US-APWR

Procedure Development Implementation Plan

November 2011

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	Rev. 0	Rev. 1		
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Revision History

Revision	Date	Page (Section)	Description
0	April 2010	All	Original issue
1	November 2011	General	Revised capitalization of section and figure titles. Revised figure number.
		p.2 (Section 2.0)	Revised “through 2.3” to “and 2.2” in second paragraph of this section. Added description to last paragraph for response to RAI 757 (Question No. 18-120).
		p.8 (Section 4.3.1)	Revised reference number.
		p.10 (Section 4.3.2)	Added description as a last bullet of “US-APWR Standard EOP Development” for response to RAI 664 (Question No. 18-88).
		p.12 (Section 5.0)	Deleted reference 5-8. Revised reference number of MUAP-10009 to 5-8. Added MUAP-10008 as Reference 5-7. Added Reference 5-18 for response to RAI 757 (Question No. 18-120). Revised description of references.

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Abstract

Plant operating procedures are used to ensure that startup, routine, non-routine, and emergency activities are conducted in a consistent and safe manner. This report describes the approach of Mitsubishi Heavy Industries (MHI) for the development of several types of plant operating procedures. This implementation plan specifies the process by which plant operating procedures are developed, verified, validated, and maintained. This document supplements the operating procedure development information provided in Design Control Document (DCD) Chapter 18, topical report MUAP-07007 Section 5.8, and technical report MUAP-09019 Part 1, Section 8.2.5.

This document fulfills the requirements of NUREG-0711, Rev. 2, Section 1.2.1 item (3) and Section 9.3 to submit an implementation plan for procedure development to the NRC for review. Upon completion of the procedure development effort, a results summary report will be submitted to the NRC, per the requirements of NUREG-0711 Rev. 2 Section 9.3.

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List of Acronyms

AOP	abnormal operating procedure
ARP	alarm response procedure
CBP	computer based procedure
CCF	common cause failure
COL	combined license
DCD	design control document
DHP	diverse HSI panel
EOF	emergency operations facility
EOP	emergency operating procedure
ERG	emergency response guideline
ESF	engineered safety feature
GOP	general operating procedure
GTG	generic technical guideline
HA	human action
HED	human engineering discrepancy
HFE	human factor engineering
HRA	human reliability analysis
HSI	human system interface
HSIS	human system interface system
IP	implementation plan
MHI	Mitsubishi Heavy Industries
NOP	normal operating procedure
OER	operational experience results
PBP	paper based procedure
PGP	procedures generation package
PRA	probabilistic risk assessment
P-STG	plant-specific technical guideline
QAP	quality assurance program
RPS	reactor protection system
SACRG	severe accident control room guideline
SAMG	severe accident management guideline
SOP	system operating procedure
STA	shift technical advisor
TA	task analysis
TSCG	severe accident technical support center guideline
V&V	verification and validation
VDU	visual display unit

1.0 Purpose

Procedures are essential to plant safety because they support and guide personnel interactions with plant systems and personnel response to plant-related events. The purpose of this technical report is to describe the process utilized by Mitsubishi Heavy Industries (MHI) to develop operating procedures for the US-APWR. For the purpose of this document, the term “operating procedures” includes procedures to govern safety-related operations activities and procedures to govern maintenance, test, and surveillance activities associated with safety significant tasks. Maintenance, test, and surveillance procedures associated with tasks that are not safety significant are outside the scope of the Human Factors Engineering (HFE) Program.

Procedures are an integral part of the Human System Interface (HSI) development for the US-APWR. Therefore, it is necessary that the procedures be developed synergistically with the HSI design and training process to ensure a high degree of integration and consistency.

This implementation plan (IP) governs the processes, methods, and criteria used to develop operating procedures for the US-APWR, including interfaces with other HFE program tasks. The IP is developed to ensure that the operating procedures developed are technically accurate, comprehensive, explicit, easy to use, verified and validated per the requirements from NUREG-0711, Rev. 2 and NUREG-0800 Section 13.5.

2.0 Scope

The scope of this implementation plan is to describe the process for developing US-APWR plant operating procedures 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 HFE principles into the system design as well as the procedures that are used to operate the plant. Figure 1 graphically represents the key elements of the US-APWR HFE Program, including operating procedure development.

In the context of this document, operating procedures refers to normal operating procedures (NOPs) and emergency operating procedures (EOPs). There are several types of procedures contained in each of these broad categories, as described in Sections 2.1 and 2.2 below. All other types of procedures are outside the scope of the US-APWR HFE program and therefore are outside the scope of this document. This is consistent with NUREG-0711, Rev. 2, Section 9.3. 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 5-18), as described in DCD Section 13.4.

2.1 Normal and Abnormal Operating Procedures

Normal operating procedures provide instructions for operating the plant or systems when the plant systems are operating as expected. General categories of normal operating procedures include the following:

- Plant General Operating Procedures (GOPs) – utilized for changing the state of the plant including startup, load change, shutdown, outage, etc., and to provide integrated operation of the plant.
- System Operating Procedures (SOPs) – utilized for energizing, filling, venting, draining, starting up, shutting down, changing modes of operation, and other instructions appropriate for the operation of individual plant systems.
- Maintenance Procedures – utilized for the repair or replacement of equipment or the performance of preventative maintenance designed to improve the reliability of the equipment. Note that only those Maintenance Procedures associated with safety significant tasks are included within the scope of the HFE Program.
- Periodic Test / Surveillance Procedures – utilized to demonstrate that systems and components are capable of performing their intended function. Note that only those Periodic Test/Surveillance Procedures associated with safety significant tasks are included within the scope of the HFE Program.

Abnormal operating procedures address operational conditions that involve unplanned or undesired conditions or events and provide instructions for how to mitigate the condition or event and include the following:

- Abnormal Operating Procedures (AOPs) – utilized to restore a function, system, or component to normal operating conditions following a transient or event.
- Alarm Response Procedures (ARPs) – utilized to restore operating variables to a normal range after an alarm alerts the operator to a departure from normal.

See Appendices A & B for a sample list of GOPs, SOPs and AOPs, which was adapted from Appendix A of Regulatory Guide 1.33 "Quality Assurance Program Requirements (Operation)" for the US-APWR. Many NOPs that do not interface with the control room are developed outside the HSI and HFE process depicted in Figure 2.1-1.

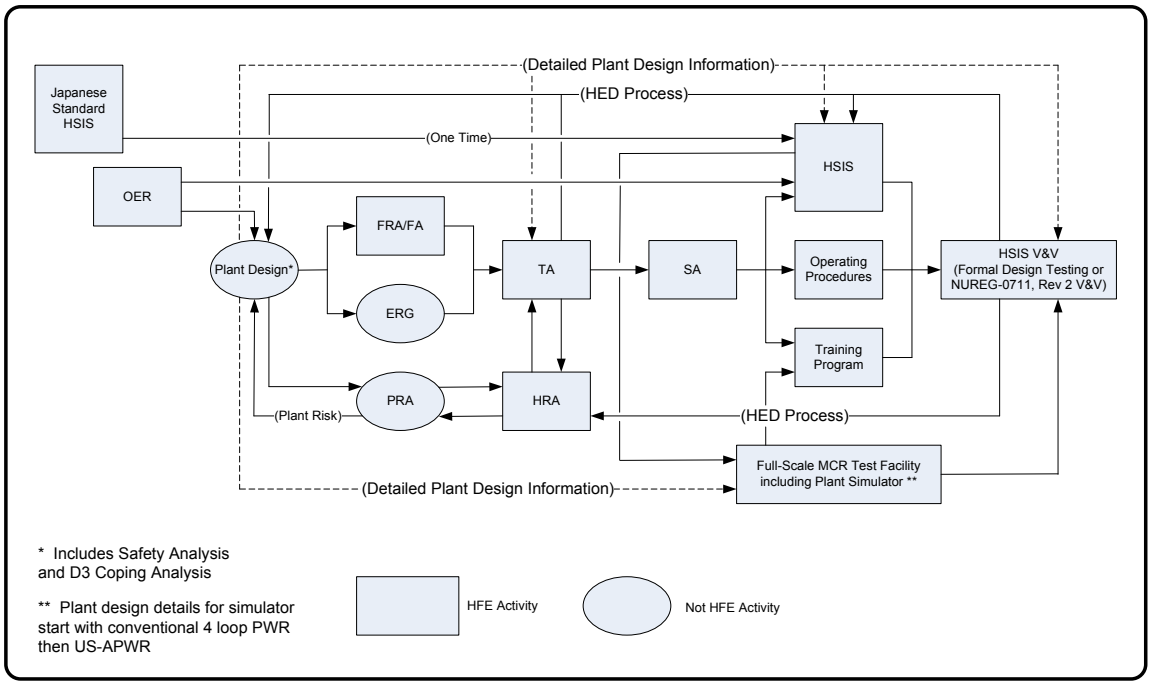

Figure 2.1-1 Overall HFE Implementation Process

2.2 Emergency Operating Procedures

Emergency operating procedures provide instructions for mitigating the consequences of transients or accidents that result in plant parameters exceeding specified reactor protection system (RPS) and or engineered safety feature (ESF) trip or actuation setpoints. General categories of emergency operating procedures applicable to the US-APWR include the following:

- Emergency Operating Procedures (EOPs) – utilized to mitigate the consequences of transients and accidents that cause plant parameters to exceed the predetermined thresholds.
- DHP Procedures – utilized when the HSI is completely unavailable and the Diverse HSI Panel (DHP) must be used to mitigate events and conditions normally covered by the EOPs.
- Severe Accident Management Guidelines (SAMGs) – utilized to mitigate the consequences of severe beyond design-basis transients and accidents that have exceeded the thresholds for application of the EOPs.

See Appendices C & D for a sample list of EOPs and SAMGs, respectively.

3.0 Applicable Codes, Standards and Regulatory Guidance

The compliance to the applicable codes and standards for the US-APWR HSIS design and HFE Process is identified in section 3.0 of the topical report “HSI System Description and HFE Process”, MUAP-07007 (Reference 5-4). 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 objective of the procedure development program is to produce procedures that support and guide human interactions with plant systems and control plant-related events and activities. As shown in Figure 1, procedure development is an integral part of the HSI design and training process for the US-APWR.

The US-APWR Procedure Development Program is designed to develop computer based procedures (CBP) with corresponding backup paper based procedures (PBP), as well as stand-alone PBP for which there are no CBP (e.g., maintenance procedures, DHP Procedures). The operating procedures and the writer's guides that govern their creation must conform to the requirements of NUREG-0711, Rev. 2, Section 9 and NUREG-0800, Section 13.5. These requirements are equally applicable to both the PBP and CBP formats. The HFE Program, as described in topical report MUAP-07007 (Reference 5-4), is responsible for verifying that normal, abnormal, and emergency operating procedures use accepted HFE principles in their form and presentation of information, and in their direction of operator interactions with the HSI. Information and control needs for each operative instruction or action in the procedures are developed through task analysis (TA). Technical report MUAP-09019 (Reference 5-6) describes the process and results of TA performed for the risk important human actions (HAs) identified by the US-APWR PRA. A similar methodology will be applied when performing the TAs for the operative actions in the procedures.

4.1 Procedure Development Bases

Procedure development is an iterative process. Procedures are developed and then tested to see if they meet the necessary HFE requirements. Feedback from the HFE team must be reflected in the procedures and then the revised procedure must be rechecked to see if the HFE requirements are met. This feedback loop is continued until technically accurate, comprehensive, explicit, easy to use procedures are developed and able to be successfully verified and validated.

The US-APWR operating procedures are based on the procedures for the existing 4-loop PWR and then modified to appropriately reflect the US-APWR design and relevant US operational experience and regulatory requirements. The following additional sources of information are also utilized as necessary inputs to the operating procedure development:

- Plant design bases
- System-based technical requirements and specifications
- Task analysis results
- Risk-important HAs identified in the human reliability analysis (HRA) and probabilistic risk assessment (PRA)
- Design basis initiating events to be considered in the EOPs
- Emergency Response Guidelines (ERGs), which are the Generic Technical Guidelines (GTGs) for the US-APWR, for the EOPs
- Generic technical guidelines for systems operations procedures (including startup, power, and shutdown), test, and maintenance procedures

- Technical Specification surveillance requirements

For EOPs, separate bases or background documents are developed; the EOP bases are provided as part of the ERGs as described in Section 4.3.2. This procedure development basis is consistent with the procedure development basis already identified and described in the Design Control Document (DCD) Subsection 18.8.2.1 (Reference 5-1) and topical report MUAP-07007, Section 5.8.2 (Reference 5-4).

4.2 Procedure Writer's Guide

A procedure writer's guide establishes the process for developing complete, accurate, consistent operational procedures that are easy for trained operators and other trained personnel to understand and follow. The writer's guide outlines criteria for ensuring that the content, organization, and style are consistent across all procedures of a similar type. Additionally, the writer's guide ensures that relevant HFE principles are appropriately incorporated into the procedures, including consistency in form and function between CBP and PBP formats. Any procedure writer's guide utilized in the US-APWR procedure development process shall address the applicable goals, requirements, and recommendations identified in NUREG-0899 (Reference 5-14) in addition to meeting the requirements of the HSIS design.

At a minimum, the writer's guide will provide instructions regarding the following aspects of CBP and PBP operational procedure development.

- Procedure identification (title, type designation, and numbering)
- Applicability and purpose
- Entry conditions
- Human action instruction steps
- Precautions such as warnings, notes, and cautions
- Transitions to other procedures
- Component identification
- Use and format of figures, tables, or attachments
- Mechanics of style (spelling, punctuation, capitalization, vocabulary, numerical values, logic terms, abbreviations, or acronyms)
- Acceptance criteria
- Check-off lists
- Reference material

As explained in Section 4.3, the EOPs, DHP Procedures, and SAMG procedures will have their own formats due to the unique attributes of these procedure types.

The procedure writer's guide ensures that when information that is unique to the CBP is added to the content of the original PBP (e.g., hyperlinks, dynamic data, checkmark and annotation functions, etc.) that paging and formatting between the PBP and the CBP remains consistent. The procedure writer's guide also facilitates the process of creating the CBP from the PBP so that the process can be as automated as possible, with minimal need for manual intervention and therefore minimal need for manual verification.

For AOPs and EOPs that will be used for degraded HSI conditions, when only safety VDUs are available, the PBP needs to distinguish steps that are not available from the safety VDUs.

4.3 General Development Process

The procedure development team uses the writer's guide to properly combine and structure the HSI design, operational analysis inputs, and other required information into useable procedures. These procedures are inputs to the training and the verification and validation (V&V) process, where they are evaluated to ensure they meet all required attributes. The V&V for procedures is described in the Verification and Validation Implementation Plan (Reference 5-10).

4.3.1 Normal and Abnormal Operating Procedures

The US-APWR normal and abnormal operating procedures define a consistent set of actions utilized to operate the plant or individual systems under normal expected operation conditions and unplanned or undesired conditions or events.

The US-APWR NOPs and AOPs are being developed using the following criteria and development process:

- The procedures conform to the requirements of NUREG-0711, Rev 2, Section 9 and NUREG-0800, Section 13.5.
- The procedures follow the applicable procedure writer's guide to ensure consistency, accuracy, completeness, readability, and high-quality among the various documents in the operating procedure set.
- The procedures are developed by a procedure development team who is tasked with combining the HSI design, operational analysis, and other relevant information into a usable procedure. As described in topical report MUAP-07007 Section 5.8.2 (Reference 5-4), the procedure development team will consist of the following personnel: human factors, systems, nuclear, I&C, computer systems, systems safety, and maintainability/inspection engineers as well as a plant operator. Typically, a subject matter expert is tasked with making the initial procedure draft. Then the other members of the development team confirm and refine the draft procedure.
- The draft procedures are then reviewed by the HFE Design Team to ensure that they reflect any operational experience results (OER) identified by the review described in technical report MUAP-08014 Part 2 (Reference 5-5). Then they are verified by analytical techniques such as task analysis and HRA as described in topical report MUAP-07007 Sections 5.4 and 5.5 (Reference 5-4), respectively. Additional details regarding the verification of procedures are described in the Verification and Validation Implementation Plan (Reference 5-10).
- Feedback from the verification steps are evaluated to determine whether or not procedure revision is needed to address the issues identified.
- A comprehensive representative sample of US-APWR NOPs and AOPs are then validated on the simulator as part of the integrated HSI system validation activity of the HSI Design described in topical report MUAP-07007 Section 5.10 (Reference 5-4) and technical report MUAP-09019 Part 3 (Reference 5-6). Additional details regarding the

validation of procedures are described in the Verification and Validation Implementation Plan (Reference 5-10).

- All remaining operating procedures, including maintenance/test procedures that require licensed operator support, are also verified/validated in a separate procedure V&V activity.
- Design changes occurring after validation but prior to fuel load are managed in accordance with the Design Implementation Plan (Reference 5-11). Design changes occurring after fuel load are managed in accordance with the Human Performance Monitoring Implementation Plan (Reference 5-12).

4.3.2 Emergency Operating Procedures

The US-APWR standard EOPs define the actions necessary to prevent or mitigate the consequences of emergency conditions. These procedures cover verification of automatic actions, operator actions to prevent or mitigate consequences, and operator actions necessary to stabilize the plant. The EOPs are designed to be flexible to handle a variety of events in a conservative manner. As such, the EOPs contain clearly specified entry and exit conditions. The US-APWR standard EOPs are developed from the US-APWR ERGs.

US-APWR ERG Development

The US-APWR ERGs are symptom-based guidelines that allow operators to take mitigative actions before diagnosing a specific event cause or component failure. Subsequent event-based guidelines are developed to address specific diagnosed transients and design basis accidents. This is the same philosophy of procedure design as the GTGs for the current fleet of operating US reactors. Note that per the terminology utilized in current NRC documents, the US-APWR ERGs are the GTGs for the US-APWR design.

As described in technical report MUAP-09019, Part 1 Section 8.2.5 (Reference 5-6), the US-APWR ERGs are being developed in two phases. The first phase of the ERG development process drafted a complete set of US-APWR specific ERGs that reflect additional input from a US multidiscipline industry team review. Phase 1 of the ERG development process was completed in December 2009.

Due to the similarity between the US-APWR and both conventional US and domestic Japanese operating PWRs, most of the general principles for dealing with transients and events for currently operating PWRs also appear in the US-APWR ERGs and subsequently developed EOPs. In developing the US-APWR ERGs, MHI considered the Japanese and US approach for defining early symptom-based operator response to various emergency conditions. To tailor the ERGs to the details to the US-APWR design, differences between the US-APWR design and conventional US and Japanese operating PWRs were listed and their impact on the post-accident operator actions identified. This process systematically mapped differences in systems and components to specific post-accident operator actions and decisions. These design features were incorporated into the applicable places in the ERGs. In addition, the operator actions credited in the US-APWR accident analysis in DCD Chapter 15 (Reference 5-2) and in the PRA in DCD Chapter 19 (Reference 5-3) were listed as actions that were required to be included in the accident response procedures. These operator actions were also incorporated into the applicable places in the ERGs. As an important check to ensure that the principles and details of the ERGs were suitable and consistent with the current US operations and training culture, the ERGs were reviewed by a

US multidiscipline team, which included licensed operators, that was chosen for knowledge of HFE, operations training practices, and plant procedures.

Phase 2 of the development process adds detailed design specific bases to the ERGs. In addition, Phase 2 develops the US-APWR standard EOP for use by the US-APWR COL applicants. The US-APWR standard EOP is essentially the ERG with the addition of details regarding the plant-specific means of accomplishing certain activities, the MHI equipment IDs, and formatting modifications that are consistent with the HFE Program approved CBP format. The standard EOP is intended to be the plant-specific technical guidelines (P-STGs) portion of the COL applicant's procedures generation package (PGP).

US-APWR Standard EOP Development

The standard US-APWR EOPs are being developed using the following criteria and development process:

- The standard EOPs conform to the requirements of NUREG-0711, Rev 2, Section 9 and NUREG-0800, Section 13.5.
- The technical content of the standard EOPs is based on the US-APWR ERGs. Additional sources of information, such as the plant design characteristics, transient and accident analysis assumptions derived from the DCD Chapter 15 (Reference 5-2), PRA assumptions derived from the DCD Chapter 19 (Reference 5-3), engineering judgment, task analysis, and operating experience are incorporated as necessary to improve the technical accuracy and ease of use of the standard EOPs.
- The standard EOPs follow the applicable procedure writer's guide to ensure consistency, accuracy, completeness, readability, and high-quality among the various documents in the EOP set. The EOPs use a two-column format that has been developed based on common industry practices used by operating PWRs in the U.S.
- The standard EOPs are developed by a procedure development team who is tasked with combining the ERGs, HSI design, operational analysis, and other relevant information into a usable emergency response procedure. As described in topical report MUAP-07007 Section 5.8.2 (Reference 5-4), the procedure development team will consist of the following personnel: human factors, systems, nuclear, I&C, computer systems, systems safety, and maintainability/inspection engineers as well as a plant operator. Typically, a subject matter expert is tasked with making the initial procedure draft. Then the other members of the development team confirm and refine the draft procedure.
- The draft standard EOPs are then reviewed by the HFE Team to ensure that they reflect any OER identified by the review described in topical report MUAP-08014 Part 2 (Reference 5-5). Then the draft standard EOPs are verified by analytical technique such as task analysis and HRA as described in topical report MUAP-07007 Sections 5.4 and 5.5 (Reference 5-4), respectively. Additional details regarding the verification of procedures are described in the Verification and Validation Implementation Plan (Reference 5-10).
- Feedback from the verification steps are evaluated to determine whether or not procedure revision is needed to address the issues identified.
- The US-APWR standard EOPs are then validated on the simulator as part of the integrated system validation activity of the HSI Design described in topical report MUAP-07007 Section 5.10 (Reference 5-4) and technical report MUAP-09019 Part 3

(Reference 5-6). Additional details regarding the validation of procedures are described in the Verification and Validation Implementation Plan (Reference 5-10).

- The COL Applicant is responsible for ensuring that subsequent procedure changes made after the validation, including changes needed due to plant design changes or HSIS design changes, are verified and validated. Design changes occurring after validation but prior to fuel load are managed in accordance with MUAP-10013 Design Implementation Plan (Reference 5-11). Design changes occurring after fuel load are managed in accordance with MUAP-10014 Human Performance Monitoring Implementation Plan (Reference 5-12).
- All RI HAs which are extracted in the HRA/PRA report (MUAP-07030) are incorporated as manual actions in procedure steps. For these steps, the appropriate HSI (i.e., the specific information and controls that should be used) and staff environment (e.g., Staffing qualification level and communication level) are extracted from the integrated HRA report (currently documented in MUAP-09019, Part 2 Section 2).

US-APWR DHP Procedure Development

This set of procedures will only be used for a common cause failure (CCF) of the digital I&C system that requires the operator to use the DHP. Due to the relatively simple and direct entry conditions for this strategy, prescriptive scenario-specific instructions will be provided for the operator actions. Due to the circumstances existing during CCF conditions, computer-based procedures cannot be credited and only paper-based procedures are developed. The format of this document will be derived from the paper-based EOP format to ensure a smooth transition to the paper-based DHP procedure.

US-APWR Severe Accident Management Guidelines (SAMG) Development

These procedures are developed to address beyond design basis event conditions. This set of guidelines, due to their nature, will not be constrained to the formats used in the NOPs or EOPs. Certain SAMGs are expected to be used in the control room by the Shift Technical Advisor (STA) and others, while other SAMGs are expected to be used in the Emergency Operations Facility (EOF) by various emergency response team members. A separate writer's guide is used for these procedural guidelines.

4.4 Transition of PBP to CBP

The CBP is the normal presentation format utilized in the plant. The US-APWR operating procedures are manually developed during the procedure writing phase of development using a generic commercial format (PDF, MS Word, HTML, etc.). This initial electronic file is the basis for the backup PBP and the transition to the CBP. The electronic file for the PBP is annotated with fields with unique tag identification for the addition of hyperlinks to the appropriate Operational Visual Display Unit (VDU) screen or other procedures. This version is manually reviewed and approved through the appropriate quality assurance program and then compiled using an automated CBP tool to integrate the CBP into the digital HSIS. This process is described in greater detail in Section 4.8 of topical report MUAP-07007 (Reference 5-4).

The CBP Basic Software and the tool used to create the CBP from the PBP are developed in accordance with a documented Software Life Cycle Program that includes augmented quality activities typical of Safety Parameter Display Systems, such as verification and validation. The V&V activities for the PBP to CBP conversion tool ensure accuracy of all text, formatting and

data. This allows the conclusions from HSI verification activities applied to CBP to be applicable to PBP without separate manual verification activities. HSI validation will include a sampling of scenarios using the backup PBPs.

The CBPs meet the following additional requirements:

- Operating procedures displayed in the HSI conform to Section 8 of NUREG-0700, Rev. 2 (plus errata) regarding HFE principles for computer displayed controls and procedures.
- The parameters and component status necessary for the operator to make each decision are provided on the same display as the procedure.
- Checklists of prerequisites or interlocks to steps needed to complete an action are included where applicable.
- The operator retains final control and authority on whether or not to proceed with specific actions.
- Plant parameters and status presented as part of the procedure displays are continuously updated. The parameter values and status at the time a step is marked "complete" are time stamped and captured in the historical plant data recording system.

As explained in Section 4.3, CBPs will not be developed or used for certain procedures (e.g., control room fire protection AOP and DHP procedures).

4.5 Training Feedback

Pre-operational training on the plant simulator offers an opportunity of the personnel generating the training materials and operators who are to be licensed to identify additional procedure improvement issues. Feedback from this portion of the HFE Program supports the goals of incorporation of HFE principles and guidance, technical accuracy, ease of use, safe operation of the plant, and the content that is both explicit and comprehensive. Additionally, this communication and feedback link helps to ensure that training is maintained up to date as procedures are modified. Training feedback will be captured as Human Engineering Discrepancies (HEDs). HEDs are resolved as explained in the HFE Program Management Plan.

4.6 Procedure Maintenance

Implementation, maintenance and revision of procedures will be in accordance with established administrative procedures. Maintenance and control of updates to both paper and computer based operating procedures is managed under the configuration control program of the US-APWR Quality Assurance Program (Reference 5-13). Changes to the CBP software are required to undergo V&V in accordance with the Software Lifecycle Management Program. Procedure revisions are reviewed to ensure consistency within a single procedure and among similar procedures within a group. Consistency between the paper and computer based procedures is maintained because they both use the same electronic base file as previously described in Section 4.4.

5.0 References

5-1 Design Control Document for the US-APWR, Chapter 18, Human Factors Engineering, MUAP-DC018, Revision 3, MHI, March 2011

5-2 Design Control Document for the US-APWR, Chapter 15, Transient and Accident Analyses, MUAP-DC015, Revision 3, MHI, March 2011

5-3 Design Control Document for the US-APWR, Chapter 19, Probabilistic Risk Assessment and Severe Accident Evaluation, MUAP-DC019, Revision 3, MHI, March 2011

5-4 HSI System Description and HFE Process, MUAP-07007, Revision 4, MHI, July 2011

5-5 US-APWR Human System Interface Verification and Validation (Phase1a), MUAP-08014, Revision 1, MHI, May 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 US-APWR HSI Design Implementation Plan, MUAP-10009, Revision 0, MHI, April 2010

5-9 US-APWR Training Program Development Implementation Plan, MUAP-10011, Revision 0, MHI, April 2010

5-10 US-APWR Verification and Validation Implementation Plan, MUAP-10012, Revision 0, MHI, April 2010

5-11 US-APWR Design Implementation Plan, MUAP-10013, Revision 0, MHI, April 2010

5-12 US-APWR Human Performance Monitoring Implementation Plan, MUAP-10014, Revision 0, MHI, April 2010

5-13 Quality Assurance Program (QAP) Description for Design Certification of the US-APWR, PQD-HD-19005, Revision 3, MHI, September 2009

5-14 Guidelines for the Preparation of Emergency Operating Procedures, NUREG-0899, Revision 0, U.S. Nuclear Regulatory Commission, 1982

5-15 Lessons Learned from the Special Inspection Program for Emergency Operating Procedures, NUREG-1358 and Supplement 1, U.S. Nuclear Regulatory Commission, 1989

5-16 Plant Procedures, Inspection Procedure IP-42700, U.S. Nuclear Regulatory Commission, June 1991

5-17 Emergency Operating Procedures, Inspection Procedure IP-42001, U.S. Nuclear Regulatory Commission, June 1991

5-18 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

APPENDICES

Appendix A
Sample List of Normal Operating Procedures

General Plant Operating Procedures

Cold Shutdown to Hot Standby
Hot Standby to Minimum Load
Recovery from Reactor Trip
Operation at Hot Standby
Turbine Startup and Synchronization of Generator
Power Operation and Process Monitoring
Plant Shutdown to Hot Standby
Hot Standby to Cold Shutdown

System Operating Procedures

Reactor Coolant System
Rod Control System
Residual Heat Removal System
Emergency Core Cooling System
Component Cooling Water System
Containment Ventilation System
Containment Spray System
Spent Fuel Pit Cooling and Purification System
Main Steam System
Pressurizer Pressure Control System
Feedwater System
Emergency Feedwater system
Essential Service Water System
Chemical and Volume Control System
Reactor Building Heating and Ventilation System
Auxiliary Building Heating and Ventilation System
Main Control Room Heating and Ventilation System
Instrument Air System
Electrical System (Emergency Power Source)
Electrical System (A.C. System)
Electrical System (D.C. System)
Nuclear Instrument system (Source Range)
Nuclear Instrument system (Intermediate Range)
Nuclear Instrument system (Power Range)
Nuclear Instrument system (Incore System)
Reactor Control and Protection System
Liquid Waste Management System
Solid Waste Management System
Gaseous Waste Management System
Area Radiation Monitoring System
Process Radiation Monitoring System

Appendix B
Sample List of Abnormal Operating Procedures

Loss of Instrument Air
Loss of Condense Vacuum
Loss of Service Water
Loss of Component Cooling System
Loss of Protective System Channel
Mispositioned Control Rods
Inability to Drive Control Rods
Emergency Boration
High Activity in Reactor Coolant
Forced Evacuation of Control Room
Turbine and Generator Trip
Malfunction of Pressurizer Pressure Control System
Plant Fires
Act of Nature
Irradiated Fuel Damage While Refueling
Abnormal Releases of Radioactivity

Appendix C
Sample List of Emergency Operating Procedures

Emergency Operating Procedures

Reactor Trip or Safety Injection
Loss of Reactor or Secondary Coolant
Steam Generator Tube Rupture

Emergency Operating Supplemental Procedures

Reactor Trip Response
Natural Circulation Cooldown
Safety Injection Termination
Post-LOCA Cooldown and Depressurization
Post-SGTR Cooldown

Emergency Contingency Action Procedures

Loss of All AC Power
Uncontrolled Depressurization of All Steam Generators
SGTR With Loss of Reactor Coolant
SGTR Without Pressurizer Pressure Control

Functional Restoration Procedures

Restoration of Subcriticality
Restoration of Core Cooling
Restoration of Secondary Heat Sink
Restoration of Reactor Vessel Integrity
Restoration of Containment Integrity
Restoration of Inventory

Appendix D
Sample List of SAMGs

Severe Accident Control Room Guidelines (SACRGs)

- Overall Procedure
- Individual Procedures
  - Containment Spray Operation for Reactor Cavity Flooding
  - Firewater Injection to Reactor Cavity
  - Preparation for Alternate Containment Cooling
  - Containment Spray Operation for Containment Depressurization
  - Implementation of Alternate Containment Cooling
  - Firewater Injection to Spray Header
  - Water Supply to Steam Generators
  - RCS Depressurization
  - Borated Water Injection to RCS
  - Containment Hydrogen Monitoring and Control System Operation

Severe Accident Technical Support Center Guideline (TSCG)

- TSC Diagnostic Flow Chart
- Accident Management Guidelines
  - Containment Isolation
  - Hydrogen Control
  - Reactor Cavity Flooding
  - Preparation for Alternate Containment Cooling
  - Containment Depressurization
  - Containment Cooling
  - Water Injection into Steam Generators
  - RCS Depressurization
  - Water Injection into RCS
  - Suspension of Containment Depressurization
  - Radioactivity Reduction in Containment Atmosphere

Knowledge Database (KDB)

- Knowledge Database for TSC Staff