

US-APWR

**Training Program Development
Implementation Plan**

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Abstract

Training of plant personnel is an important factor in ensuring the safe and reliable operation of a nuclear power plant. This report describes the approach of Mitsubishi Heavy Industries (MHI) for the development of the Training Program for the US-APWR, which provides assurance that plant personnel have the knowledge, skills, and abilities to properly perform their roles and responsibilities. This implementation plan specifies the processes for the development of the following aspects of personnel training:

- General Approach
- Organization of training
- Learning Objectives
- Content of Training Program
- Evaluation of Training
- Periodic Re-training

This document supplements the training development information provided in DCD Chapter 13, Section 13.2, Chapter 18, Section 18.9, and MUAP-07007 Section 5.9.

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List of Acronyms

AOP	abnormal operating procedure
ARP	alarm response procedure
COL	Combined License
DCD	Design Control Document
EOP	emergency operating procedure
HED	human engineering deficiency
HFE	human factor engineering
HRA	human reliability analysis
HSI	human system interface
HSIS	human system interface system
JPM	job performance measure
MHI	Mitsubishi Heavy Industries
NOP	normal operating procedure
OER	operating experience review
OJT	on-the-job training
PRA	probabilistic risk assessment
SAT	systematic approach to training
TA	task analysis
V&V	verification and validation
VDU	visual display unit

1.0 Purpose

This implementation plan governs the processes, methods, and criteria used by Mitsubishi Heavy Industries (MHI) to develop training programs for the personnel listed in 10 CFR 50.120 and 10 CFR 52.78 for the US-APWR. It also is intended to satisfy the requirements of NUREG-0711, Revision 2.

New plant designs, such as the US-APWR, are employing modern control rooms and digital control and display systems to help prevent or mitigate potential human errors. Training is an integral part of the Human System Interface (HSI) development for the US APWR. Therefore, it is necessary that the training be developed in harmony with other elements of the HSI design to ensure a high degree of integration and consistency.

2.0 Scope

The scope of this implementation plan is to describe the process for developing US-APWR plant training programs stressing the important interfaces with other HFE program tasks. The US-APWR Human Systems Interface System (HSIS) is designed using a systematic process for integrating human factor engineering (HFE) principles into the system design as well as the training that is developed and administered to plant personnel that perform duties in the plant. Figure 2.0-1 graphically represents the key elements of the US-APWR HFE Program, including training development.

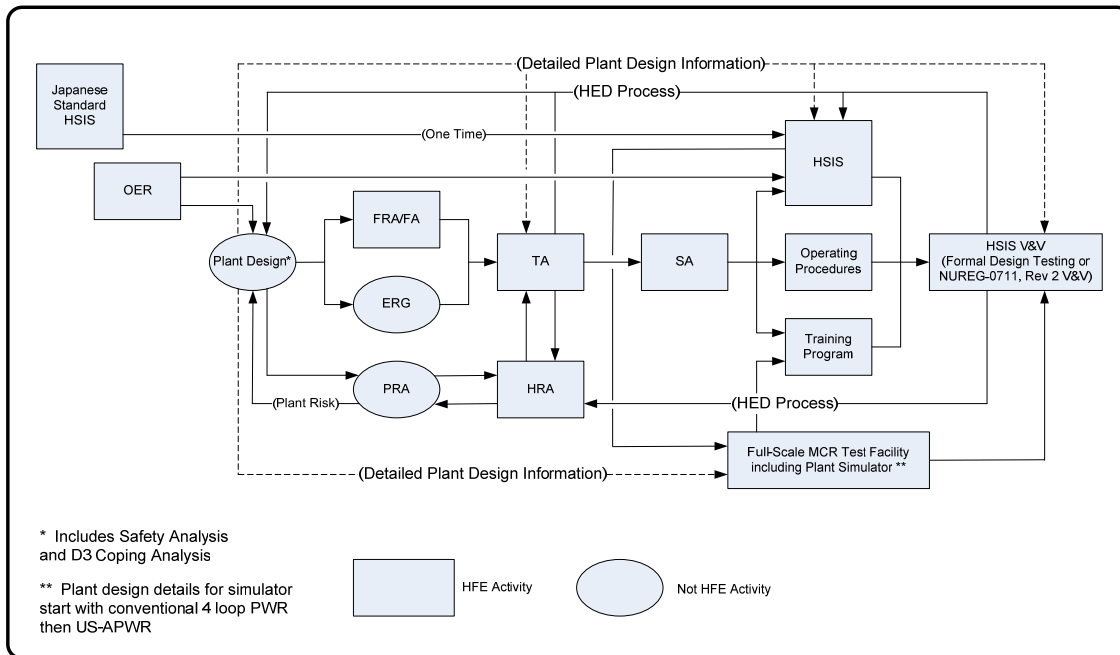


Figure 2.0-1 HFE Work Flow Process

2.1 Categories of Personnel Training

The training program encompasses the following categories of plant personnel listed in 10 CFR 50.120:

- Licensed reactor operators
- Licensed senior reactor operators (shift supervisors)
- Non-licensed operators
- Shift technical advisors
- Instrument and control technicians
- Electrical maintenance personnel
- Mechanical maintenance personnel
- Radiological protection technicians

- Chemistry technicians
- Engineering support personnel

The training program provides assurance that plant these personnel have the knowledge, skills, and abilities to perform their job duties in supporting safe operation of the plant. The personnel receive both initial training and retraining and include all phases of plant operation, including normal, abnormal, emergency, shutdown, and refueling conditions.

The Training Program Development covered by this HFE program element pertains only to safety significant tasks conducted by these plant personnel. Other training, such as administrative training, fitness-for-duty, diversity, general skills and human resource development, etc. is outside the scope of this program.

2.2 Systematic Approach to Training

Effective training and development includes using sound principles of performance management and good, basic training techniques. Adopting a systematic approach to training (SAT) helps ensure that supervisors are getting the most out of themselves and their employees. A SAT includes taking the time to analyze what results the organization needs from its employees, if employees are accomplishing those results, and what training and development approaches are needed by employees to better accomplish those results. A systematic approach includes evaluating approaches before, during and after training to ensure employees truly benefited from the training in terms of enhanced results to the organization.

The SAT process is comprised of five phases which include:

Analysis - Analysis of the organization's needs and identify training goals which, when reached, will equip learner's with knowledge and skills to meet the organization's needs. Usually this phase also includes identifying when training should occur and who should attend as learners.

Design – Design a training system that learners and trainers can implement to meet the learning goals and typically includes identifying learning objectives (which culminate in reaching the learning goals), needed facilities, course content, lessons, and sequencing of lessons.

Development - The development phase of training often is highly integrated with the design phase. Training "packages" of resources and materials are developed, e.g., audio-visuals, graphics, manuals, lesson plans, simulator scenarios, OJT books, preparing needed facilities, piloting course content to ensure it is understandable, establishing criteria for mastery of the learning objectives, etc.

Implementation - Implement the training package, including delivering the training, support group feedback, clarifying training materials, administering tests and conducting the final evaluation to verify trainee mastery of the learning objectives. This phase can include administrative activities, such as copying, scheduling facilities, taking attendance data, etc.

Evaluation – Evaluate training during and after implementation of the training to ensure an effective ongoing program..

In a systematic approach to training, each phase of the process produces results needed by the next phase, and each phase provides ongoing evaluation feedback to other phases in order to improve the overall systems process.

3.0 Applicable Codes, Standards and Regulatory Guidance

The compliance to the applicable codes and standards for the US-APWR HSI design and HFE process are identified in DCD Chapter 18.9 and section 3.0 of the topical report “HSI System Description and HFE Process”, MUAP-07007. The topical report includes following standards and guidelines.

- Code of Federal Regulations
- Staff Requirements Memoranda
- NRC Regulatory Guides
- NRC Branch Technical Positions
- NUREGs
- Other Reference Guidelines

4.0 Implementation Plan

The training program includes classroom, simulator, and on-the-job training settings. The design and development of the training program will be shaped by Mitsubishi Heavy Industries using existing US-APWR design specific information such as system descriptions, P&ID drawings, and operator tasks with support of the COL applicant, while the training implementation and evaluation phases are the responsibility of the COL applicant using the materials provided by MHI. The training approach follows applicable guidance in NUREG-0800 Section 13.2 Training, as defined in 10 CFR 55.4, and as required by 10 CFR 52.78 and 50.120.

NEI 06-13A (Reference 5-8), which requires the Systems Approach to Training (SAT) process to be taken, is utilized as a template for program basic structure and content.

However, as described in DCD Section 13.2, training program development is the responsibility of the COL Applicant. The development of operational programs and their implementation is the responsibility of the COL Applicant in accordance with SECY-05-0197 (Reference 5-9), as described in DCD Section 13.4.

4.1 General Approach

The analysis portion of training development receives input and feedback from the other HFE processes as shown in Figure 2.0-1. The analysis process is governed by a training process guideline that ensures it meets the requirements set forth in NUREG-0800 Chapter 13, NUREG-1220, Regulatory Guide 1.8, and ANSI/ANS 3.1. The analysis generates the requirements for the knowledge and skills to be presented by training to ensure that trainees meet job performance requirements and that they have the knowledge, skills, and ability to safely perform their assigned tasks. Using the inputs outlined below, training needs analyses are performed using a systematic method to objectively and consistently determine performance and training requirements. Inputs to the analysis phase include:

Operational analysis – HRA/PRA inputs including risk-important human actions, OER, DCD specifications, System Design Specifications, and the Defense-in-Depth and Diversity report. The process also receives feedback input from the other HFE processes including Staffing & Qualifications, HSI Design, Training, Procedure Development, Verification and Validation, and ultimately, Human Performance Monitoring. These inputs are processed through Functional Requirements Analyses, Allocations of Functions, and Task Analyses.

Staffing and Qualification – Generates numbers, skill types, and qualification requirements.

HSI design – The final HSI design including controls, component IDs, indications, VDU screen format, human interaction mechanisms and options, queues, and alarms, is a direct input to the analysis portion of the training development process.

Procedure development – Normal, abnormal, alarm, and emergency operating procedures are direct inputs into the analysis phase of training to ensure classroom and simulator training accurately address all phases of plant operation.

Regulatory requirements – Training development is governed by a training process guideline that ensures it meets the requirements set forth in NUREG-0800 Chapter 13; NUREG-1220; NUREG-1021; Regulatory Guide 1.8; ANSI/ANS 3.1; and other applicable regulations. These regulations set many of the minimum standards for training and are direct inputs that guide the analysis.

Training evaluation – Written and oral tests and review of personnel performance during walkthrough job performance measures (JPMs), simulator exercises, and on-the-job observation. Training evaluation assesses the overall effectiveness of the training programs and trainee mastery of training objectives as defined in training design and development. This process generates training enhancements designed to improve the content or delivery of training.

Verification and Validation – Once training is developed for a given subject, it is validated and verified using pilots, walk-through, mock-ups, and the full-scope simulator. V&V training enhancements are fed back into the training revision process. The resulting revised training results are then put through the V&V process again to validate the adequacy of the changes. The training V&V program is conducted separately from the HSI V&V discussed in the HSI V&V Implementation Plan, since the training for operators who participate in the HSI V&V is abbreviated compared to the complete training encompassed by this program element.

Human Performance Monitoring – During the design process, Human Factor Engineering addresses a wide range of potential causes of human error to produce training that matches the HSI and procedures. However, a good operational safety culture from the COL Applicant encourages the continuing identification of issues for improvement including further reducing the potential for human errors. The potential for improvements to the training continue into the operational phase. During and after the Implementation phase and as an integral part of the Evaluation phase, improvements to training are still sought, evaluated, tracked and resolved through the human performance monitoring (HPM) process governed by the HPM Implementation Plan.

The design portion of training program development process takes the performance and training requirements generated in the training analysis phase along with the knowledge and abilities contained in NUREG-1122 and begins the process of creating the details and attributes that support training implementation. The design phase will define the:

- Learning objectives, which specify the conditions and standards for which successful learning is assessed
- Instructional units and sequencing of training and re-training
- Target groups for training
- Organization ownership of the training
- Training setting (classroom, simulator, OJT, study guides, etc) and duration
- Pass/fail criteria
- Remediation process for unsatisfactory performance
- Trainee qualifications and the requirements for documenting qualification equivalencies where allowed

The development phase ensures:

- Course material content supports mastery of the learning objectives
- Course materials are structured to provide consistent presentation
- Course material presentation sequence supports effective learning
- Course materials support successful presentation in their specified venue including classroom, mockup, part-task simulator, full-scope simulator, walk-through, laboratory, drills, and OJT

- Instructor certifications and training required to present training is specified for each course
- Exam question banks, examination structure and content are developed

Training materials generated include instructor guides, lesson plans, OJT materials, simulator guides and scenarios, exam banks, and both initial and requalification training requirements and frequencies. The course materials are used to deliver training in the venue most appropriate for the desired learning in the implementation phase. Trainee mastery of the learning objectives is measured through the use of appropriate evaluations' e.g. written or oral exams, JPMs, simulator operating exams, etc.

The evaluation phase of training development provides methods for evaluating the overall effectiveness of the training programs, such as student feedback forms, where trainee/supervisor suggestions to future training improvements are solicited for future processing.

Training is provided for all plant conditions and exercises procedures including:

- General Operating Procedures; integrated plant procedures such as plant startup/shutdown, load change, etc.
- System Operating Procedures; specific plant system and system component operations, i.e. filling and venting, startup/running/shutdown, boration, etc.
- Alarm Response Procedures
- Abnormal Operating Procedures
- Emergency Operating Procedures
- Surveillance Test Procedures
- Radiation Control Procedures
- Procedures to ensure safety system operability after maintenance
- Administrative procedures as outlined in NUREG-0800, Section 13.5.1.I.A. category (a) and (b)
- Other RO/SRO administrative topics contained in NUREG-1021, ES-301 B.1:
 - Conduct of Operations
 - Equipment Control
 - Radiation Control
 - Emergency Procedures/Plan

Procedures that involve evolutions in/at the:

- Main Control Room (MCR)
- Remote shutdown room (RSR)
- Technical support center (TSC)
- Local control stations (LCSs) - consideration of HFE activities for LCSs are limited to those LCSs that support:
 - On-line testing, radiological protection activities, and required chemical monitoring supporting technical specifications

- Testing required by technical specifications, and testing after maintenance to ensure safety system operability, emergency and abnormal conditions response
- Emergency operations facilities (EOFs)

4.2 Organization of Training

The training program development process and training material development specific to the US-APWR will be performed by Mitsubishi Heavy Industries (MHI) with support from subcontractor experienced in training development for U.S. nuclear plants, and supported by COL Applicant. The generic training materials will be developed during Phase 2 of the HFE program. Site specific changes will be made during Phase 3 of the HFE program.

Training Implementation and Evaluation is the responsibility of the COL applicant. MHI has the ability to support the COL applicant's training efforts.

Training materials are developed using existing sources of information and design specific information, such as training material from currently operating PWRs, from the US-APWR. The role of the HFE design team is to provide input to the training program. For example, the US-APWR design team supplies system descriptions, planned operator tasks, and the Emergency Procedure Guidelines (EPGs), which are integrated into specific training programs.

The Staffing and Qualifications implementation plan for the US-APWR establishes the required responsibilities, skill sets, and qualifications of plant personnel. The training development process establishes the organization and processes required to achieve and maintain the qualifications and certifications of plant personnel. Initial and requalification training are provided to establish and maintain proficiency in required job tasks.

Resources such as part-task, full-scope, and training simulators are used in the US-APWR HFE implementation process for both design V&V and training V&V. These facilities and resources include features of the HSI that are based on the inputs of the HFE team.

4.3 Learning Objectives

Learning objectives are derived from the analysis that describes desired performance after training. This analysis includes training needs identified in the following:

- Licensing basis - Final Safety Analysis Report, system descriptions, system operating manuals and operating procedures, facility license and license amendments, licensee event reports, and other documents identified by the HFE design team and the COL Applicant as being important to training.
- Operating Experience Review - lessons learned from events and previous training deficiencies and operational problems. This information is maintained in the OER database and is used to improve overall training effectiveness and trainee mastery of the learning objectives.
- Functional requirements analysis and allocation of functions - new or modified tasks that are identified to be performed by automation, by human, or both.

- Task Analysis - tasks identified during task analysis that pose unusual demands, including new or different tasks and tasks requiring a high degree of coordination, high workload, or special skills.
- Human Reliability Analysis - coordinating individual roles to reduce the likelihood and/or consequences of human error associated with risk-important HAs and the use of advanced technology.
- HSI design - design features, the purpose or operation of which may be different from the past experience or expectations of personnel.
- Plant procedures - tasks that have been identified during procedure development as being problematic (for example, procedure steps that have undergone extensive revision as a result of plant safety concerns)
- Verification and Validation (V&V) - training concerns identified during HSI V&V and training V&V, including HSI usability concerns identified during HSI validation or HSI suitability verification and operator performance concerns (for example, misdiagnoses of plant events) identified during validation trials.

Learning objectives also address the knowledge and skill attributes associated with all relevant dimensions of the trainee’s job, such as interaction with the plant, the HSIs, and other personnel. Table 4.3-1 provides an example of skill and knowledge dimensions.

Table 4.3-1 Example of Knowledge and Skill Dimensions for Learning Objectives Identification

Topic	Knowledge	Skill
Plant Interactions	Understanding of plant processes, systems, operational constraints, and failure modes.	Skills associated with monitoring and detection, situation awareness, response planning and implementation.
HSI and Procedure Interactions	Understanding of procedures and HSI structure, functions, failure modes, and interface management tasks (actions, errors, and recovery strategies).	Skills associated with interface management tasks.
Personnel Interactions (In the CR and in the plant)	Understanding information requirements of others, how actions should be coordinated with others, policies and constraints on crew interaction.	Skills associated with crew's interactions (i.e., teamwork).

(Source: NUREG-0711)

4.4 Content of Training Program

The content of the training program should be defined based on the template of NEI 06-13A (Reference 5-8).

4.5 Evaluation of Training

The effectiveness of training programs is evaluated based on three independent inputs or perspectives: the supervisor of the trainee, the trainee, and an educational content evaluation as described in the template of NEI 06-13A (Reference 5-8).

4.6 Periodic Re-training

Personnel undergo periodic retraining. The periodicity of the retraining is established based on regulatory requirements in 10 CFR 55.59 and MUAP-07007-P, "HSI System Description and HFE Process", Sections 5.9.7, "Retraining", and 5.12, "Human Performance Monitoring Plan".

4.7 Results Summary Report

The development of operational programs and their implementation is the responsibility of the COL Applicant in accordance with SECY-05-0197 (Reference 5-9), as described in DCD Section 13.4. Therefore, a results summary report describing training program development is not required.

5.0 References

- 5-1 Operator Licensing Examination Standards for Power Reactors, NUREG-1021, Revision 9, U.S. Nuclear Regulatory Commission, July 2004
- 5-2 Knowledge and Abilities Catalog for Nuclear Power Plant Operators: Pressurized Water Reactors, NUREG-1122, Revision 2, U.S. Nuclear Regulatory Commission, June 1998
- 5-3 Design Control Document for the US-APWR, Chapter 13, Conduct of Operations, MUAP-DC013, Revision 3, MHI, March 2011
- 5-4 Design Control Document for the US-APWR, Chapter 18, Human Factors Engineering, MUAP-DC018, Revision 3, MHI, March 2011
- 5-5 HSI System Description and HFE Process, MUAP-07007, Revision 4, MHI, July 2011
- 5-6 US-APWR HSI Design, MUAP-09019, Revision 0, MHI, June 2009
- 5-7 US-APWR Staffing and Qualifications Implementation Plan, MUAP-10008, Revision 0, MHI, April 2010
- 5-8 Template for an Industry Training Program Description, NEI 06-13A, Revision 1, Nuclear Energy Institute, March 2008
- 5-9 Staff Requirements-SECY-05-0197-Review of Operational Programs in a Combined License Application and Generic Emergency Planning Inspections, Tests, Analyses, and Acceptance Criteria, SRM-SECY-05-0197, U.S. Nuclear Regulatory Commission, February 2006