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DCP/NRC0704
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Document Control Desk
U. S. Nuclear Regulatory Commission
Washington, DC 20555

ATTENTION: T. R. QUAY

SUBJECT: DRAFT WCAP-14822, AP600 QUALITY ASSURANCE PROCEDURES SUPPORTING NRC REVIEW OF AP600 SSAR SECTIONS 18.2 AND 18.8

REFERENCES:

1. WCAP-12601 REVISION 19, AP600 PROGRAM OPERATING PROCEDURES.
2. NSD-NRC-96-4874, PROGRESS TOWARD RESOLVING ELEMENT 2 AND 4 OPEN ITEMS FOR AP600, 12/16/96.
3. LETTER FROM NRC TO WESTINGHOUSE (HUFFMAN TO LIPARULO), COMMENTS ON OPEN ITEMS ASSOCIATED WITH THE AP600 SAFETY PARAMETER DISPLAY SYSTEM (SPDS), 12/19/96.
4. LETTER FROM NRC TO WESTINGHOUSE (HUFFMAN TO LIPARULO), COMMENTS ON AP600 RELATED OPEN ITEMS ASSOCIATED WITH ELEMENT 1 OF THE HUMAN FACTORS ENGINEERING PROGRAM REVIEW MODEL 1 (HFEPRM), 12/20/96
5. LETTER FROM NRC TO WESTINGHOUSE (HUFFMAN TO LIPARULO), COMMENTS ON AP600 RELATED OPEN ITEMS ASSOCIATED WITH ELEMENT 7 OF THE HUMAN FACTORS ENGINEERING PROGRAM REVIEW MODEL (HFEPRM), 12/20/96.

Dear Mr. Quay:

This letter is written to address DSER Chapter 18 open items for NUREG-0711 Elements 1 and 7 which are related to information from Reference 1. Attached is a draft of WCAP-14822 which is comprised of the pertinent procedures from Reference 1 and is created to facilitate NRC review of AP600 SSAR Sections 18.2 and 18.8. The NRC is requested to review the attachments to this letter to ensure they contain enough information for the NRC to consider Westinghouse activities complete for the following DSER open items:

E004

DSER Item	OITS #	Status
18.2.3.3-1	1305	WCAP-14822 will complete Westinghouse activities for this item.
18.2.3.3-2	1306	WCAP-14822 will complete Westinghouse activities for this item.
18.2.3.3-3	1307	WCAP-14822 will complete Westinghouse activities for this item.
18.2.3.3-4	1308	WCAP-14822 will complete Westinghouse activities for this item.
18.2.3.3-5	1309	WCAP-14822 will complete Westinghouse activities for this item.
18.2.3.3-6	1310	Inclusion of the attached SSAR Section 18.2.3.5 markup in the SSAR and WCAP-14822 will complete Westinghouse activities for this item.
18.2.3.4-1	1311	The NRC is reviewing the Design Issues Tracking System information submitted in Reference 2. Assuming acceptability of that information, submittal of WCAP-14822 will complete Westinghouse activities for this item.
18.8.1.3-1	1354	WCAP-14822, and closure of OITS item 1356 will complete Westinghouse activities for this item.
18.8.1.3-3	1356	Inclusion of the attached SSAR Section 18.8.1.9 markup in the SSAR and revision to WCAP-14396 Revision 1 to identify workload as a performance measure for concept test 4 (see attached markup) will complete Westinghouse activities for this item.
18.8.1.3-7	1360	WCAP-14822 will complete Westinghouse activities for this item.
18.8.1.3-8	1361	WCAP-14822 will complete Westinghouse activities for this item.

Please note that this letter does not address NRC comments received in Reference 3 for the AP600 Safety Parameter Display System, which is also part of NUREG-0711 Element 7. That DSER open item is 18.8.2.3-1 and will be resolved separate from this letter.

The following table lists the Quality Assurance procedures from Reference 1 which are contained in the attached draft WCAP. The NRC reviewed these procedures during an audit on April 5 and 6, 1995, at the Westinghouse office in Rockville, Maryland. For each of these procedures, the table provides the procedure number, revision number reviewed by the NRC, the current revision, and an explanation of changes. In addition to these procedures, the attached WCAP contains a markup of the AP600 Program Procedure Matrix which provides some information related to design organizations external to Westinghouse.

In summary, the NRC is requested to review the attached draft WCAP and advise Westinghouse as to whether or not it meets the NRC needs with respect to review of AP600 SSAR Sections 18.2 and 18.8. This WCAP is expected to be released as Revision 0 in February 1997. Please contact Robin K. Nydes (412) 374-4125 if you have any questions regarding this transmittal.

Brian A. McIntyre, Manager
Advanced Plant Safety and Licensing

/jml

enclosure

cc: Jim Bongara, NRC - 1L, 1E
Bill Huffman, NRC - 1L, 5E
John O'Hara, BNL - 1L, 1E
Jim Higgins, BNL - 1L, 1E
Meena Mutyala, Westinghouse - 1L, 1E

AP600 Procedure Number	Audited Revision Number, Date	Current Revision Number, Date	Description of Changes
AP 3.1	1, 2/28/91	2	Revision 2 is a basic re-write to make reference to the SSD Writers Guide and to clarify the SSD preparation and revision process.
AP 3.2	3, 3/11/94	6	Revision 4 adds responsibilities for Design Certification Project Manager, adds requirements for reporting for CCB members that are absent or not represented at a CCB meeting, for design changes due to incorrect design, for Class 1 and 2 Design Certification Impact Review, and for concurrence of APSL Manager for Class 2 DCPs. Revised Engineer's responsibilities to ensure review of impacted areas in addition to those identified in the DCP. Revised criteria in tables 1, 2, and 3 for determining DCP Class. Added Table 4 to identify systems that are analyzed in PRA. Revision 5 clarifies the responsibilities of the DCP initiator, Westinghouse Project Manager, CCB Secretary, and DCP Administrator; clarifies the process for DCPs submitted by organizations external to ATBA; clarifies the process when DCPs are withdrawn, not approved, or when impactees do not concur. It also adds new options for dispositioning DCPs and a flowchart to describe the DCP process. Revision 6 eliminates the use of "Advanced DCPs" and incorporates a 10CFR50.59 type change control.
AP 3.5	1, 8/9/91	2 (draft)	Although Revision 2 is not currently available, it will include a Human Factors Engineering checklist similar to that previously contained in WCAP-9817 (which is obsolete).
AP 3.6	2, 3/11/94	2	n/a
AP 3.7	0, 2/8/91	0	n/a
AP 3.12	0, 10/31/91	1 (draft)	Revision 1 will be a basic re-write to reflect functional requirements rather than details which would require future updates (e.g., deleting reference to SQL-Link, InterLink, VAX, etc.)
AP 3.14	0, 10/31/91	0	n/a
AP 7.2	0, 8/9/91	1	Revision 1 is a basic re-write to prescribe the process for control of supplier submittals.

The "AP600 Program Procedure Matrix" of Reference 6 identifies the procedures that apply to subcontractor design organizations. The procedures of Reference 6 that describe the design documentation apply to these external organizations with respect to content and format requirements.

Activities within subcontractor design organizations are performed in accordance with the written procedures of those organizations. Effective implementation of each organization's quality assurance program is monitored by their respective internal audit programs, and by supplier audits. See Section 17.3 for quality assurance requirements associated with subcontractor human factors engineering design efforts.

18.2.4 Human Factors Engineering Issues Tracking

A tracking system is used to address human factors issues that are known to the industry and/or identified throughout the life cycle of the human factors engineering/human system interfaces design, development, and evaluation. The tracking system enables the documentation and tracking of issues that need to be addressed at some later date.

Tracking of human factors engineering issues is accomplished within the framework of the overall plant design process. In this manner, human factors engineering issues are addressed in the same way as those for other disciplines.

The design issues tracking system database is used to track AP600 design issues to resolution, including human factors engineering issues. This database receives input from the following three sources:

- Operating experience review
- Design reviews
- Design issues associated with the design of the man-machine interface/human sy interface and the operations and control centers system

For each design issue entered into the database, the actions taken to address the issue an final resolution of the issue are documented.

The human factors issues in the operating experience review report (Reference 1) tha identified as requiring further consideration by the AP600 design are entered into the de issues tracking system database.

The design review process also provides input to the design issues tracking system database. For each design issue identified through the design review process, an action item is initiated. Action items are entered into the design issues tracking system database. Human factors action items from design reviews are included in the database. For preliminary and intermediate design reviews, some action items may be deferred to a more appropriate, subsequent design review. The responsibility of entering design review action items into the design issues tracking system database is assigned to the manager responsible for the system reviewed.

Human factors engineering design issues directly associated with the AP600 human system interfaces and the operations and control centers system (such as the main control room, remote shutdown facility, and technical support center) are entered into the design issues tracking system database. These are design issues that are identified by the human system

Figure 18.2-3 provides a program milestone schedule of human factors engineering tasks showing relationships between human factors engineering elements and activities, products, and reviews. Internal design reviews are performed at various points throughout the design process.

18.2.6 Combined License Information

The Combined License applicant referencing the AP600 certified design is responsible for the emergency operations facility design including specification of the location.

18.2.7 References

1. NUREG-0711, "Human Factors Engineering Program Review Model," U.S. NRC.

2. WCAP-14645, "Human Factors Engineering Operating Experience Review Report For The AP600 Nuclear Power Plant."

3. WCAP-14694, "Designers Input to Determination of the AP600 Main Control Room Staffing Level."

4. WCAP-14644, "AP600 Functional Requirements Analysis and Allocation."

5. Reason, J.T., "Human Error," Cambridge, U.K., Cambridge University Press, 1990.

6. WCAP-14822 Revision 0, "AP600 Quality Assurance Procedures Supporting NRC Review of AP600 SSAR Sections 18.2 and 18.8", February 1997.

Test Method: The participant will be asked to locate a particular piece of information requi navigation through the displays. Specific information requests will be defined to exercise var available navigation mechanisms.

Testbed Characteristics: This test will be performed in the high-fidelity simulator at Waltz

Type of Materials: The test will be performed using physical displays and possibly function displays for the plant simulated in the high-fidelity simulator at Waltz Mill. The displays, while not AP600-specific, will be representative of the AP600 Functional Requirements for workstation displays.

Performance Measures:

To assess the performance issues, the following will be recorded:

- Whether the information is located
- Response times
- The navigation path taken to get to the target display

The navigation path length to get to the target information will be compared to the *optimal* navigation path identified *a priori* by the designer.

In addition, subjective judgments will be elicited from the participants regarding the adequacy of display coding conventions and navigation mechanisms, and to assess workload.

Outcome: This test will assess the adequacy of the AP600 Functional Requirements for display coding and navigation.

Concept Test 5: Coordination of physical and functional displays

Issue: This test addresses the use and coordination of physical and functional displays supporting situation awareness and response planning (Evaluation Issue 6), including the types of information expected to be drawn from physical and functional displays, when these displays should be accessed, and how physical and functional displays are to be coordinated.

Specific issues include whether the workstation physical and functional displays support the operator in:

- Distinguishing situations where physical displays should be examined from situations where functional displays should be examined
- Understanding interrelationships among systems and processes
- Assessing whether currently active processes are performing correctly

The human system interface resources are chosen based upon utility requirements and review of operating experience. The goal of the human system interface design is to provide the operators with effective means for acquiring and understanding plant data and executing actions to control the plant's processes and equipment. Through implementation of the human system interface design process, the identified AP600 human system interface resources are developed. The man-in-the-loop concept testing is used to determine the adequacy of the human system interface resource. As shown in Figure 18.2-3, the results of the concept testing are used to refine the design.

Design alternatives for a feature within an human system interface resource (such as the use of a mouse, trackball, or touchscreen for soft controls) are evaluated. A decision is made based upon evaluation methods including human factors/trade-off studies, reviews of nuclear industry operating experience or reviews of other industry experience, man-in-the-loop concept testing, and utility input. The basis and rationale for the decisions are provided in the functional design documentation.

18.8.1.9 Human System Interface Characteristics: Identification of High Workload Situations

Identification of high operator workload situations and their consequent changes in operator response times or likelihood of operator error, is a usability issue. Potential impact on operator workload is a criterion in selecting the human performance issues identified in Section 18.11.

Identification of high-workload situations through analytic techniques and part-task simulations, is part of the human factors engineering program (Section 18.5 on Task Analysis and Reference 9 on the AP600 man-in-the-loop test plan).

Reference 9 includes concept tests to assess the impact of secondary tasks associated with display system navigation and management. The series of concept tests include collection of data designed to characterize the quality and severity of workload. Subjective workload assessment techniques are used.

(such as the SWAT technique (Reference 46), the NASA TLX technique (Reference 47) or equivalent techniques

Use of Workload Measurement Techniques

As part of task analysis activities (Section 18.5), analytic approaches are used to estimate workload. Analytic methods include the use of computer-based models of cognitive responses to control room events. This tool or functionally similar tools are used to support workload analysis.

Usability Guidance

Design guideline documents are developed that synthesize results of reviews of the relevant human system interface literature, experience in nuclear power plants and related industries, and results of in-house concept tests. These documents contribute to the design basis for design of human system interface resources. For example, the use of soft controls in the design of the AP600 human system interface builds on existing human system interface

18.8.2.6 Minimum Information

The AP600 human system interface resources used to address the Safety Parameter Display System requirements are the alarm system, plant information system, and the computerized procedure system. The AP600 human system interface displays sufficient information to determine plant safety status with respect to the Safety Parameter Display System safety functions. The safety functions and respective parameters presented in Table 2. of Reference 31 is used as a starting point for the AP600. The human system interface design implementation plan is described in subsection 18.8.1 and includes the integration of Safety Parameter Display System requirements into the human system interface. The Safety Parameter Display System design issue of "minimum information" is tracked by the human factors engineering issues tracking system.

18.8.2.7 Procedures and Training

As stated in Sections 13.2 and 13.5, the development of training programs and plant procedures are the responsibility of the Combined License applicant. Reference 30 describes how training insights are passed from the designer to the Combined License applicant. Reference 31 provides input to the Combined License applicant for the development of plant operating procedures.

18.8.3 Operation and Control Centers

The human system interface includes the design of the operation and control centers (operation and control centers). The design of each of these control centers is conducted using the human system interface implementation plan presented in subsection 18.8.1. The mission for each of the operation and control centers in the AP600 is provided in the next eight subsections. Coupled with each mission statement is a brief description of the major tasks and design features that are supported by that center.

18.8.3.1 Main Control Room Mission and Major Tasks

The mission of the main control room is to provide a seismically qualified habitable and comfortable location for housing the resources for a limited number of humans to monitor and control the plant processes.

The major tasks performed in the main control room include monitoring, supervising, managing, and controlling those aspects of the plant processes related to the thermodynamic and energy conversion processes under normal, abnormal, and emergency conditions. Operating staff can monitor, supervise, manage, and control processes that have a real-time requirement for protecting the health and safety of operating personnel. The main control room supports the operator's decision-making process, and promotes the interaction with other plant personnel, while preventing distractions by non-operating personnel. The main control room provides the interfacing resources between the operation of the plant and the maintenance of the plant. Its areas include the main control area, the switching and tagging area, the shift

7. NUREG/CR-6501, "Human Factors Engineering Guidelines for the Review of Advanced Alarm Systems," U.S. Nuclear Regulatory Commission, Washington, D.C., September 1994.

8. U.S. Department of Defense, "Human Engineering Guidelines for Management Information Systems," DOD-HDBK-761A, Office of Management and Budget, Washington, D.C., 1990.

9. WCAP-14396, "Man-In-The-Loop Test Plan Description.", Revision 2, January 1997

10. AP600 Document Number OCS-J1-008, "Effects of Control Lag and Interaction Mode on Operators' Use of Soft Controls," September 23, 1994.

11. Hoecker, D.G. and Roth, E. M., "Man-Machine Design and Analysis System (MIDAS) Applied to a Computer-Based Procedure-Aiding System," Westinghouse STC Report 1SW5- CHICR-P2, May 25, 1994; also in "Proceedings of the Human Factors and Ergonomics Society 35th Annual Meeting," October 1995.

12. Hoecker, D.G. and Roth, E. M., "MIDAS in the Control Room: Applying a Flight Deck Cognitive Modeling Tool to Another Domain," Westinghouse STC Report 1SW5-CHICR-P3, September 26, 1994; also in RAF Institute of Research and Development, "Proceedings of the Third International Workshop on Human-Computer Teamwork," Cambridge, UK, September 26, 1994.

13. Roth, E. M. and Hoecker, D. G., "Human Factors Issues Associated with Soft Controls: Design Goals and Available Guidance," 1994.

14. Beranek, L. L., " Revised Criteria for Noise in Buildings," Noise Control, Vol. 3, Nr.1, p. 19ff.

15. Grandjean, E., "Fitting the Task to the Man: An Ergonomic Approach," London: Taylor and Francis Ltd., 1981.

16. Van Cott and Kinkade, "Human Engineering Guide to Equipment Design," Washington D.C.: U.S. Government Printing Office, 1972.

17. Electric Power Research Institute, "Human Factors Guide for NPP Control Room Development," Final Report on Project 1637-1. EPRI NP-3659, 1984.

18. Electric Power Research Institute, "Advanced Light Water Reactor Utility Requirements Document, Vol. III. ALWR Passive Plant, Chapter 10: Man-Machine Interface Systems," Revision 6, December 1993.

19. International Electrotechnical Commission, "Design for Control Rooms of Nuclear Power Plants," IEC Standard 964. 1989.

20. International Electrotechnical Commission, "Operating Conditions for Industrial-Process Measurement and Control Equipment," IEC Standard 654-1, 1979.

21. Proctor, D H. and Hughes, J. P., "Chemical Hazards of the Workplace," 1978.

22. 29CFR1910, "Occupational Safety and Health Standards," 1975.

23. WCAP-14651, "Integration of Human Reliability Analysis With Human Factors Engineering Design Implementation Plan.", Revision 1, September 1996.

24. WCAP-14401, "Programmatic Level Description of the AP600 Human Factors Verification and Validation Plan."

25. WCAP-14695, "Description of the Westinghouse Operator Decision Making Model and Function Based Task Analysis Methodology," Revision Ø, July 1996.

26. 10 CFR 50.34 (f) (2) (iv).

27. NUREG-0737, Supplement 1; "Requirements for Emergency Response Capability."

28. NUREG-0696, "Functional Criteria For Emergency Response Facilities."

29. NUREG-0711, "Human Factors Engineering Program Review Model," July 1994.

30. WCAP-14655, "Designer's Input for the Training of the Human Factors Engineering Verification and Validation Personnel."

31. WCAP-14690, "Designer's Input to Procedure Development for the AP600."

32. NUREG-1342, "A Status Report Regarding Industry Implementation of Safety Parameter Display Systems."

33. Rasmussen, J., 1986, "Information Processing and Human-Machine Interaction, An Approach to Cognitive Engineering,".(New York, North-Holland).

34. O'Hara, J. M. and Wachtel, J., 1991, "Advanced Control Room Evaluation: General Approach and Rationale" in "Proceedings of the Human Factors 35th Annual Meeting," pp. 1243-1247, (Santa Monica, CA, Human Factors Society).

35. Woods, D. D. and Roth, E. M., 1988, "Cognitive Systems Engineering," Helander, M. (ed.), "Handbook of Human-Computer Interaction," pp.3-43, (New York, NY, Elsevier Science Publishing Co., Inc.).

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42. U.S. Department of Defense, 1989, "Military Standard 1472D; Human Engineering Design Criteria for Military Systems, Equipment and Facilities," (Washington, D.C., U.S. Department of Defense).

43. American National Standards Institute, 1988, "ANSI/HF 100-1988, American National Standard for Human Factors Engineering of Visual Display Terminal Workstations," (Santa Monica, CA, Human Factors Society, American National Standards Institute).

44. WCAP-14694, "Designer's Input To Determination of the AP600 Main Control Room Staffing Level."

45. WCAP-14701, "Methodology and Results of Defining Evaluation Issues for the AP600 Human System Interface Design Test Program."

47. S.G. Hart and L.E. Staveland, "Development of NASA-TLX: Results of empirical and theoritical research", 1988. In P.A Hancock and N. Meshkati (eds.), "Human Mental Workload". Amsterdam, North Holland.

46. G.B. Reid and T.E. Nygren, "The subjective workload assessment technique: A scaling procedure for measuring mental workload", 1988. In P.A. Hancock and N. Meshkati (eds.), "Human Mental Workload". Amsterdam, North Holland.