GE Energy
Nuclear

3901 Castle Hayne Rd
Wilmington, NC 28401

NEDO-33277
Revision 2
Class I
March 2007

LICENSING TOPICAL REPORT

HUMAN PERFORMANCE MONITORING IMPLEMENTATION PLAN

INFORMATION NOTICE

This document NEDO-33277, Revision 2, contains no proprietary information.

IMPORTANT NOTICE REGARDING CONTENTS OF THIS REPORT PLEASE READ CAREFULLY

The information contained in this document is furnished for the purpose of obtaining NRC approval of the ESBWR Certification and implementation. The only undertakings of General Electric Company with respect to information in this document are contained in contracts between General Electric Company and participating utilities, and nothing contained in this document shall be construed as changing those contracts. The use of this information by anyone other than that for which it is intended is not authorized; and with respect to **any unauthorized use**, General Electric Company makes no representation or warranty, and assumes no liability as to the completeness, accuracy, or usefulness of the information contained in this document.

Table of Contents

1 OVERVIEW 1
1.1 Purpose 1
1.2 Scope 1
1.2.1 Responsibilities of GE 2
1.2.2 Responsibilities of ESBWR Licensee 3
1.2.3 Responsibilities of COLOG 3
1.3 Definitions and Acronyms 5
1.3.1 Definitions 5
1.3.2 Acronyms 7

2 APPLICABLE DOCUMENTS 8
2.1 Supporting and Supplemental GE Documents 8
2.1.1 Supporting Documents 8
2.1.2 Supplemental Documents 8
2.2 Codes and Standards 8
2.3 Regulatory Guidelines 9
2.4 DOD and DOE Documents 10
2.5 Industry/Other Documents 10

3 METHODS 11
3.1 Design Implementation and Testing 11
3.1.1 Background 11
3.1.2 Goals 12
3.1.3 Basis and Requirements 12
3.1.4 General Approach 12
3.1.5 Application 13
3.2 Operation and Monitoring 13
3.2.1 Background 13
3.2.2 Goals 13
3.2.3 Basis and Requirements 14
3.2.4 General Approach 14
3.2.5 Application 15
3.3 Generic FSAR Changes 15
3.3.1 Background 15
3.3.2 Goals 15
3.3.3 Basis and Requirements 16
3.3.4 General Approach 16
3.3.5 Application 16
3.4 Pilot FSAR Changes 16
3.4.1 Background 17

3.4.2 Goals 17
3.4.3 Basis and Requirements 17
3.4.4 General Approach 17
3.4.5 Application 18

4 IMPLEMENTATION 19
4.1 Design Implementation and Testing 19
4.1.1 Assumptions 19
4.1.2 Inputs 19
4.1.3 Process 19
4.1.4 Outputs 20
4.2 Operation and Monitoring 20
4.2.1 Assumptions 20
4.2.2 Inputs 20
4.2.3 Process 20
4.2.4 Outputs 21
4.3 Generic FSAR Changes 22
4.3.1 Assumptions 22
4.3.2 Inputs 22
4.3.3 Process 22
4.3.4 Outputs 22
4.4 Pilot FSAR Changes 23
4.4.1 Assumptions 23
4.4.2 Inputs 23
4.4.3 Process 23
4.4.4 Outputs 24

5 RESULTS 25
5.1 HPM Results Summary Report 25
5.2 Periodic Reports 25
5.3 Technical Output Reports 25

Figure 1 - HFE Implementation Process 26

Figure 2 – Human Performance Monitoring Implementation Plan Flow Chart 27

1 OVERVIEW

This plan addresses human performance monitoring (HPM) during ESBWR operations. HPM employs diverse programmatic inputs and an integrated system of evaluation. This plan also links human factor engineering (HFE) results developed during design with methods for monitoring human performance during operation by the Combined Operating License (COL) licensee. The human performance monitoring implementation plan (HPMIP) as shown in Figure 2 illustrates how the HFE activities are performed during the design support the ESBWR operations. This implementation plan is one of the twelve elements for HFE review identified in NUREG-0711, Rev. 2.

The COL Owners Group (COLOG) provides a means for consistently maintaining safety performance levels established through staffing, training, procedures, and design as described in the ESBWR Design Control Document (DCD). Individual ESBWR licensees' programs may vary in content and level of detail; however, the standards established by the COLOG are followed.

1.1 Purpose

The objective of the ESBWR HPMIP is to ensure that no safety degradation occurs due to changes in design, procedures, training, or staffing. The HPMIP incorporates a strategy for monitoring the performance of personnel and equipment that is integrated with existing programs. Preservation and improvement of human performance and economic efficiency are predicated on the continued and coordinated operation of a standardized fleet.

HPM integration with existing programs provides an assurance that the ESBWR HFE design bases remain valid during the operational phase of the plant. These programs include:

- Corrective Action (CAP)
- Maintenance Rule (MR)
- Human Reliability Analysis/Probabilistic Risk Assessment (HRA/PRA)
- In-service Inspection / In-service Testing (ISI/IST)

This HPMIP outline builds upon the HFE design activities that are carried forward into the operational phase. The ESBWR licensees' CAP, procedures, and training programs are incorporated to support the HPMIP.

1.2 Scope

This document illustrates how HPM elements employ HFE information developed during the ESBWR HSI design. Completion and documentation of the initial plant HFE/HSI design verification by the ESBWR licensee provides a basis for HPM when plant operations begin. For example, the HPMIP uses benchmarks for human performance, established during the ESBWR design for specific tasks defined in the function allocation and task analysis, and verified during simulator testing in the V&V phase.

The monitoring of performance relative to these benchmarks ensures sufficient margin to fulfill assumptions supporting the General Design Criteria (GDC). The HPM strategy provides a reasonable assurance that the ability to interface among various HSIs within each facility is maintained effectively throughout the ESBWR operational phase in the following areas:

- Main control room (MCR)
- Remote shutdown station (RSS)
- Risk-important local control stations (LCS)
- Emergency support centers (emergency operating facility (EOF) and technical support center (TSC)

There are three entities that are tasked with developing and implementing the HPMIP during the ESBWR operating phase:

- GE
- ESBWR licensee
- COLOG

1.2.1 Responsibilities of GE

GE supports safe and economic ESBWR fleet operation by:

- Determining and documenting the scope and structure of the HPMIP
- Forming and chairing an advisory owners' group, COLOG, that addresses ESBWR fleet issues
- Maintaining the certified ESBWR HFE design basis during the operating life of the ESBWR program
- Providing analysis of design issues arising during V&V, start-up testing, and plant operation, as commissioned by the COLOG
- Providing procedure analysis and requisite changes during V&V, start-up testing, and plant operation, as commissioned by the COLOG
- Reviewing operational issues related to the standard FSAR and producing periodic reports, as commissioned by the COLOG
- Processing standard FSAR amendments that are in the long-term interest of the ESBWR partners, as commissioned by the COLOG

1.2.2 Responsibilities of ESBWR Licensee

The following are the responsibilities of the ESBWR licensee:

- Implements the plant level strategy for HPM during the operating life of the plant by assessing:
  1. Design information
  2. Risk importance measures
  3. Operating Experience Reviews (OER)
  4. Training simulator capabilities
- Participates in the COLOG
- Performs start-up and design implementation testing
- Screens operating events (similar to a 10CFR 50.59 screen)
- Determines if the generic FSAR is potentially impacted
- Forwards events that have the potential to impact the standard FSAR to the COLOG for analysis and review
- Implements generic FSAR changes and timeline mandated by the COLOG
- Implements pilot changes to the generic FSAR and restores facilities to standard design when the pilot change has expired

1.2.3 Responsibilities of COLOG

The following are the COLOG responsibilities:

- Evaluates data from individual plants
- Trends data from individual plants
- Screens operating events for importance
- Analyzes events to determine the root cause
- Trends simulated performance of critical tasks to identify change
- Develops corrective actions for significant events

- Evaluates pre-operational V&V and functional test results and determines whether pursuit of a change to the standard FSAR is warranted
- Commissions GE to evaluate standard FSAR related issues
- Commissions GE to change the standard FSAR for the long-term benefit of continued safe and economic operation of the ESBWR fleet
- Maintains the HFE Issue Tracking System (HFEITS) to record, track, and trend HFE issues, impacts, evaluation, and resolution during the operating phase of the ESBWR
- Determines the type, scope, and duration of pilot changes to the generic FSAR
- Monitors the effectiveness of the corrective actions

1.3 Definitions and Acronyms

1.3.1 Definitions

Several terms are defined to provide a common basis for developing HPM recommendations referred to in this plan.

Accident Sequence - a representation in terms of an initiating event followed by a combination of system, function and operator failures or successes, of an accident that can lead to undesired consequences, with a specified end state (for example, core damage or large early release). An accident sequence may contain many unique variations of events (minimal cut sets) that are similar. (ASME PRA Std.)

Accident Situation - from the operator's perspective, an abnormal plant state occurring during an event, which may lead to a new damage condition. Operations staffs' actions can prevent, mitigate or exacerbate the accident progression using the HSI. (IEEE working group)

Function - An activity or role performed by a human, structure, or automated system to fulfill an objective. (NEDO-33219, ESBWR Functional Requirements Analysis Implementation Plan)

Human-System Interfaces - A human-system interface (HSI) is that part of the system through which personnel interact to perform their functions and tasks. In this document, "system" refers to a nuclear power plant. Major HSIs include alarms, information displays, and controls. Procedures are also HSIs, but are developed and treated in a separate activity plan, and are treated separately in this plan. Operator controls and information displays, however, for the purposes of displaying on-line procedures are HSIs in the context of this activity.

Initiating Event - any event either internal or external to the plant that perturbs the steady state operation of the plant, if operating, thereby initiating an abnormal event such as transient or LOCA within the plant. Initiating events trigger sequences of events that challenge plant control and safety systems whose failure could potentially lead to core damage or large early release.

Local Control Station - An operator interface related to nuclear power plant (NPP) process control that is not located in the main control room. This includes multifunction panels, as well as single-function HSIs such as controls (for example, valves, switches, and breakers) and displays (for example, meters) that are operated or consulted during normal, abnormal, or emergency operations.

Maintenance - Activities carried out to keep systems and equipment available. Specific types of maintenance include preventive, and corrective. Activities associated with preventive maintenance include testing, surveillance, inspection, and calibration. Activities associated with corrective maintenance include repair, replace, and modify.

Response - to react to a cue for action in initiating or recovering a desired function.

Safety systems - those systems that are designed to prevent or mitigate a design-basis accident. (ASME PRA Std. amplified)

Task - A collection of activities with a common purpose, often occurring in temporal proximity, with an identifiable start and end point for which human actions are performed.

1.3.2 Acronyms

The following is a list of acronyms used in this plan:

AOF	Allocation of Function
BRR	Baseline Review Record
CA	Corrective Action
CAP	Corrective Action Program
COL	Combined Operating License
COLOG	Combined Operating License Owners Group
D3	Defense-in-Depth and Diversity
EOC	Extent of Condition
EOF	Emergency Operations Facility
ESBWR	Economically Simplified Boiling Water Reactor
FRA	Functional Requirements Analysis
FSAR	Final Safety Analysis Report
FSS	Full Scope Simulator
GDC	General Design Criteria
HFE	Human Factors Engineering
HFEITS	Human Factors Engineering Issue Tracking System
HPES	Human Performance Evaluation System
HPM	Human Performance Monitoring
HPMIP	Human Performance Monitoring Implementation Plan
HSI	Human System Interface
INPO	Institute of Nuclear Power Operations
ISI/IST	In-Service Inspection / In-Service Testing
LCS	Local Control Station
LER	Licensee Event Report
MCR	Main Control Room
OER	Operating Experience Review
HRA/PRA	Human Reliability Analysis/Probabilistic Risk Assessment
RSS	Remote Shutdown Station
RTS	Representative Training Simulator
S&Q	Staffing and Qualification
TA	Task Analysis
TSC	Technical Support Center
V&V	Verification and Validation

2 APPLICABLE DOCUMENTS

Applicable documents include supporting documents, supplemental documents, codes and standards and are given in this section. Supporting documents provide the input requirements to this plan. Supplemental documents are used in conjunction with this plan. Codes and standards are applicable to this plan to the extent specified herein.

2.1 Supporting and Supplemental GE Documents

2.1.1 Supporting Documents

The following supporting documents were used as the controlling documents in the production of this plan. These documents form the design basis traceability for the requirements outlined in this plan.

1. ESBWR DCD, Chapter 13, Rev 3, (GE 26A6642BL)
2. ESBWR DCD, Chapter 18, Rev 3, (GE 26A6642BX)
3. ESBWR DCD, Chapter 19, Rev 3, (GE 26A6642BZ)
4. NEDO-33217, Rev 2, ESBWR Man Machine Interface System and Human Factors Engineering Implementation Plan

2.1.2 Supplemental Documents

1. NEDO-33219, Rev 1, ESBWR Functional Requirements Analysis Implementation Plan
2. NEDO-33220, Rev 1, ESBWR Allocation of Functions Implementation Plan
3. NEDO-33221, Rev 1, ESBWR Task Analysis Implementation Plan
4. NEDO-33229, Rev 1 DCIS Hardware/Software Development Plan
5. NEDO-33262, Rev 1, ESBWR Operating Experience Review Implementation Plan
6. NEDO-33266, Rev 1, ESBWR Staffing and Qualifications Plan
7. NEDO-33267, Rev 1, ESBWR Human Reliability Analysis Implementation Plan
8. NEDO-33268, Rev 2, ESBWR Human System Interface Design Implementation Plan
9. NEDO-33274, Rev 2, ESBWR Procedures Development Plan
10. NEDO-33275, Rev 1, ESBWR Training Program Development Plan
11. NEDO-33276, Rev 1, ESBWR HFE Verification & Validation Implementation Plan

2.2 Codes and Standards

1. ANSI/ANS 3.1-1993; R1999: Selection, Qualification, and Training of Personnel for Nuclear Power Plants (American Nuclear Society).

2. ANSI/ANS-3.2-1994; R1999, "Administrative Controls and Quality Assurance for the Operational Phase of Nuclear Power Plants."

3. ANSI/ANS-3.4-1996; R2002, "Medical Certification and Monitoring of Personnel Requiring Operator Licenses for Nuclear Power Plants."

4. ANSI/ANS 3.5-1998: Nuclear Power Plant Simulators for Use in Operator Training and Examination (American Nuclear Society).

5. IEEE Std 610 -1991, "IEEE Standard Computer Dictionary, A Compilation of IEEE Standard Computer Glossaries" The Institute of Electrical and Electronics Engineering.

2.3 Regulatory Guidelines

1. CN Number 05-030: NRC Inspection Manual: Chapter 0609, Significance Determination Process (NRC, 2001).

2. CN Number 05-031: NRC Inspection Manual: Chapter 2515, Light-Water Reactor Inspection Program - Operations Phase (NRC, 2002).

3. IP 71715: Sustained Control Room and Plant Observation. (NRC, periodically updated).

4. NUREG-1649 Rev.3: Reactor Oversight Process (NRC, 2000).

5. INPO 85-017 Rev 2, Guidelines for the Conduct of Operations at Nuclear Power Stations. (10 CFR 50.120: U.S. Code of Federal Regulations, Part 50, "Training and Qualification of Nuclear Power Plant Personnel," Title 10, "Energy").

6. NUREG-0700 Rev. 2, Human-system Interface Design Review Guidelines (NRC, 2002).

7. NUREG-0711 Rev 2, Human Factors Engineering Program Review Model, 2004.

8. NUREG-0737, Clarification of TMI Action Plan Requirements Supplement 1 (NRC,1983), Requirements for Emergency Response Capability.

9. NUREG-0800, Section 13.2.1, Rev 2, Reactor Operator Training, 2005.

10. NUREG-0800, Section 13.2.2, Rev 2, Training for Non-Licensed Plant Staff, 2005.

11. Regulatory Guide 1.149 Rev. 3: Nuclear Power Plant Simulation facilities for Use in Operator Training and Licensing Examination (NRC, 2001).

12. Regulatory Guide 1.174, Rev 1, An Approach for using Probabilistic Risk Assessment in Risk-Informed Decisions on Plant-Specific Changes to the Licensing Basis, 2002.

13. Regulatory Guide 1.8 Rev. 3: Qualification and Training of Personnel for Nuclear Power Plants (NRC, 2000).

2.4 DOD and DOE Documents

1. AD-A226 480, U.S. Army Test and Evaluation Command, Human Factors Engineering, Test Operation Training 1-2-610 (Part 1), May 1990.
2. DOE Order 5480.19, Conduct of Operations Requirements for DOE Facilities, DOE Change 2 Oct 2001.
3. MIL-STD 1472F, Human Engineering Design Criteria Standard, Department of Defense. 1999.
4. MIL-HDBK-46855A, Human Engineering Requirements for Military Systems, Equipment and Facilities (Dept. of Defense) May 1999.

2.5 Industry/Other Documents

1. EPRI-TR-016780-V2R8, Advanced Light Water Reactor Utility Requirements Document, Vol. II ALWR Evolutionary Plant, Chapter 10, Man-Machine Interface Systems, Rev. 8, 1999.
2. EPRI-NP-1567, Human Factor Review of Power Plant Maintainability, 1980.
3. EPRI-NP-2360, Human Factors Methods for Assessing and Enhancing Power Plant Maintainability, 1982.
4. EPRI NP-3659, Human Factors Guide for Nuclear Power Plant Control Room Development, 1984.
5. EPRI-NP-3701 Computer-generated Display System Guidelines Vol. I and II, revised 1984.
6. IAEA INSAG-13 Management Of Operational Safety In Nuclear Power Plants, 1999.
7. IAEA Safety Series No. 75-INSAG-4: "Safety Culture", 1991.
8. IAEA - Technical Report Series (TECDOC-596), "Reviewing operational experience feedback", IAEA, 1991.
9. IAEA- Technical Report Series (TECDOC-525), Guidebook on Training to Establish and Maintain the Qualification and Competence of Nuclear Power Plant Operations Personnel, Vienna, 1989.
10. IAEA- Technical Report Series (TECDOC-668), The Role of Automation and Humans in Nuclear Power Plants, IAEA, Vienna, 1992.
11. Rasmussen, J. "Information Processing and Human-Machine Interaction, An Approach to Cognitive Engineering," Elsevier Science publishing company, New York 1986.

3 METHODS

HPMIP identifies areas needing improvement to enhance the operation and maintenance of the ESBWR fleet. This plan is part of an overall HFE process that enhances the HSI in the design of a nuclear power plant illustrated in Figure 1, HFE Implementation Process. HPM provides the mechanism to improve human performance, mitigate, and prevent human errors, through changes in design, staffing, procedures, and training.

The HPM implementation plan provides a process to ensure that events are documented, trended, and analyzed to identify changes necessary to enhance the safe operation of the ESBWR fleet. These identified changes are implemented fleet wide to ensure all ESBWR units benefit from the operating experience review of individual plants.

The essential elements for developing an HPM strategy include considerations for data collection, screening for importance, analyzing events to determine the cause, and for trending and developing corrective actions. Where possible, the elements of the HPM draws upon existing information sources and programs.

Advanced uses of risk and reliability techniques in the nuclear industry are developed to provide up-to-date risk and reliability information to the control room. Such tools are used to support asset management by including trip monitors and derate models. The goal of these models is to provide estimates of the trip or derate probability as a function of configuration changes in the plant. This permits operators to more clearly understand complex relationships between systems undergoing maintenance and testing. The use or non-use of this tool, as it relates to an event, provides the HPM program the mechanism to evaluate the operators' actions and decisions. In addition, any modifications necessary for training, procedures, or the decision-making tools are evaluated.

This section describes the following four activities:

- Design implementation and testing
- Operation and monitoring
- Generic FSAR Changes
- Pilot Changes

3.1 Design Implementation and Testing

3.1.1 Background

The HPM plan is structured to ensure that the implemented design is:

- Consistent with the design evaluated by the V&V plan
- Reconciled to the verified design
- Monitors human actions commensurate with risk importance

3.1.2 Goals

The goals of the HFE design implementation and testing section include:

- Assurance that the rendered design meets the HFE V&V acceptance criteria.
- Identification of HFE issues prior to the operating phase.
- Provision of an impetus to issue resolution .

3.1.3 Basis and Requirements

ESBWR licensee HPM program requirements include:

1. Acceptance criteria and bases are established prior to start-up testing.
2. Performance requirements are established by initial baseline V&V testing results.
3. Pre-operational testing of systems and subsystems is performed as early as practical.
4. Integrated simulation testing is performed prior to operational phase.
5. When actual conditions cannot be simulated, monitored, or measured, the available information that most closely approximates performance data in actual conditions is used to assess the impact on risk via the HRA/PRA models and data.
6. Startup testing is performed concurrent with initial heat-up.
7. Start-up/functional test results are promptly evaluated and any required corrective actions are performed in a timely manner and verified to be effective.
8. Degradation in performance is detected and corrected before plant safety margin is compromised.
9. Deviations or issues identified during V&V and start-up test evaluations, as well as corrective actions, are documented in the HFEITS.

3.1.4 General Approach

The HFE design team, when allocating specific human actions to systems and integrated accident management processes, establishes the basic human performance requirements for the ESBWR.

The V&V portion of the HFE strategy provides a reasonable assurance that:

- The HSI design accommodates control room personnel and coordination among the control room, local control stations, and support centers to address expected transients, design basis events, operating events, and hypothetical accident scenarios identified by the HRA/PRA.
- The staffing plan and initial training assure that human actions using HSI information, cues, and controls are accomplished within margins on time to meet GDC performance criteria used to determine the probability of success assessments for the HRA/PRA.

- Plant procedures are adequate to ensure that critical tasks support GDC requirements and do not contribute to the initiation of an operating event.

The HPM design implementation and testing section ensure that the human performance requirements demonstrated during the HFE V&V are confirmed during startup and design change testing. In addition, HPM ensures that any significant degradation in human performance is identified, evaluated and reconciled.

Once a significant issue or change to the standard ESBWR is identified or developed, it is evaluated for influence on human performance. Changes with the potential to impact human performance are modeled into the Full Scope Simulator (FSS) or hardware training to measure and evaluate the impact on human performance. When the evaluation shows that the change provides enhancement to the plant operation /safety, it is implemented in the ESBWR fleet.

3.1.5 Application

The HPMIP:

- Evaluates deviations from the verified standard design.
- Identifies the possibility of latent errors embedded in the application of the standard design.
- Determines if the standard design needs modification.

3.2 Operation and Monitoring

3.2.1 Background

During the operational phase of the ESBWR the HPM strategy provides reasonable assurance that:

- The acceptable level of performance established during the integrated V&V is maintained. The methods for evaluation and trending of plant operators performance stem from INPO established human performance evaluation system (HPES) approaches.
- The changes made to standard ESBWR HSIs, procedures, staffing, and training are screened for generic FSAR impact and consistently applied at all ESBWRs in a timely manner. Verification that targeted deficiencies have been mitigated and that changes have not created new deficiencies or degrades personnel performance (for example, a change that interferes with previously trained skills).
- The changes made to the HSI are tested in the FSS prior to implementation in the plant.

3.2.2 Goals

The goals of HFE operation and monitoring include:

- Detection of degrading human performance before design margin is eroded.
- Identification of latent errors that have the potential to contribute to an operating event.
- Identification of active errors that have the potential to contribute to an operating event.

3.2.3 Basis and Requirements

ESBWR licensee HPM program requirements include:

- Operator training simulator evaluation results are trended.
- Licensee corrective action programs screen adverse conditions and trends for potential impact to the generic FSAR.
- All issues with the potential to impact the generic FSAR are promptly forwarded to the COLOG.
- Issues are trended and analyzed on a fleet-wide basis.

3.2.4 General Approach

The ESBWR licensee maintains a database of events, significance evaluations, cause determinations, and corrective actions taken during the event evaluation to support trending of performance degradation and failures.

Existing programs such as licensed operator training and the CAP include appropriate data for trending human performance as well as other performance indicators for the plant. The HPM plan uses existing utility and industry programs for data collection, rather than developing new monitoring programs.

The strategic elements are implemented through the use of a FSS during periodic training exercises. An assumption for use during the HSI design process is that the control room simulator is maintained and upgraded to match the actual control room with good interface and dynamic response fidelity.

Periodic evaluation and trending of operators' performance of tasks with respect to time and accuracy goals are performed to demonstrate performance consistent with that developed during the various analyses that support the standard FSAR (or justify/validate changes to the standard FSAR).

The plan uses precursor analysis to understand the impact of the deviations. The impact of human deviations and system or component failures are mapped into generic accident sequence event trees as ones and zeros to produce a change in the accident sequence probability under the identified conditions. This precursor analysis is an ongoing process continuing through all phases of the ESBWR plant life cycle including:

- Pre-operational plant simulation.
- Full-scope simulator training.
- Construction and testing.
- Initial start-up and low-power testing.
- Power ascension and warranty testing.

- ESBWR operating phases (including abnormal, emergency, and transient).
- Generic FSAR changes.
- Generic FSAR pilot changes.

This process is superseded, if the HRA/PRA of the plant is sufficiently detailed, to model the deviation. Then the standard risk-importance measures are used. The risk-importance prioritization scheme includes:

- Screening and trending of operating occurrences.
- Systematic assessment for potential nuclear safety impact.
- Corrective actions, scope and timeframe evaluations.
- Aggregate plant (ESBWR fleet) risk-sensitivity.

3.2.5 Application

The HPMIP:

- Collects and processes operating, training, and equipment data.
- Identifies trends that have the potential to contribute to an operating event through precursor monitoring and licensed operator evaluation trending.
- Evaluates deviations in training evaluation results.
- Identifies latent errors embedded in the application of the standard design through precursor monitoring and licensed operator evaluation trending.
- Assesses the impact of issues on the standard design.

3.3 Generic FSAR Changes

3.3.1 Background

An important element of HPM is to understand the impact of deviations on plant operation and safety. A root cause analysis is typically conducted to determine if a proposed corrective action addresses the cause of the deviation or component failure.

3.3.2 Goals

The goals of this section include:

- Maintain the ESBWR fleet as a standard design.
- Provide an economically efficient method to update/maintain the standard ESBWR design.
- Maintain the HFE and design bases during the operating phase of ESBWR.
- Identification of possible latent errors that have the potential to contribute to an operating event.

- Identification of possible active errors that have the potential to contribute to an operating event.

3.3.3 Basis and Requirements

ESBWR licensee and COLOG requirements for changes to standard design, procedures, and training include:

- Issues are resolved by the licensee and COLOG within time constraints consistent with safety significance.
- Issue resolutions benefit the long-term safe and economic operation of the ESBWR fleet.
- Human performance is restored before design margin is eroded.

3.3.4 General Approach

The Generic FSAR Change section ensures that the human performance requirements are maintained during the operating phase by allowing controlled fleet-wide changes to the standard design in response to:

- Obsolescence.
- Operating events.
- New Technologies.
- Changing Expectations.

Once a significant issue or change to the standard ESBWR is identified or developed, it is tested for impact on human performance. Changes that have the potential to impact human performance are modeled into the FSS or hardware training to measure and evaluate the impact on human performance. When the evaluation shows that the change provides enhancement to the fleet operation /safety, it is implemented throughout the ESBWR fleet. Change implementation timetables are determined by agreement between the licensee and the COLOG.

3.3.5 Application

The HPMIP:

- Identifies possible latent errors embedded in standard design changes.
- Determines how the standard design is modified.
- Evaluates deviations in training evaluation results.
- Assesses the impact of issues on the standard design.

3.4 Pilot FSAR Changes

The pilot change process allows deviations from the standard FSAR that are:

- Limited in scope and/or duration.

- Economically or technologically necessary.
- Promoted by the COLOG.
- Benefit the ESBWR fleet as a whole.

3.4.1 Background

A pilot change is a change to the standard FSAR that does not affect all ESBWR plants. A pilot change can be long term or short term to allow deviation from the standard FSAR due to issues such as obsolescence, component availability, technology changes and so forth. The pilot change allows new plants to employ modern technology while not forcing existing plants to immediately upgrade systems that are performing adequately.

3.4.2 Goals

The goals of HFE pilot FSAR design changes include:

- Restoration of human performance before design margin is eroded.
- Flexibility in design, training, and/or procedures to meet operational needs.
- Maintenance of a standardized ESBWR fleet through standard design, procedures, training, and monitoring.
- Identification of possible latent errors that have the potential to contribute to an operating event.
- Identification of possible active errors that have the potential to contribute to an operating event.

3.4.3 Basis and Requirements

ESBWR licensee HPM program requirements for pilot changes to standard design, procedures, and training include:

- Issues are resolved by the COLOG within time constraints consistent with safety significance.
- Scope and duration of pilot changes are managed by the licensee and COLOG.
- Issue resolutions benefit the long-term safe and economic operation of the ESBWR fleet.
- Human performance is restored before design margin is eroded.

3.4.4 General Approach

The pilot FSAR Change section ensures that the human performance requirements are maintained during the operating phase by allowing controlled fleet-wide changes to the standard design in response to:

- Obsolescence.

- Operating events.
- New Technologies.
- Changing Expectations.

Once a significant issue or change to the standard ESBWR is identified or developed, it is tested for impact on human performance. Changes with the potential to impact human performance are modeled into the FSS or hardware training to measure and evaluate the impact on human performance. When the evaluation shows that the change provides enhancement to plant operation /safety, it is implemented in a portion of ESBWR fleet per Section 4.3 Generic FSAR Change process.

3.4.5 Application

The HPMIP:

- Identifies latent errors embedded in pilot design changes.
- Determines how the standard design is modified.
- Evaluates deviations in training evaluation results.
- Assesses the impact of issues on the standard design.

4 IMPLEMENTATION

The HPM plan executes the following four activities:

- Design implementation and testing.
- Operation and monitoring.
- Generic FSAR changes.
- Pilot changes.

4.1 Design Implementation and Testing

4.1.1 Assumptions

- Design, training, and procedures are generic to the ESBWR fleet.
- The design is developed through though the HFE process.
- A full scope simulator is used to V&V the design.

4.1.2 Inputs

These sources include:

- Examination of OER documents.
- Review of events in the integrated HFE Issue Tracking System.
- Evaluation of HRA data sources and tools.
- Criteria and bases used for the HFE V&V.
- The COLOG charter.
- Dynamic simulation of plant accident sequences.
- Measurement and trending of operator performance and plant responses.

4.1.3 Process

The following are HPM process options:

1. The ESBWR licensee constructs the plant per the COL and generic FSAR.
2. The ESBWR licensee performs start-up testing.
3. The COLOG evaluates start-up test results.
4. The COLOG determines if a change to the standard FSAR is recommended.
5. If no generic FSAR changes are recommended, then the ESBWR licensee operates the plant per Section 4.2 Operation and Monitoring.

6. If generic FSAR changes are recommended, then the COLOG processes the change per Section 4.3 Generic FSAR Changes.

4.1.4 Outputs

The HPM outputs include the following:

- Start-up and change test reports.
- Training evaluation reports.
- Identification and resolution of HFE issues.
- Determinations to pursue a generic FSAR and pilot FSAR changes in the areas of:

    1. Training.
    2. Procedures.
    3. Changes to HSI software.
    4. HSI hardware upgrades.

4.2 Operation and Monitoring

4.2.1 Assumptions

The HPM operations and monitoring assumptions include the following:

- Design, training, and procedures are generic to the ESBWR fleet.
- Each licensee maintains a standardized and effective corrective action program.
- Each licensee participates in the COLOG.

4.2.2 Inputs

ESBWR licensee monitored CAP process includes the following inputs:

- Industry operating experience review.
- Simulator performance of critical tasks supporting the GDCs.
- Maintenance Rule Program.
- HRA/PRA updates.
- In-Service Inspection/ In-Service Testing (ISI/IST) Program.
- INPO/NRC inspection/evaluation results.
- NRC and other regulatory initiatives.

4.2.3 Process

The following includes the HPM process elements:

1. The ESBWR licensee operates the plant per the FSAR and COL.
2. The ESBWR licensee monitors the plant and personnel performance during the operating phase.
3. The ESBWR licensee determines the significance of operating events.
4. The ESBWR licensee stores and trends operating event data.
5. The ESBWR licensee determines the causes and circumstances surrounding the failure or degraded human performance.
6. The ESBWR licensee illuminates the mode and effect of the nonconformance and develops appropriate corrective actions (CAs).
7. The ESBWR licensee assesses the extent of condition (EOC) for plant and personnel deficiencies.
8. The ESBWR licensee screens Operating Events, Causes, and CAs to determine if the generic FSAR is affected.
9. The ESBWR licensee provides CAP reports, HFE issues, and operating trends that potentially impact the generic FSAR to the COLOG.
10. The COLOG evaluates issues that potentially impact the generic FSAR.
11. The COLOG determines if a change to the generic FSAR should be pursued per Section 4.3 Generic FSAR Changes.
12. The COLOG determines if a pilot change to the generic FSAR should be pursued per Section 4.4 Pilot FSAR Changes.

4.2.4 Outputs

Outputs include:

- Operating data, trends, and reports.
- Training evaluation trends and reports.
- Determinations to pursue a generic FSAR and pilot FSAR changes in the areas of:

    1. Training.
    2. Procedures.
    3. Changes to HSI software.
    4. HSI hardware upgrades.

4.3 Generic FSAR Changes

4.3.1 Assumptions

- Design, training, and procedures are generic to the ESBWR fleet.
- The generic FSAR is developed through the HFE process.
- A full scope simulator is used to V&V the design.
- Each licensee participates in the COLOG.

4.3.2 Inputs

- Recommendation to pursue a generic design change.
- OER data.

4.3.3 Process

The generic FSAR change elements include:

1. The COLOG evaluates issues that impact the generic FSAR.
2. The COLOG determines if a change to the generic FSAR is recommended.
3. The COLOG determines the type of change(s) to recommended from the following:
   - Staffing and Qualifications.
   - Procedures.
   - Training.
   - Design Change.
5. The COLOG commissions GE to perform a formal evaluation.
6. GE evaluates the request for change and determines if a change to the standard FSAR is required.
7. GE prepares the standard FSAR change, including a recommended implementation timeline.
8. Changes are implemented and tested per Section 4.1 Design Implementation and Testing.

4.3.4 Outputs

The generic FSAR outputs include:

- Generic FSAR changes.
- Design changes.
- Procedure changes.

- Training program changes.
- Staffing and qualification changes.

4.4 Pilot FSAR Changes

4.4.1 Assumptions

The following assumptions are pertinent to the pilot FSAR changes:

- Design, training, and procedures are generic to the ESBWR fleet.
- The generic FSAR is developed through the HFE process.
- A full scope simulator is used to V&V the design.
- Each licensee participates in the COLOG.

4.4.2 Inputs

The pilot FSAR changes require the following inputs:

- Recommendation to pursue a pilot design change.
- OER data.

4.4.3 Process

The pilot FSAR change process includes the following elements:

1. The COLOG evaluates issues that impact the generic FSAR.
2. The COLOG determines if a "pilot change" to the FSAR is recommended.
3. The COLOG determines the type, scope, and duration of the proposed FSAR pilot change.
4. The COLOG commissions GE to evaluate the proposed pilot change.
5. GE performs analysis of proposed pilot FSAR change.
6. GE determines if a pilot change to the FSAR is required.
7. GE prepares the pilot FSAR change (including, evaluation and close out implementation timelines) and supports proposed standard FSAR change through NRC review and approval.
8. ESBWR licensee obtains NRC approval and implements pilot FSAR change(s).
9. ESBWR licensee performs functional testing on pilot change(s).
10. ESBWR licensee operates the plant and collects data per Section 4.1 Design Implementation and Testing.
11. The COLOG evaluates data from pilot plant(s).
12. The COLOG recommends:

- Applying the pilot change(s) generically per Section 4.3 Generic FSAR changes.
- Continuing operation and monitoring with pilot change(s).
- Restoring from pilot change to the generic FSAR per Section 4.3 Generic FSAR changes.

13. ESBWR Pilot Plant licensee(s) restores the pilot plant(s) FSAR and facility to the standard ESBWR configuration.
14. ESBWR Pilot Plant licensee(s) performs V&V testing to assure that the plant has been restored in accordance with the generic ESBWR FSAR.

4.4.4 Outputs

Pilot FSAR change outputs include:

- Pilot FSAR changes.
- Pilot design changes.
- Pilot procedure changes.
- Training program pilot changes.
- Staffing and qualification pilot changes.

5 RESULTS

5.1 HPM Results Summary Report

The activities and results of the HPMIP are summarized in the result summary report published prior to initial criticality. The report addresses:

- The HPM team members and backgrounds.
- The HPM strategy including scope, structure, and provisions for specific cause determination, trending of performance degradation and failures, and corrective actions.
- The methodology and implementation of HPM activity concluding that the activity was performed in accordance with implementation plans.

5.2 Periodic Reports

1. The ESBWR licensee provides operating data per Figure 2 in a timely manner to the COLOG.
2. The COLOG publishes a periodic operating summary report (documenting ESBWR generic issues, issue resolution, implementation status and operating results) no less frequently than bi-annually.
3. GE publishes an updated standard FSAR bi-annually incorporating all approved changes.

The reporting frequencies above are the minimum requirements; frequencies are to be commensurate with the seriousness, scope, and urgency of the initiating event and/or issue(s).

5.3 Technical Output Reports

N/A

Figure 1 - HFE Implementation Process

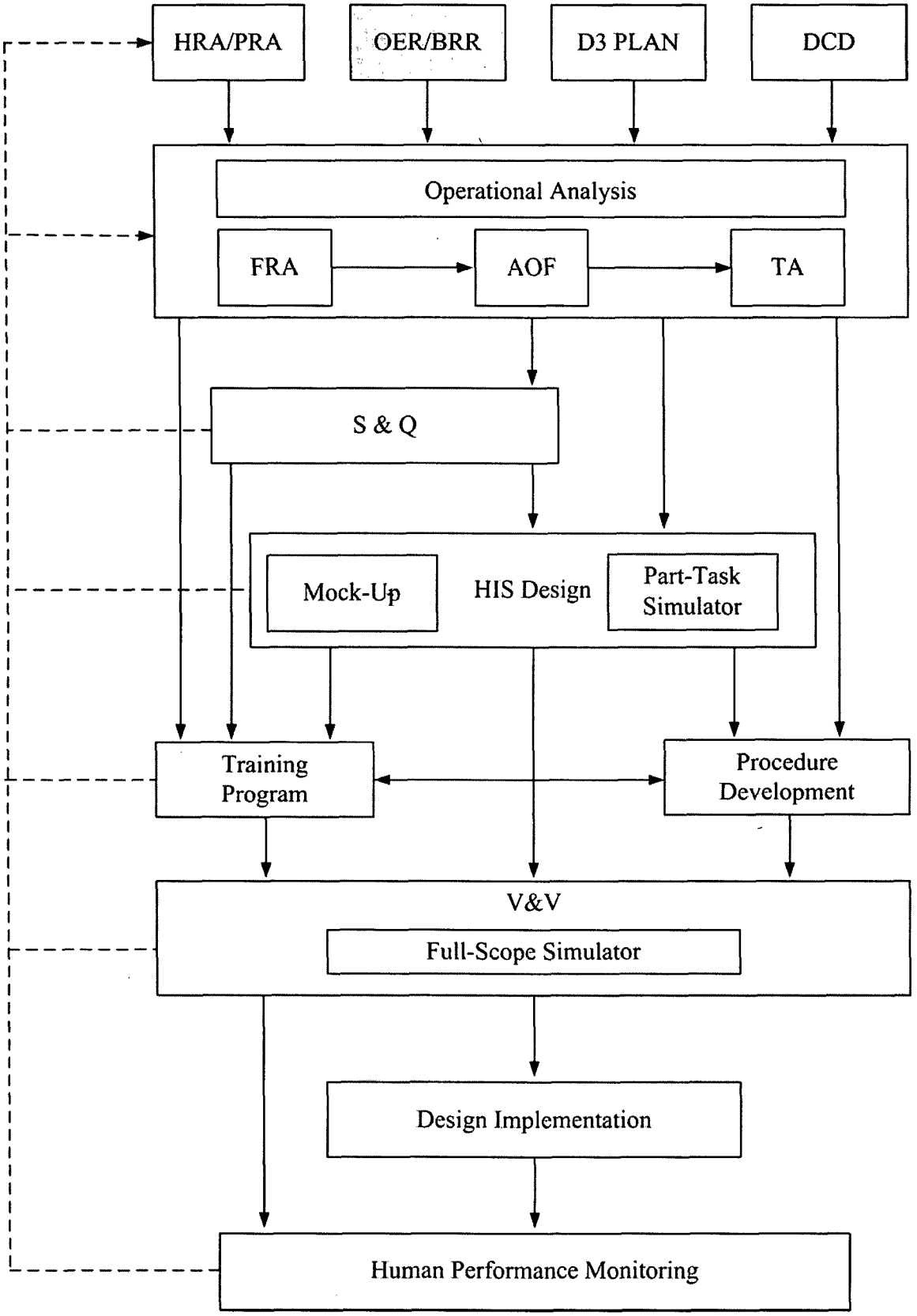

Figure 2 – Human Performance Monitoring Implementation Plan Flow Chart

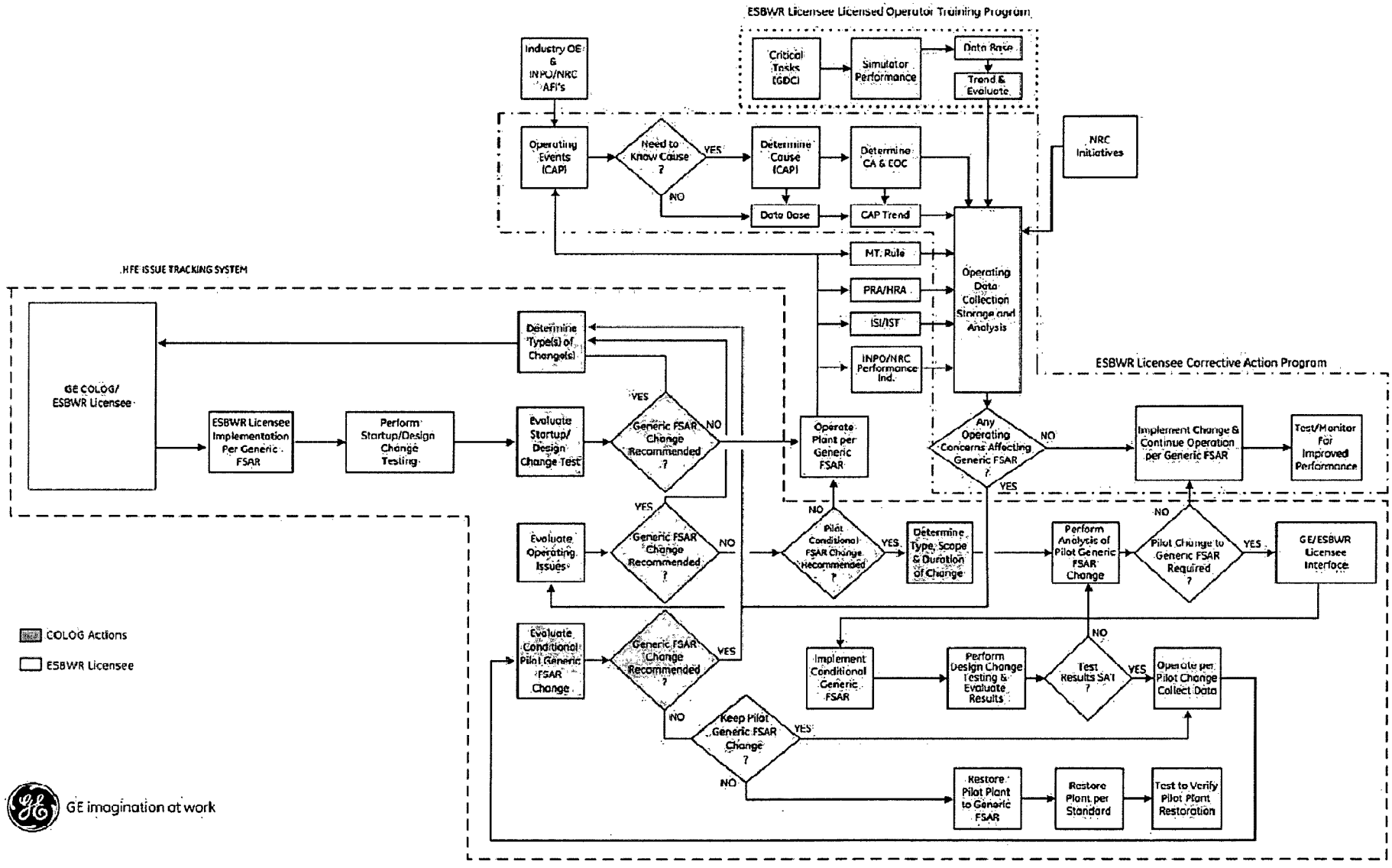

Figure 1 - HFE Implementation Process

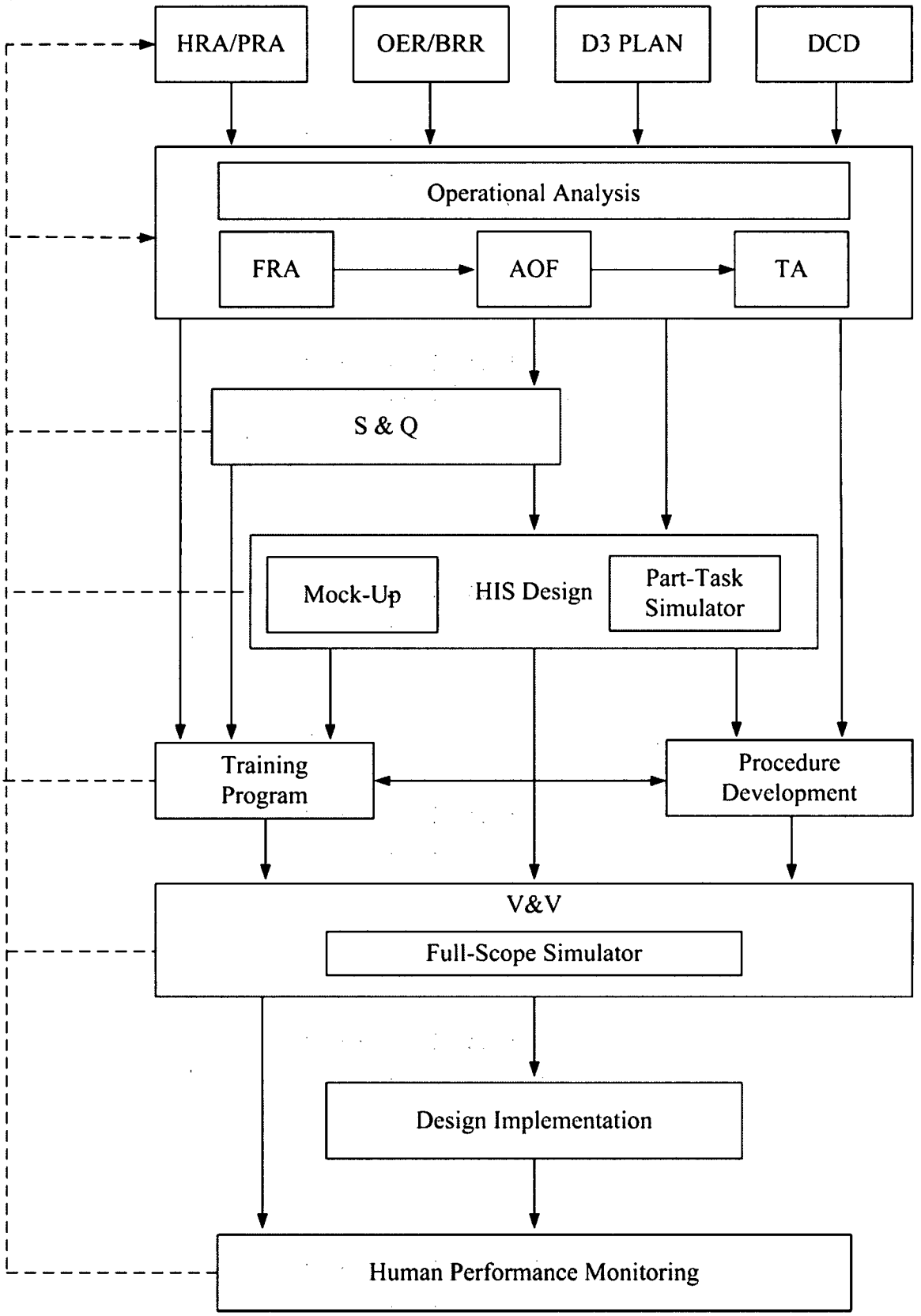

Figure 2 – Human Performance Monitoring Implementation Plan Flow Chart