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U.S. EPR™ Project Design Guideline Document

Document No: 118 - 9023868 - 003

U.S. EPR Human Factors Operating Experience Review Implementation Plan

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Record of Revision

Revision No.	Pages/Sections/ Paragraphs Changed	Brief Description / Change Authorization
000	N/A	Initial Release
001	ALL	Complete re-write
002	Section 1.4, addition	Addition of HFE team disciplines interfacing with OER
002	Section 1.5, partial re-write	Purpose rephrasing. Short description of the document structure
002	Section 1.6, addition	Addition of document objectives
002	Section 1.8, addition	List of acronyms extension
002	Section 2.3, addition	Addition of 4 Industry Guidance
002	Section 3.0., Global reorganization, additions	Reorganization of the part. Additional inputs are mentioned. Methodology is developed. Input sources are identified. Interviews content is extended. Initial write of HFE OE analysis
002	Sections 4.0, reorganization, additions	Several additions about expected outputs. Addition of Figure 4-1. The OER review process is developed.
002	Section 5.0, updates and additions.	Update of 2 references. Addition of 9 references.
002	Appendix A	Modification of Figure A-1
003		Changes due to RAI 319

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1.0 INTRODUCTION

1.1 Applicability

The U.S. EPR™ Human Factors Operating Experience Review (OER) Implementation plan applies to the U.S. EPR™ design activities.

1.2 Owner

Program Manager, Human Factors Engineering (HFE) is responsible for providing this implementation plan.

1.3 Interfaces

The U.S. EPR™ Human Factors OER interfaces with other HFE design team disciplines, as shown in Table 1-1 below:

Table 1-1: Integration of OER with other HFE team disciplines

Technical Project Manager	<ul style="list-style-type: none"> Provides schedule and management of the HFE design and implementation process
Systems Engineering	<ul style="list-style-type: none"> Provides knowledge of the purpose, operating characteristics and technical specifications of major plant systems. Provides inputs to HFE analyses.
I&C Engineering	<ul style="list-style-type: none"> Provides detailed knowledge of the HSI design, information display design, content and functionality.
Architect Engineering	<ul style="list-style-type: none"> Provides design characteristics of the control room, remote shutdown area, and local control stations.
Human Factors Engineering	<ul style="list-style-type: none"> Provides knowledge of human performance capabilities and limitations, applicable human factors design and evaluation practices, and human factors principles, guidelines, and standards Develops and performs human factors analyses and participate in the resolution of identified human factors problems.
Plant Operations	<ul style="list-style-type: none"> Provides knowledge of operational activities including HSI characteristics, environmental characteristics. Provides support to development of HSI, procedures and training programs.
Computer System Engineering	<ul style="list-style-type: none"> Participates in the design of computer based equipment such as controls and displays.
Plant Procedure Development	<ul style="list-style-type: none"> Provides inputs for the development of emergency operating procedures, procedure aids, computer-based procedures and training procedures.
Personnel Training	<ul style="list-style-type: none"> Develops content and format of personnel training programs.

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Technical Project Manager	<ul style="list-style-type: none"> Provides schedule and management of the HFE design and implementation process
Systems Safety Engineering	<ul style="list-style-type: none"> Identifies safety concerns and performs a system safety hazard analysis
Maintainability / Inspectability Engineering	<ul style="list-style-type: none"> Provides knowledge of maintenance, HSI characteristics, human performance demands and environmental characteristics. Supports the design, development and evaluation of the control room and other HSI.
Reliability / Availability Engineering	<ul style="list-style-type: none"> Provides inputs to the design of HSI equipment.

The Human Factors OER relates to other HFE program elements as shown in Table 1-2 below:

Table 1-2: OER Contribution to HFE Elements

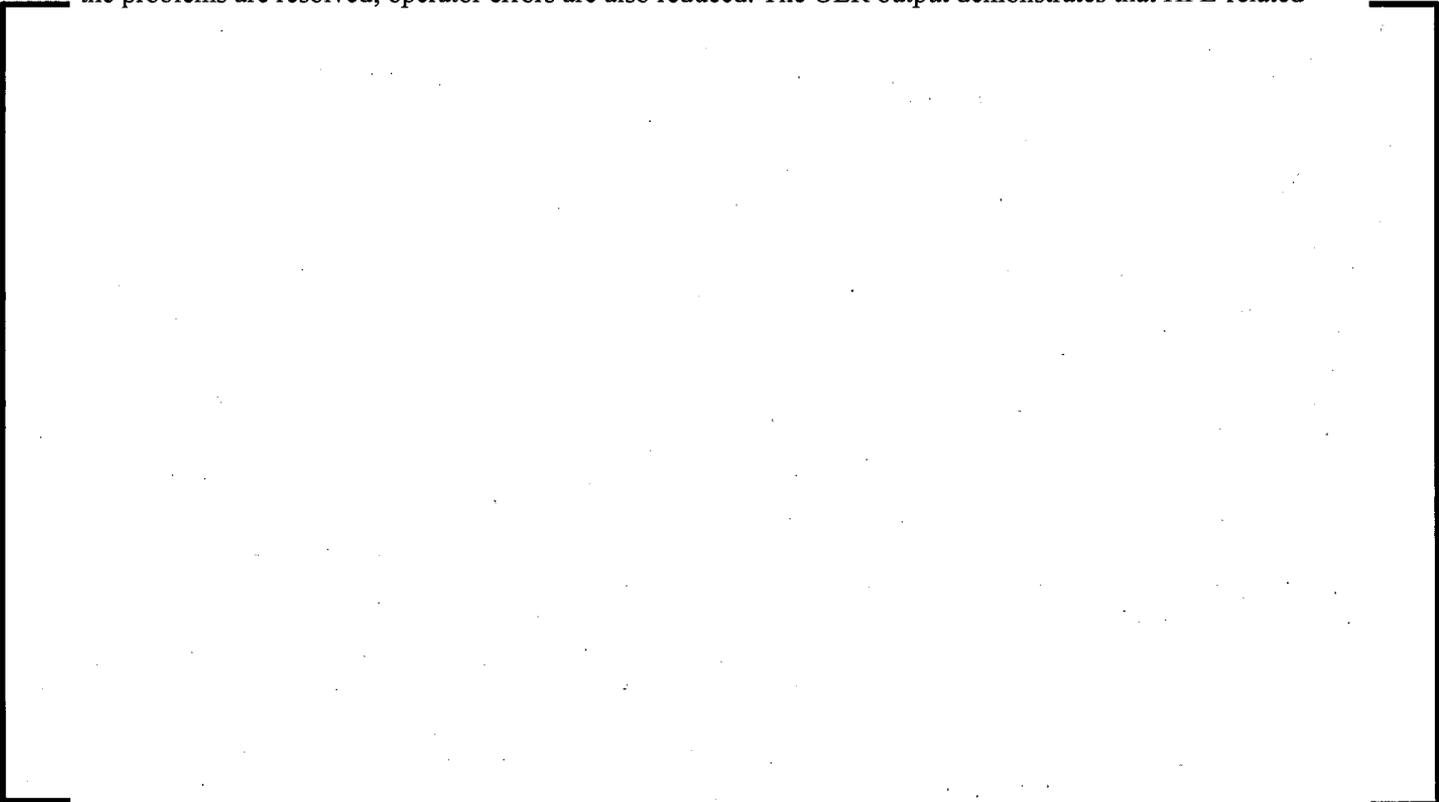
1.4 Purpose

The purpose of this Human Factors OER Implementation Plan is to provide a process to perform the Human Factors OER activities. This document provides the inputs used to obtain operating experience (OE), the method to obtain the OE from those inputs, and the method to analyze the OE for HFE-related issues that are relevant to the U.S. EPR™ design. Additionally, this plan details the outputs produced from the Human Factors OER.

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1.5 Objectives and Scope

The OER identifies problems and issues with the HSI. Evaluation and control of the HSI design is promoted when the problems are resolved; operator errors are also reduced. The OER output demonstrates that HFE-related



1.6 Definition of Terms

Term	Definition
Human System Interface	A human-system interface (HSI) is that part of the system through which personnel interact to perform their functions and tasks.
Operating Experience Review	A review of relevant history from the plant's on-going collection, analysis, and documentation of operating experiences and from interviews with plant staff.
Precursor Plant	A Precursor Plant is defined as the large 4-loop nuclear plants from which the EPR™ design evolved such as the French N4 plants and the German Konvoi plants.
Predecessor Plant	A Predecessor Plant is defined as the EPR™ plants (Olkiluoto 3 and Flamanville 3) whose conceptual design was complete prior to the beginning of the U.S. EPR™ design and are also considered sources of inheritance.
Risk-important human action	Actions that are performed by plant personnel to provide reasonable assurance of plant safety.

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1.7 List of Acronyms

Acronym	Definition
ADS	Automatic Depressurization System
AEOD	Analysis and Evaluation of Operational Data
ATWS	Anticipated Transient Without Scram
BWR	Boiling Water Reactor
CAP	Corrective Action Program
CR	Control Room
EPR™	Trademarked brand name for AREVA's evolutionary PWR reactor design
EPRI	Electric Power Research Institute
FA	Functional Allocation
FA3	Flammanville 3
FRA	Functional Requirements Analysis
HA	Human Actions
HFE	Human Factors Engineering
HITS	HFE Issues Tracking
HRA	Human Reliability Assessment
HSI	Human System Interface
IAEA	International Atomic Energy Agency
I&C	Instrumentation & Control
I&CSC	I&C Service Center
IEEE	Institute of Electrical and Electronics Engineers
INPO	Institute of Nuclear Power Operations
LCS	Local Control Station
LOCA	Loss Of Coolant Accident
MCR	Main Control Room
MUX	Multiplexer
N4	4 loops PWR, EPR™ precursor
OE	Operating Experience
OER	Operating Experience Review
OL3	Olkiluoto 3

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Acronym	Definition
POP	Plant Overview Panel
PRA	Probabilistic Risk Assessment
PWR	Pressurized Water Reactor
QDS	Qualified Display System
RSS	Remote Shutdown Station
TA	Task Analysis
TMI	Three Mile Island
TSC	Technical Support Center
V&V	Verification and Validation

2.0 CODES, STANDARDS, AND REGULATIONS

2.1 Regulations and Regulatory Guidance Documents

NUREG-0711, "Human Factors Engineering Program Review Model," Rev.2 – 02/2004 (Reference [1])

NUREG/CR-6400, "Human Factors Engineering (HFE) Insights for Advanced Reactors Based Upon Operating Experience," January 1997 (Reference [2])

NUREG-0800, Standard Review Plan Section 18.0, "Human Factors Engineering," Rev 1 – 02/2004 (Reference [3])

NUREG-0933, "A Prioritization of Generic Safety Issues," September 2007 (Reference [4])

2.2 Codes and Standards

IEEE Standard 1023-2004, "IEEE Recommended Practice for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations and Other Nuclear Facilities" (Reference [5]).

2.3 Other Industry Guidance

INPO 97.011 (1997), "Guidelines for the Use of the Operating Experience" [15]

EPRI-1008122, "Human Factors Guidance for Control Room and Digital Human-System Interface Design and Modification: Guidelines for Planning, Specification, Design, Licensing, Implementation, Training, Operation and Maintenance," EPRI, Palo Alto, CA, the U.S. Department of Energy, Washington, DC: 2004 (Reference [6])

AREVA guide GU ARV SHS INS 005 EN, "Human Factors Characterization in Nuclear Events," January 2007 (Reference [7])

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CEA/DPSN/SSN/FT/034 – Ind.0 – “Intégration des Facteurs Humains et Organisationnels dans les rapports de sûreté,” 30 janvier 2008 (Reference [8])

AREVA Risk Management Consulting SAS (ex AXILYA) - Human Factors Engineering referential (Reference [9])

INSAG-12 Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 rev 1, October 1999 (Reference [10])

3.0 METHOD

3.1 Responsibilities

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3.2 Inputs

3.2.1 Precursor / Related Plants and Systems

The U.S. EPR™ is an evolutionary Pressurized Water Reactor (PWR) design based on years of operation and design experiences from the precursor PWR plants (i.e. based on the European N4 and Konvoi plants which are in turn based upon Westinghouse-designed PWRs currently operating in the U.S.).

The U.S. EPR™ Human Factors OER is based upon OE from highly similar plants and systems. Data is obtained through the following types of information:

- EPR™ precursor plants (N4 and Konvoi).
- Highly similar PWR plant systems.
- Boiling Water Reactor (BWR) plants using similar systems.
- Plants' Corrective Action Programs (CAP) (e.g. OL3 and FA3 for construction and eventually operating OE and also CAP data fed into the INPO and NRC databases from operating plants) and modernization programs related to HFE issues / challenges with similar systems, such as NUREG/CR-6749 [11].

3.2.1.1 Data from related plants and system reviews

The Human Factors OER evaluates OE obtained from operating plants using similar technology or systems (such as the use of computer-based procedures) as well as HFE evaluations performed in full scope simulators. Review of plants and systems-related OE also contains official documents related to CAP or modernization programs (Reference [11]).

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3.2.1.2 Collection of related plants and systems data

OE data from related plants and systems is collected from the following areas:

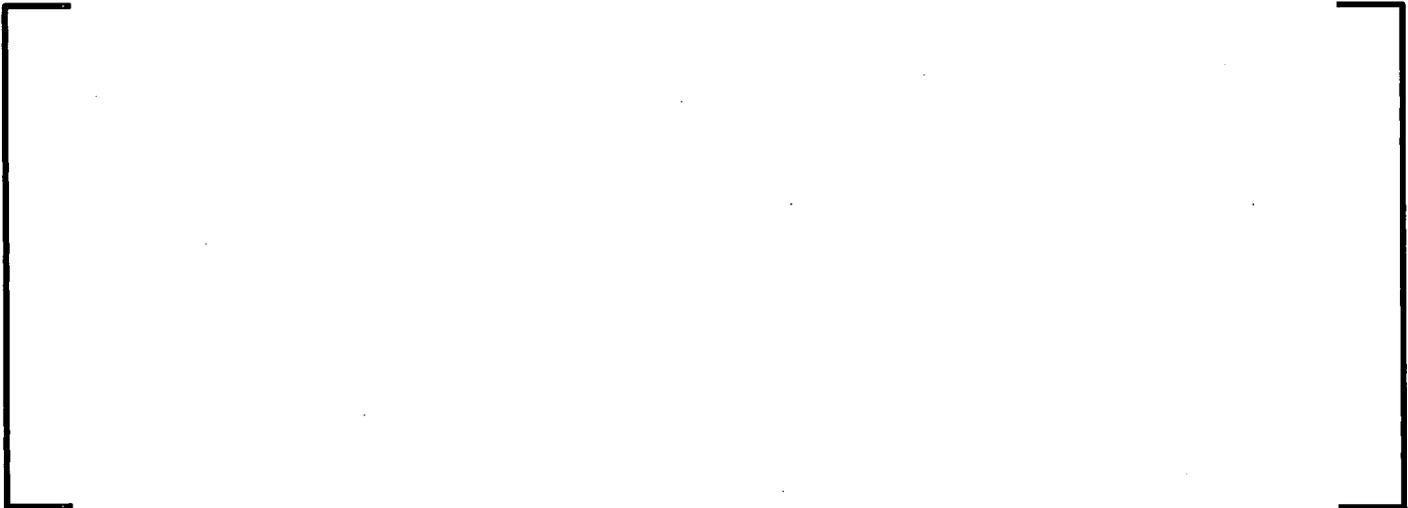
- NUREG documents related to CAP or modernization programs available through the NRC [11]
- Event reports (see Section 3.2.2.6)

Note that the U.S. EPR™ Human Factors OER program continues throughout the HSI design process, and any applicable OE collected during the HSI design process is integrated into the design of the HSI.

3.2.2 Recognized Industry HFE Issues

Recognized industry HFE issues are reviewed for HFE-related OE applicable to the U.S. EPR™ design. These issues cover the following topics:

3.2.2.1 Unresolved Safety Issues



3.2.2.2 TMI issues



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3.2.2.3 NRC generic letters and information notice reviews

NRC generic letters and information notices are reviewed for HFE-related issues that are applicable to the U.S. EPR™ design. The following are examples of NRC letters and notice review:

3.2.2.4 Reports from AEOD

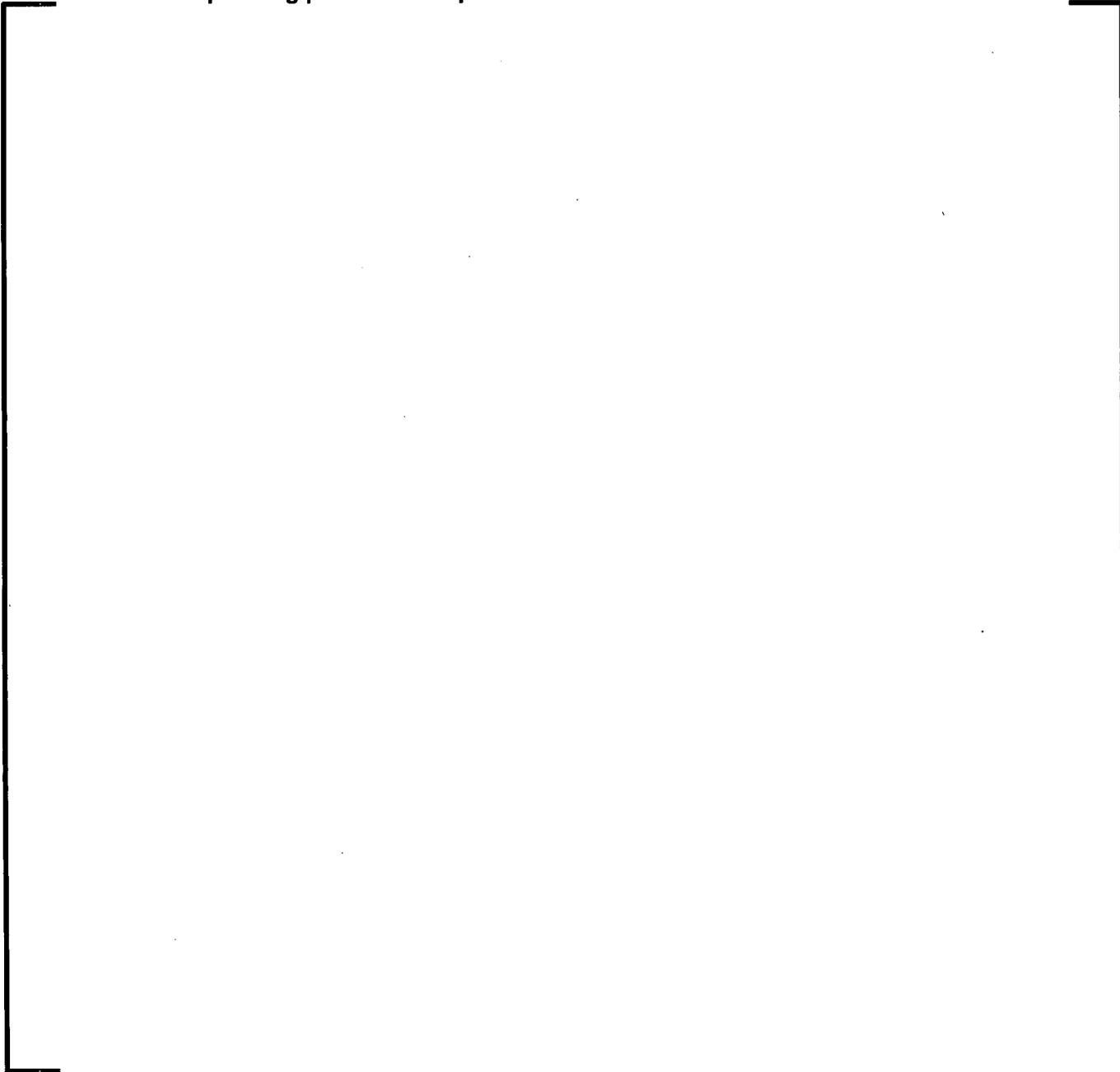
3.2.2.5 Low power and shutdown operations

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3.2.2.6

Operating plant event reports



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3.2.3 HFE-related technology



3.2.3.1 Types of Related-HFE technology

Examples of advanced related-HFE technology include, but are not limited to, the use of the following equipment:

- Qualified Display System (QDS)
- "Intelligent" computer based procedures
- Touch screen interfaces
- Plant Overview Panel (POP)
- Multi-screen display

3.2.3.2 Collection of related HFE technology data



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3.2.4 Operators Interviews

3.2.4.1 Type of Data Collected from Activity Observation and Operators Interviews



3.2.4.2 Interviews content



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3.2.4.2.1 **Plant Operations**



3.2.4.2.2 **HSI Use**



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3.2.5 Risk-Important Human Actions from existing nuclear plants

The U.S. EPR™ Human Factors OER identifies human actions (HAs) that have caused errors in past designs. Risk-important HAs are defined as actions that are performed by plant personnel to provide reasonable assurance of plant safety. Risk-important HA are those actions that if performed incorrectly by plant personnel could impact plant safety. Potentially risk-significant HAs should be provided from HRA/PRA for help in search criteria (Reference [14]). The actions thought to be risk-important are then sent to HRA/PRA for evaluation. This is in accordance with NUREG-0933 task HF7.”

3.2.5.1 Type of data for Risk-Important Human Action review

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3.3 Screening Criteria

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3.4 OE Analysis

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3.4.1 Staffing

The Staffing dimension defines the number of and qualification of personnel required to operate the plant.

Examples of Staffing related data:

- Number of personnel involved in the plant operating
- Level of Automation

3.4.2 Work Organization

The Work Organization dimension deals with the operating procedures, the rules that define the allocation of safety functions between human and automation, as well as personnel roles and responsibilities.

Examples of Work Organization related data:

- Procedures
- Functional allocation between human and automation
- Coordination between disciplines
- Responsibilities, hierarchy
- Shift duration and rotation

3.4.3 Workability

The Workability dimension deals with the requirements for usability of the plant equipment (in particular the HSI) in order to maintain operating goals.

Examples of Workability related data:

- Plant operating principles
- Workspace layout

3.4.4 Maintenance Capability

The Maintenance Capability dimension deals with the ability to safely and efficiently maintain the plant. This dimension concerns all the maintenance and repair activities.

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Examples of Maintenance Capability related data:

- Control equipment
- Access material

3.4.5 Environmental

The Environmental dimension deals with the physical characteristics of the working environment and the impact on personnel physiology, health and performance.

Examples of Environmental related data:

- Personnel irradiation risks
- Physical conditions (lightning, heating, noise level, etc.)
- Emergency procedures

3.4.6 Layout Issues

The Layout Issues dimension deals with the space available to perform human actions. This dimension is often linked with maintenance problems.

Examples of Layout Issues related data:

- Control Rooms (CRs) and workstations size
- Traffic flow inside the CR

3.4.7 Health / Accidents Anticipation

The Health / Accidents Anticipation dimension deals with the health and security of plant personnel.

Examples of Health / Accidents Anticipation related data:

- Safety equipment
- Workspace organization
- Procedures

3.4.8 Education and Training

The Education and Training dimension deals with the personnel training program.

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Examples of Education and Training related data:

- Education and training length
- Incidental / Accidental training on full-scope simulator
- Junior operators coaching

4.0 RESULTS AND DOCUMENTATION

Results of the U.S. EPR™ Human Factors OER are used as a design input. The tracking database is populated with all the OE extracted from physical databases as well as the operator interviews. Relevant industry data is also added as applicable. Each entry is dispositioned in accordance with the relevant engineering personnel.

4.1 Tracking Database

4.1.1 OE extracted from documents

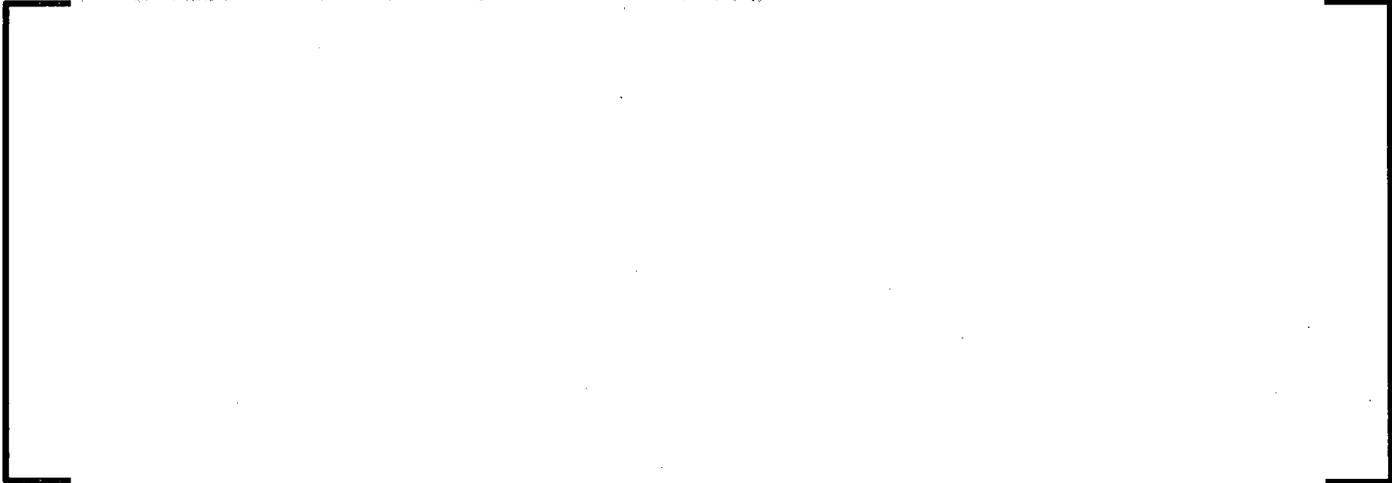


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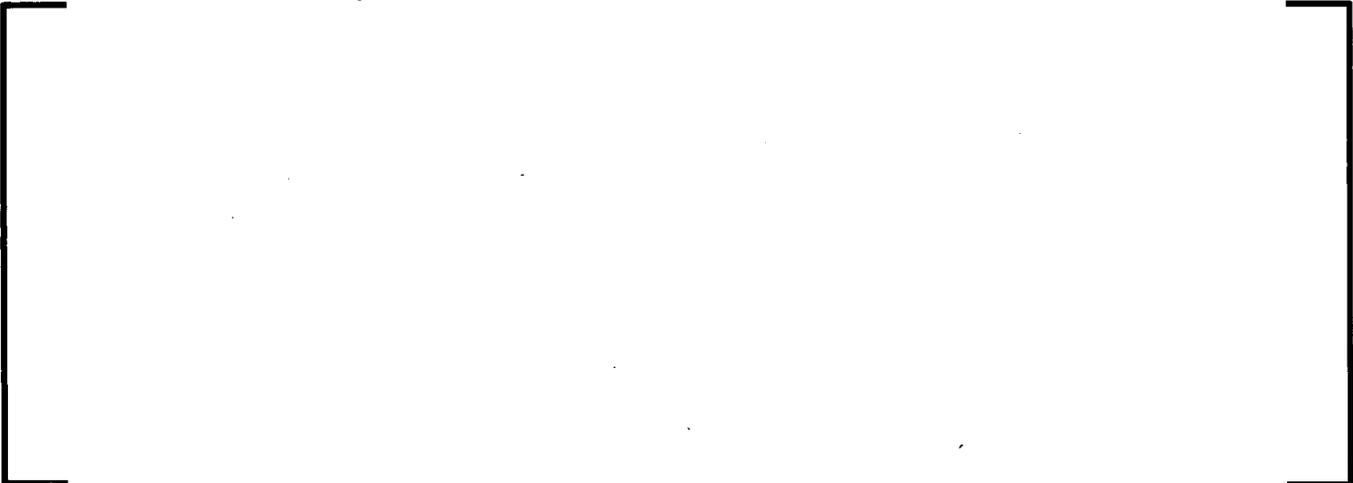
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4.1.2 Interviews reports

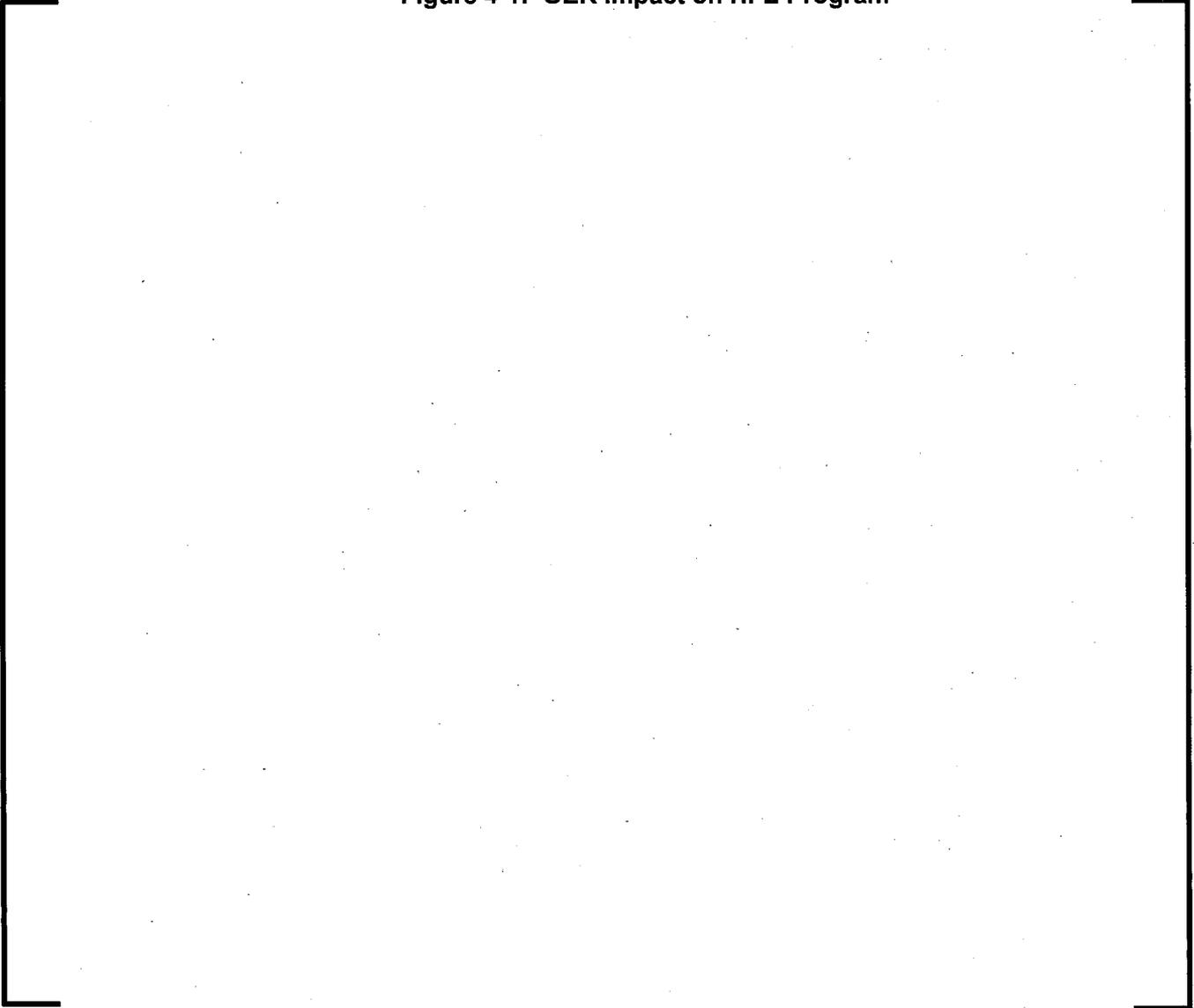


4.2 Summary Report



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Figure 4-1: OER impact on HFE Program



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5.0 REFERENCES

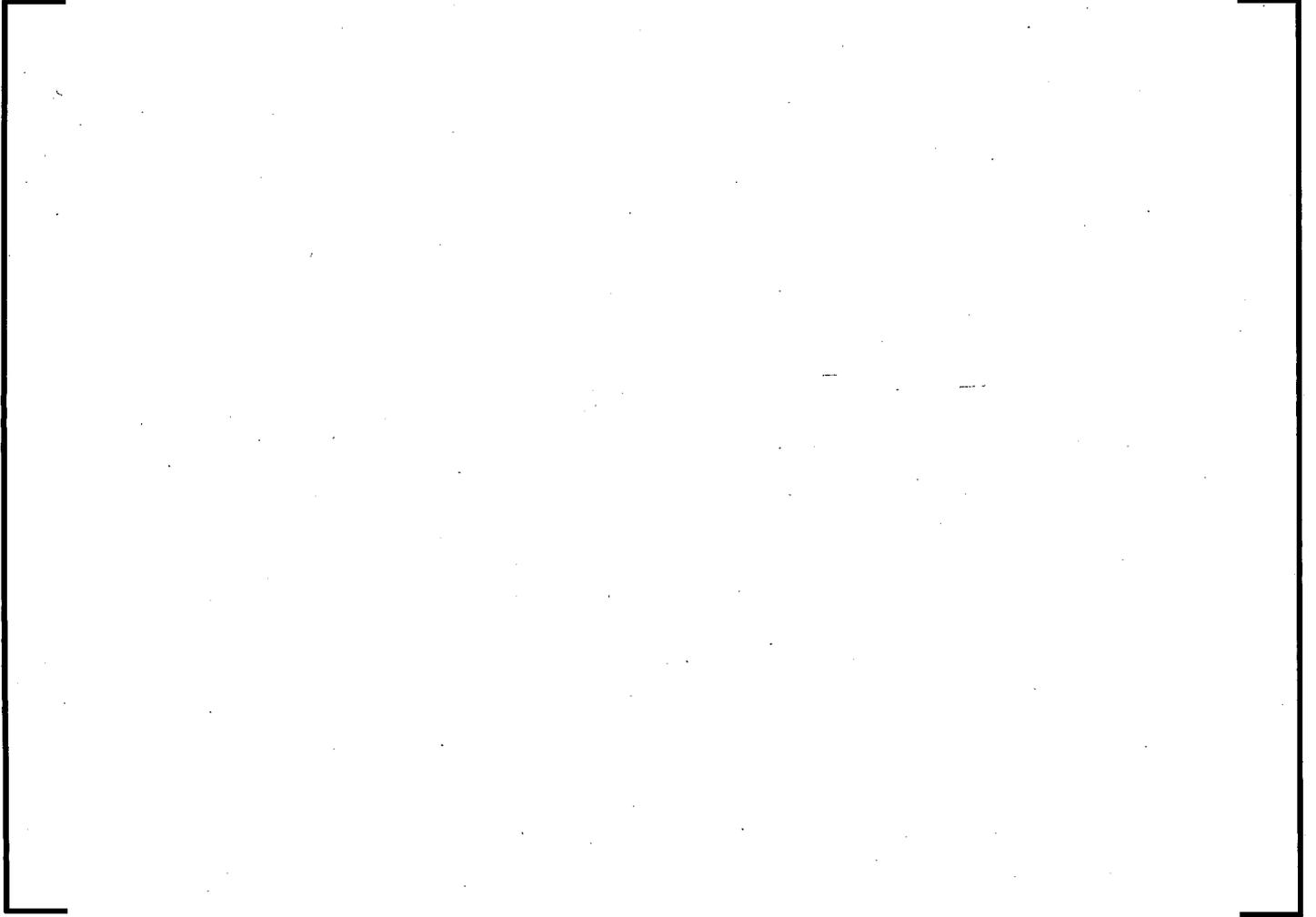
1. NUREG-0711, "Human Factors Engineering Program Review Model," Rev. 2 – February 2004
2. NUREG/CR-6400, "Human Factors engineering (HFE) Insights for Advanced Reactors Based Upon Operating Experience," January 1997
3. NUREG-0800, Standard Review Plan Section 18.0, "Human Factors Engineering," Rev 1, February 2004
4. NUREG-0933, "A Prioritization of Generic Safety Issues," September 2007
5. IEEE Standard 1023-2004, "IEEE Recommended Practice for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations and Other Nuclear Facilities"
6. EPRI-1008122, "Human Factors Guidance for Control Room and Digital Human-System Interface Design and Modification: Guidelines for Planning, Specification, Design, Licensing, Implementation, Training, Operation and Maintenance," EPRI, Palo Alto, CA, the U.S. Department of Energy, Washington, DC: 2004
7. AREVA guide GU ARV SHS INS 005 EN, "Human Factors Characterization in Nuclear Events," January 2007
8. CEA/DPSN/SSN/FT/034 – Ind.0 – (In French), "*Organizational and Human Factors Integration in safety reports.*" "Intégration des Facteurs Humains et Organisationnels dans les rapports de sûreté," January 2008
9. AREVA Risk Management Consulting SAS (ex AXILYA) - Human Factors Engineering referential, July 2005
10. INSAG-12 Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 rev 1, October 1999
11. NUREG/CR-6749, "Integrating Digital and Conventional Human-System Interfaces: Lessons learned from a Control Room Modernization Program," September 2002
12. NUREG 1275 vol. 8, "Operating Experience feedback report: Human performance in operating events," December 1992
13. NUREG 1449, "Shutdown and low power operation at commercial nuclear power plants in the United States," September 1993
14. AREVA NP Document 118-9038835-002, "U.S. EPR Implementation Plan for the Integration of Human Reliability Analysis (HRA) with the Human Factors Engineering (HFE) Program"
15. INPO 97.011, Rev 1, "Guidelines for the Use of Operating Experience," November 2006
16. AREVA NP Procedure EPR-EN-PR-1002-000, "Design Control Process," October 2008

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APPENDIX A: OER REVIEW PROCESS

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APPENDIX B: EXAMPLE OER DATABASE ENTRY FORM

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