation of SPDS in a new advanced plant will and should be different than that which was backfit into existing NPPs. An implementation as proposed by Westinghouse may satisfy the SPDS requirements. However, the high-level concepts and criteria still should be addressed in such a new implementation. Given the current state of the MCR HSI design, it is not possible to determine whether the SPDS will meet the requirements. Thus the SPDS implementation is considered an open item.

Proposed Resolution: 10 CFR 50.34 (f)(2)(iv) indicates that the design should provide a plant safety parameter display console that will display to operators a minimum set of parameters defining the safety status of the plant, capable of displaying a full range of important parameters and data trends on demand, and capable of indicating when process limits are being approached or exceeded. These requirements are addressed below.

(a) A plant safety parameter display console will be provided that will display to operators a minimum set of parameters defining the safety status of the plant.

In RAI 620.48, Revision 2, Westinghouse addresses the SPDS concerns and criteria via an integrated design rather than a stand-alone, add-on system, as is used at most current operating plants. The regulatory requirements will be met by integrating the SPDS requirements into the design requirements for the alarm and display systems. In NUREG-0800, the staff indicated that, for applicants who are in the early stages of the control room design, the "function of a separate SPDS may be integrated into the overall control room design" (p. 18.0-1).

This general approach to addressing Requirement (a) is acceptable to the staff. However, for the implementation of an integrated SPDS to be acceptable, it must meet the detailed SPDS requirements contained in this open item.

(b) The SPDS will be capable of displaying a full range of important parameters and data trends on demand.

The minimum set of parameters defining safety status is reviewed in Criterion 8. With respect to other "important parameters," the Westinghouse's integrated M-MIS design provides parameter display to operators via the wall panel information display and the workstation displays. A complete specification of the individual parameters to be displayed will be developed as the MCR design and its supporting analyses, such as FBTA and HRA, continue. In response to RAI 620.48 (Revision 2), Westinghouse indicated that ESF actuation signals (reactor trip, safety injection, containment isolation) are signals that are available for display. In SSAR Section 18.9.5.1, Westinghouse indicates that the plant parameters needed to satisfy RG 1.97 are identified in an analysis of operator monitoring of the RCS, secondary heat removal system, the containment and the system used for attaining safe shutdown conditions. SSAR chapter 7 identifies parameters for the monitoring of CSFs and PAM. The ability of operators to call up data trends on demand is implied in Section 18.9.5.

Requirement (b) remains open, the details of which are described in the staff's evaluation of criterion 8 of this review.

(c) The SPDS will be capable of indicating when process limits are being approached or exceeded.

This SPDS function of Requirement (c) will be satisfied by the AP600 alarm management system.

Another set of top level requirements for the SPDS is contained in NUREG-0737-Supplement No. 1, 3.8.a, Items (1), (2), and (3). These are expressed in terms of one acceptable way of implementation with other proposals to be reviewed as necessary.

Item (1) states that the licensee/applicant should review the functions of the nuclear power plant operating staff that are necessary to recognize and cope with rare events that (a) pose significant contributions to risk, (b) could cause operators to make cognitive errors in diagnosing them, and (c) are not included in routine operator training programs.

Item (2) states that the licensee/applicant should combine the results of this (1) review with accepted human factors principles to select parameters, data display, and functions to be incorporated into the SPDS.

Item (3) states they should then design, build, and install the SPDS in the control room and train its users.

Westinghouse's selection of rare events that present significant contributions to risk for use in control room (and hence SPDS) design is discussed in their June 30, 1995 response to DSER open items 18.5.3-1 and -2 (a detailed discussion to this response is provided separately). However, the staff and Westinghouse have not yet reached resolution on risk criteria for selecting those activities to design the control room (and hence the SPDS). Thus, NUREG 0737, Supplement No. 1, 3.8.a, Item (1) remains open.

Westinghouse has committed to design, build and install the SPDS/control room in accordance with accepted human factors principles as discussed throughout the entire Section 18. This commitment acceptably addresses NUREG 0737, Supplement No. 1, 3.8.a, Item (2). Further, the training of users is acceptably discussed by Westinghouse in their response to the PRM Training Element and, therefore, NUREG 0737, Supplement No. 1, 3.8.a, Item (3) is adequately addressed.

10 CFR 50.34 (f)(2)(iv) Requirement (b) and NUREG 0737, Supplement No. 1, 3.8.a, Item (1) remain open.

STATUS OF THE CRITERION: ACTION W AND ACTION N

2. RAPID AND CONCISE DISPLAY OF SAFETY PARAMETERS

Criterion: The SPDS should provide a rapid and concise display of critical plant variables to control room operators.

DSER Evaluation: The rapidity with which SPDS related alarms and displays will be presented is not explicitly discussed. In SSAR Section 18.9.2.4.9, Westinghouse describes the processing time, update rate, and display access time requirements for the alarm system as a whole. The maximum processing time permitted from data input to alarm display is given as 2-3 seconds. The refresh rate for the display of a process variable is no less frequently than once every two seconds. The time permitted for the system to create and show a requested display (or to acknowledge the request for a complex display) is two seconds.

DSER Evaluation of the conciseness of the presentation of SPDS-related information depends on implementation details not available at this time.

Proposed Resolution: The basis for the requirement for a concise display stems from the lack of centralized display capability in the TMI-2 control room. TMI-2 control room personnel could not easily develop an overview of plant conditions, which contributed to the severity of the accident. In their response to RAI 620.48 (Revision 2) checklist items 3.1, 3.2 and 3.3, Westinghouse states that backfit applications of the AWARE alarm management system are organized around the concept of plant process functions, which include the five safety functions defined by the NRC for the SPDS. The layout of these functions ensures that they are always visible. For the AP600, a similar design will be used for the Wall Panel Information System. Further, the Westinghouse computerized Emergency Operating Procedure (EOP) System (COMPRO) provides a continuous display of the overall state of each of the five safety

functions. The AP600 computerized procedures for the EOPs will have the same feature. Westinghouse has also committed to group the individual parameters that support the safety functions by those safety functions in both the AP600 alarm system and the Plant Information System displays. And, Westinghouse has stated that the status of all five safety functions will always be displayed via the alarm system overviews that will be displayed to the operators through the Wall Panel Information System.

Regarding the criterion of a rapid display, this includes the concepts of real-time data, sample rate, update rate, system response times, and an easy-to-understand format that can be rapidly comprehended.

Westinghouse, in item 5 of the checklist response to RAI 620.48 (Revision 2), states that while the full control room (and SPDS) is not designed yet, the design goal for the graphical display response time is 2 sec; the design goal for AP600 M-MIS is to update the displays every 1 to 2 sec; the process data sampling is 1 sec or less; and sequence of events points can be sampled at a rate of once every millisecond and are available as appropriate within the AP600 M-MIS. Westinghouse also commits to develop appropriate human-factored display formats. These commitments meet the criterion with the exception of response time, as explained following.

The acceptability of a display response time of two seconds for operator support during transient operations may be problematic for operators. The staff recognizes that this is within the response time originally developed for SPDS. However, such SPDS consoles were supplemental to the available indications and controls. It is also recognized that 2 sec. response time is within the time range recommended by most current HFE guidelines. However, these HFE response times are based on general literature and, therefore, the times may not be fully adequate for emergency operations in a process control environment such as a nuclear power plant. They have the potential to create frustration in operators who are used to having information instantly available through continuously displayed analog instruments. The staff recommends that Westinghouse commit to verify the acceptability of the two second criterion and if found unacceptable to determine the appropriate display response time.

This item is open pending a commitment to determine display response time during the MCR (SPDS) conceptual testing and evaluation.

STATUS OF THE CRITERION: ACTION W

3. CONVENIENT DISPLAY OF SAFETY PARAMETERS

Criterion: The location of the SPDS should be convenient to control room operators.

DSER Evaluation: In SSAR Section 1.9.3, item (2)(iv), Westinghouse states that "displays are available at the operator workstations, the supervisor workstation, the remote shutdown workstation, and the technical support center."

Proposed Resolution: To meet this criterion the SPDS should be convenient to all operators/users of the SPDS. In Westinghouse's response to RAI 620.48 (Revision 2) in section 5 of the checklist, they indicated that the SPDS would utilize the main control alarm system and display system in order to fully integrate the SPDS into the AP600 M-MIS. All process displays and controls (including the SPDS) will be available at each of the two redundant operator workstations. The control room supervisor has another console that contains all of the same displays. The STA also has a console with all displays. Finally, the Wall Panel Information System is a parallel display device that also contains the SPDS information and is available and viewable by all in the control room.

Based on this information, this DSER issue is considered resolved.

This criterion will be satisfied when the commitment to have a convenient display of safety parameters is made in an appropriate ITAAC and the SSAR is revised to include a description of the process Westinghouse will use to ensure that SPDS will be convenient to operators.

STATUS OF THE CRITERION: RESOLVED (ACTION W)

4. CONTINUOUS DISPLAY OF SAFETY PARAMETERS

Criterion: The SPDS should continuously display plant safety status information.

DSER Evaluation: In the response to RAI 620.50 Westinghouse states that "the AP600 control room design concept is that few or no displays will be fixed or continuously displayed." The response notes that the advantages of spatial dedication are employed in the alarm overview displays and the wall panel information system, but notes that the displays have operator-selectable elements and are dynamic (i.e., change with plant state).

Proposed Resolution: Westinghouse's response to RAI 620.48 (Revision 2) indicates that the status of all five safety functions is always displayed via the alarm management system. The alarm system is organized on the dark board concept for all plant modes. Thus, no alarms indicates that the status of all safety functions is acceptable. The alarm system also will have failure indicators to ensure the operability of the alarm system itself. Further, the response in checklist item 3.1 states that the AP600 computerized procedures for EOPs will provide a continuous display of the overall state of each of the safety functions as part of the EOP requirement to monitor the status of the Critical Safety Function Status Trees.

Based on this information, this DSER issue is considered resolved.

This criterion will be satisfied when the commitment to provide a continuous display of safety parameters is made in an appropriate ITAAC and the SSAR is revised to include a description of the process Westinghouse will use to provide a continuous display of safety parameters.

STATUS OF THE CRITERION: RESOLVED (ACTION W)

5. HIGH RELIABILITY

Criterion: The SPDS should have a high degree of reliability.

DSER Evaluation: A response to this criterion was not received by the staff in time to be evaluated for inclusion in the DSER.

Proposed Resolution: The SPDS is to be incorporated into the AP600 control room, however the control room is not yet designed. Westinghouse's response to RAI 620.48 (Revision 2), checklist item 4 indicates that availability and reliability criteria will be included in the design process as is standard for Westinghouse I & C systems. The Westinghouse response to this criterion (i.e., a commitment by Westinghouse to provide a description of how a high degree of reliability will be achieved for all I&C systems including the SPDS) has been determined acceptable by the Instrumentation and Control Branch.

Based on this information, this DSER issue is considered resolved.

This criterion will be satisfied when the commitment to provide the SPDS function with a high degree of reliability is made in an appropriate ITAAC and the SSAR is revised to include a description, acceptable to the Instrumentation and Control Branch, of the process Westinghouse will use to provide the high degree of reliability for the SPDS function.

STATUS OF THE CRITERION: RESOLVED (ACTION W)

6. ISOLATION

Criterion: The SPDS should be suitably isolated from electrical or electronic interference with safety systems.

DSER Evaluation: A response to this criterion was not received by the staff in time to be evaluated for inclusion in the DSER.

Proposed Resolution: Westinghouse's response to RAI 620.48 (Revision 2), checklist item 7 states that a discussion of the electrical isolation for the control room is in SSAR Chapter 7. The Westinghouse response to this criterion (i.e., that data links are fiber-optic isolated, transmit only, to the monitor bus) has been reviewed by the Instrumentation and Control Branch and determined to acceptably address suitable isolation of the SPDS.

Based on this information, this DSER issue is considered resolved.

This criterion will be satisfied when the commitment to provide a suitably isolated SPDS function is made in an appropriate ITAAC.

STATUS OF THE CRITERION: RESOLVED (ACTION W)

7. HUMAN FACTORS ENGINEERING

Criterion: The SPDS should be designed incorporating accepted human factors principles.

DSER Evaluation: While the human factors engineering of the alarm system and graphic displays that serve the SPDS function, as described in SSAR Section 18.8 and 18.9, is addressed as part of the overall control room human factors engineering design process review, specific commitment to SPDS HFE as per NRC requirements is needed.

Proposed Resolution: Westinghouse's response to RAI 620.48 (Revision 2) states that the SPDS will be incorporated in the control room alarm and display systems. In accordance with the PRM element on HSI design (evaluated herein), it is considered that the HSI design is acceptable at the program plan level. The detailed implementation of SPDS displays, controls, and interface management (e.g., navigation) characteristics will not be complete until after design certification.

Based on this information, this DSER issue is considered resolved at the program plan level.

This criterion will be satisfied when the commitment to provide an SPDS designed to incorporate accepted human factors principles is made in an appropriate ITAAC and the SSAR is revised to include a description of the process Westinghouse will use to provide an SPDS designed to incorporate accepted human factors principles.

STATUS OF THE CRITERION: RESOLVED (ACTION W)

8. MINIMUM INFORMATION

Criterion: The SPDS should display sufficient information to determine plant safety status with respect to safety functions (as shown in Table 2 of NUREG-1342). The safety functions and parameters of Table 2 were developed for conventional PWRs. They will still generally be applicable for the AP600, but will need to be revised slightly to address the AP600, passive plant differences.

DSER Evaluation: DSER Evaluation of this level of detail is premature, hence this criterion will remain open and is part of Open Item 18.8.2.3-1 above.

Proposed Resolution: In discussing the minimum parameters for display, NUREG-1342 states that the minimum information to be provided shall be sufficient to provide information about the following five safety functions: reactivity control, reactor core cooling and heat removal from the primary system, RCS integrity, radioactivity control, and containment conditions. The specific parameters to be displayed are to be determined by licensees and applicants. Sample acceptable parameter for BWRs and PWRs are contained in Tables 2 and 3 of NUREG-1342.

In Westinghouse's response to RAI 620.48 (Revision 2) checklist item 2.1, they indicate that presentation of process data through the abnormality (alarm) messages on the Wall Panel Information System and through the VDU graphical displays is organized around these five safety functions. However, Westinghouse takes exception to the reactor core cooling and heat removal function. Specifically, Westinghouse will define that function at the level of individual parameters such as RCS temperature, RCS water mass inventory, RCS pressure, RCS circulation, steam generator water level, RHR flow, and RHR heat exchanger delta-temperature. Westinghouse states that integrating these parameters into a single function increases operator workload because if a problem occurs, then the operator must mentally determine which of the sensed variables (parameters) must be addressed. Further, Westinghouse indicates that the AP600 M-MIS will support the operator activity of situation assessment at the same level of abstraction as the control devices with which operators must use to take corrective actions.

In the staff's opinion, decomposing the reactor core cooling and heat removal function into several parameters will, potentially, detract from the operator's ability to monitor that CSF i.e., rapid determination that the status of each CSF is acceptable. Westinghouse's proposed approach appears to create additional workload associated with the operator having to check each individual parameter status to determine that the function is satisfactory. This is one of the problems that led to the staff's requirement for an SPDS. Presenting both levels of display (function and individual parameter) however, is an approach consistent with a levels of abstraction view. When a problem occurs, operators will not have to "mentally determine which of the sensed variable must be addressed," with the more detailed information being presented (e.g., automatically) and will also be able to monitor the status of the CSF. The Westinghouse approach seems to imply that information should only be presented at one level of abstraction, i.e., the level at which the operator controls the process. However, the design philosophy generally seems to be that various levels of abstraction are desirable because, depending on the task, different levels are necessary. The task of monitoring CSFs is supported by a display at a higher level. As an example for the function in question (reactor core cooling and heat removal from the primary system), potential function level displays could be subcooling margin, heat transfer rate from the reactor, and heat transfer rate from the primary to the secondary.

In Westinghouse's response to RAI 620.48 (Revision 2) checklist item 2.2, they indicate that the variables depicting each of the five safety functions are in SSAR Section 7.5.3.2, Table 7.5-5 (Type B Variables and parameters). Individual parameters for the safety functions acceptable by the staff for PWRs are listed in Table 2 of NUREG-1342 and were used as the starting point for the staff's review.

(i) For reactivity control, the SPDS should display power range, intermediate range and source range reactor power. SSAR Table 7.5-5 indicates that for AP600 this function will include neutron flux, control rod position, and boric acid concentration. Various ranges of neutron flux are not described.

(ii) For reactor core cooling and heat removal, the SPDS should monitor RCS level, subcooling margin, temperatures (Th, Tc, core exit), steam generator (SG) pressure, and RHR flow. SSAR Table 7.5-5 contains all of these except RCS level, subcooling margin, and steam generator pressure.

(iii) For RCS integrity, the SPDS should monitor RCS pressure, Tc, containment sump level, and for the steam generator (SG) - pressure, level, and blowdown radiation. SSAR Table 7.5-5 indicates that this function will include RCS pressure, WR Th, WR Tc. Sump levels (except perhaps as containment water level) and SG parameters are not addressed.

(iv) For radioactivity control, the SPDS should monitor effluent stack monitors, steamline radiation, and containment radiation. Of these, only containment area high range radiation is included in Table 7.5-5.

(v) For containment conditions, the SPDS should monitor containment pressure, containment isolation status, and hydrogen concentration. SSAR Table 7.5-5 indicates that this function will include containment pressure, containment area high range radiation, containment water level, and hydrogen concentration. Containment isolation status does not appear to be addressed.

This item remains open. Westinghouse should provide further explanation of why their proposed approach to monitoring the core cooling and heat removal function will not result in an increase operator workload and explanation for the parameters that are not included as noted in the staff's review.

STATUS OF THE CRITERION: ACTION W

9. PROCEDURES AND TRAINING

Criterion: Procedures and operator training, addressing actions with and without SPDS, should be implemented.

DSER Evaluation: Since SPDS is not treated as a separate entity in the SSAR, procedures addressing actions related to SPDS are not discussed. Due to the integrated nature of the proposed SPDS implementation for AP600 the common approach could be acceptable.

Proposed Resolution: Concerning the relationship between procedures and SPDS, Westinghouse's response to RAI 620.48 (Revision 2) indicates that all parameter units, labels and abbreviations on SPDS are consistent with the units of measure included in the EOPs. Since detailed displays and EOPs have not been developed yet, this should be a commitment to verify. Provisions for operations with and without critical safety function monitoring should be included in the commitment.