18.3 Planning, Development, and Design

18.3.1 Introduction

An integrated program plan to incorporate HFE principles and to achieve an integrated design of the control and instrumentation systems and HSI of the ABWR was prepared and implemented. The program plan presents formal decision analysis procedures to facilitate selection of design features which satisfy top level requirements and goals of individual systems and the overall plant. Also included is a comprehensive, synergistic design approach with provisions for task analyses and human factors evaluations.

Specific procedures developed as part of the implementation of the program plan are:

(1) Implementation Procedure for Development of System Functional and Performance Requirements

(2) Implementation Procedure for Analysis of Tasks and Allocation of Functions

(3) Implementation Procedure for Evaluation of Human Factors and Human-Machine Interfaces

(4) Implementation Procedure for the Design of Hardware and Software

(5) Implementation Procedure for the Verification and Validation of Hardware and Software

The program plan and the associated procedures provided guidance for the conduct of the ABWR HSI design development activities, including:

(1) Definition of the standard design features of the control room HSI (Subsections 18.3.2 and 18.4.2)

(2) Definition of the inventory of controls and instrumentation necessary for the control room crew to follow the operation strategies given in the ABWR Emergency Procedure Guidelines and to complete the important operator actions described in the Probabilistic Risk Assessment (Subsection 18.3.3 and Appendix 18F)

18.3.2 Standard Design Features

The ABWR control room HSI design contains a group of standard or basic features which form the foundation for the detailed HSI design. These features are described in Subsection 18.4.2.

The development and testing of the control room HSI standard design features was accomplished under a program which is described in Appendix 18G. This development program included (1) consideration of existing control room operating experience; (2) a review of trends in control room designs and existing control room data presentation methods; (3)

evaluation of new HSI technologies, alarm reduction and presentation methods; and (4) validation testing of two full-scale prototypes. The prototypes were evaluated using test scenarios especially developed for the purpose of utilizing experienced nuclear plant control room operators. Following the completion of the prototype tests and employing their results, the basic control room HSI standard design features were finalized.

18.3.3 Inventory of Controls and Instrumentation

The ABWR Emergency Procedure Guidelines (EPGs), presented in Appendix 18A, and the important operator actions identified in the Probabilistic Risk Assessment (PRA), presented in Chapter 19, provided the bases for an analysis of the information and control capability needs of the main control room operators based upon the operation strategies. This analysis defines a minimum set of controls, displays, and alarms which will enable the operating crew to perform the actions that would be specified in the emergency operating procedures and the important operator actions identified in the PRA. Appendix 18F contains the tabulated results of this analysis. The controls, displays and alarms needed by the operators to perform and validate the completion of those steps and important actions are listed in Tables 18F-1 through 18F-3, respectively.

18.3.4 Detailed Design Implementation Process

The process by which the detailed equipment design implementation of the ABWR HSI will be completed is discussed in Section 18.7 and in Appendix 18E. This process builds upon the standard HSI design features and design technologies which are discussed in Subsection 18.4.2 and 18.4.3, respectively. Embedded in the process, (Figure 18E- 1) are a number of NRC conformance reviews in which various aspects and outputs of the process are evaluated against the established acceptance criteria presented in Tables 18E-1 through 18E-4.