Enclosure 7
Technical Report MPWR-TECR-005003 (Redacted)

babcock & wilcox nuclear energy

Operating Experience Program
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B&W mPower™
a progressive energy solution

B&W mPower™ Reactor Program
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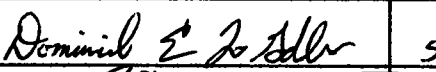
Reviewed By:	Dominick LoGalbo		5/30/12
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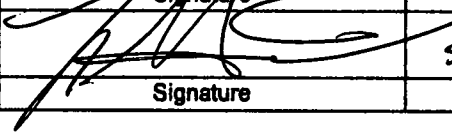
Approved By:	Thomas Graham		5/31/12
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ABSTRACT

This technical report describes the process of gathering, analyzing, and then transferring human factors engineering related operating experience information to the project members and incorporating it into the design process to increase the safety, reliability and efficiency of the design. NUREG-0711 describes the process of evaluating the human factors engineering program to verify that accepted human factors engineering practices and principles have been incorporated to support development of a design control document. This is based on the guidance necessary to produce a complete and coherent human-system interface to allow for safe operation of the plant. The B&W program implements the structured collection and use of operating experience during the design process.

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RECORD OF REVISION

Revision No.	Date	Preparer	Description of Changes
000	05/31/2012	Daniel Laughman	Initial issue

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1. INTRODUCTION

1.1 Applicability

This document is applicable to all human factors design activities for the Babcock & Wilcox (B&W) mPower™ reactor. This includes all B&W employees and contractors assigned to design activities of the B&W mPower reactor within the scope of the human factors engineering (HFE) program described in this report.

1.2 Scope

The scope of this technical report is to establish the operating experience program (OEP) for administering the retrieval, review, and incorporation of HFE related operating experience (OE) within the B&W mPower reactor design and modification activities.

1.3 Responsibilities

Work performed within the scope of this technical report is under the direction of the Unit Manager of the Integrated Design Process and Human Factors Engineering Program. The individuals performing the work are selected from the HFE design team. These HFE team members include, at a minimum, operations and systems engineering personnel. Engineers outside of the HFE design team may be consulted on an as-needed basis. Other engineering personnel may be assigned to work within the bounds of the functional requirements analysis/function allocation (FRA)/function allocation (FA) process and follow the direction of the FRA team members.

1.4 Operating Experience Program

The operating experience program is comprised of the operating experience review (OER) and the operating experience feedback (OEF) process.

U.S. nuclear power industry reporting practices produce a growing resource base of industry lessons learned that requires a systematic method of identifying, retrieving, and analyzing the experience that is relevant to the B&W mPower design. This systematic process is called the OER. The OER serves as part of the HFE program by identifying human factors-related safety or operational issues. The knowledge gained in the review enables design choices to be made that avoid or mitigate those issues while maintaining applicable positive features of previous design. In an effort to reduce the cost and delay associated with late stage design changes, the OER starts early in the design process. Operating experience review is an ongoing process to provide continual OEF throughout the life of the design effort. After analysis, operating experience that is applicable to the system design is incorporated into the design requirements.

Events with significant consequences are often preceded by several smaller events. By including information about these precursor events into the design effort, the OER helps to make the design more robust and significantly reduces the probability of minor events that may lead to more serious events. Closing the feedback loop in the design process ensures the efficiency of the overall process.

1.5 Operating Experience Review

Operating experience reviews are essential for identifying both positive features and problems with similar designs and reporting them to the project engineers. The OER provides a framework and process for retrieving and analyzing operating experience. The process identifies specific methods of collection through industrial/governmental database searches, subject matter expert interviews, and new technology reviews. The process also identifies the sources of information considered. The results of the process are compiled into an OER system report that is stored in the B&W operating experience database (see Figure 1). Broad based OERs that have been completed as part of other projects have influenced existing regulations and initial design requirements. The more focused reviews conducted as part of the HFE OE program are intended to result in more specific design requirements.

1.6 Operating Experience Feedback

The feedback mechanism delivers the collected information to the HFE project team in a timely manner. The integrated system design process incorporates the collected information. In support of regulatory and corporate review and inspection, the individual system design engineers document the influence of the operational experience feedback on their final design decisions. Based on the feedback, applicable OE is then incorporated into the design basis and requirements, and documented within the system design documentation.

1.7 Development of Summary Reports

As required by the various management and regulatory bodies, summary reports are developed to describe and document the OEP results. These reports are per system and also for the entire B&W mPower design project.

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Figure 1: Operations Experience Program **[CCI per Affidavit 4(a)-(d)]**

2. BACKGROUND

Operating experience reviews are an important part of the process used in all design and modification activities. Jointly referred to as the OEP, OERs enable designers to retain and reinforce system design features that have been proven to work effectively while also providing opportunities to avoid or mitigate known problem areas. An effective OEP incorporates maintainability from the earliest conceptual stages and enables detailed design choices that enhance system overall reliability.

3. METHODOLOGY

3.1 Operating Experience Program

The OEP effectively uses industry experience for design activities. The OEP coordinator (OEPC) is responsible for formal establishment of the OEP and the routine operation of the program, but is supported by additional personnel to implement the process and its findings. All safety systems and common systems are researched.

3.1.1 Structure and Flow

When an engineer is assigned an OE search topic, the affected system(s) is first determined. The engineer may then proceed to gather OE relevant to the topic. Operating experience is obtained from various sources and may come in a variety of forms. Operating experience reports from previous or current plants, interviews from personnel, and survey results are all common methods of recording OE.

Implementation of the OEP requires the development of an OE report. An OE report contains detailed source information such as:

- The form of the OE (report, survey, interview)
- The database(s) or source from which the OE was obtained (e.g., Institute of Nuclear Power Operations [INPO], U.S. Nuclear Regulatory Commission [NRC], U.S. Department of Energy, Lessons Learned)
- Specific search criteria that was used (keywords, phrases)

The OE report includes the name of the person(s) compiling the report, the date, and disciplines to be notified for review. This information is collected to provide assurance that the correct personnel were involved with the collection and disposition of the OE.

The relevancy of each operating experience is determined to ensure that the information is sufficient to address the issue in reference. This provides sufficient data collection and eliminates unnecessary data.

The relevancy of any HFE OE may be determined using the following criteria:

- Similar processes or incidents (during what procedure or incident did the event occur)
- Similar effects (the outcome of the event)
- Similar criticality (either safety or operations related)
- Similar technology (human-system interface [HSI] equipment or HFE technology related to B&W mPower design)
- Similar plant operational data as described in Section 3.2.2.1

Once the search is done, the relevant OE is documented in the OER report. This includes the OE document number, title, and synopsis of the OE in the report. The reports focus on the relevant engineering information and avoid inclusion of the company name or plant specific data.

The OE report contains the necessary OE to use as a design recommendation. This design recommendation can be in the form of a topical area or a specific recommendation. In addition to the recommendations, specific actions that were taken to remove or mitigate the OE concern are documented.

Design recommendations provide the feedback portion of the process. The OEPC reviews and ensures that the whole report is completed. This includes completion of the mitigation section and the documentation verifying that the system has gone through a detail design review. The detail design review check ensures that a multi-discipline team has reviewed the information for consistency, completeness, appropriateness, and accuracy.

Upon completion, the OEPC ensures that the report is loaded in the OE database. If there are design recommendations that cannot be immediately resolved by the responsible engineer, they are entered in an HFE issue tracking system. Subsequent system design reviews are expected to evaluate these open items for design inclusion or closure. The item is officially closed after reasons for closure are appropriately documented. The OEP is specifically designed to track to resolution all open items. All items that cannot be resolved through the design process will remain for resolution through the construction process.

3.1.2 Responsibilities

3.1.2.1 Operating Experience Program Coordinator

The responsibilities of the OEPC include organizing and delegating the OE collection to the responsible engineer(s) and ensuring that applicable OE is given proper consideration for design incorporation. Summary reports are developed for senior management and regulatory bodies (when requested) and include the potential design issues and appropriate means of addressing them. Archived and new OE event reports are reviewed and distributed for early design incorporation to reduce costs and design changes. The gathered OE is clear, succinct, and distributed in a manner that encourages use and consideration. Design incorporation of OE is tracked in a database to track its use and distribution.

Additional duties of the OEPC include producing an OE training plan and materials, establishing a project-specific OE database accessible to the design organization, training engineers to effectively search external OE databases, and directing OERs to ensure OE incorporation is properly documented.

3.1.2.2 Responsible Engineer

Duties of the responsible engineer encompass the OE review and documentation for design incorporation, as well as providing summary documentation for any OE mitigation strategies incorporated in the design. Participation of the responsible engineer in assessment reviews by the design organization determines the correct and effective use of the OE. Assessments of detail design structures, systems, and components are also the responsibility of the individual responsible engineers.

3.1.2.3 Design Review Team

The duties of the design review team are within the normal design change process expectations in accordance with the general design review process. The inclusion of this information here is to document that this HFE process uses the established design change process to include assessing the OE incorporation into the individual and overall plant design during the normal system reviews.

3.2 Operating Experience Review

3.2.1 Scope of Operating Experience

The operating experience collection effort focuses on plant and system design aspects, as well as several HFE design considerations. Plant and system OE involves any aspect of the reactor, plant structures, systems, and components that are applicable to the B&W mPower design. Human factors OE may include the main control room, operations support center, technical support center, remote shutdown station, risk-important local control stations, and emergency operations facility.

3.2.1.1 Existing and Predecessor Plant Designs and Systems

Existing plant systems that are identical or similar to the proposed B&W mPower design are examined for relevant operating experience. This might include a pressurized water reactor, boiling water reactor, or fossil fuel plant depending on the system being examined. Operating experience from an unrelated industry may be used if it is determined to be relevant to the B&W mPower design.

Human-system interface OE may include any reports or lessons learned in one or more of the categories in Section 3.2.3.1.

Operating experience related to plant operations includes anything which addresses:

- Normal plant evolutions

- Instrument failures
- HSI equipment and processing failures
- Transients
- Accidents
- Remote systems used for plant operation (S/U, S/D, etc.)

3.2.1.2 Recognized Industry HFE Issues

Several HFE issues are widely recognized in the industry and should be given proper consideration in the B&W mPower design. These issues are generally broad in scope and may involve any unresolved or generic safety issues, Three Mile Island/Chernobyl/ Fukushima issues, and low power and shut down operations. They are reported through various means (e.g., generic letters, information notices, reports) by the NRC, INPO, or from current operating plants. Therefore, multiple databases are searched for this material.

3.2.1.3 Related HFE Technology

Technology that involves, incorporates, or affects human factors is reviewed for all possible consequences. This typically includes any I/O device alternatives, computer based procedures, or alternative media for visual and auditory cues.

3.2.1.4 Risk-Important Human Actions

Results of the human reliability assessment (HRA), which identify risk-important human actions, are inputs to the OEP. Targeted OE searches are conducted to identify industry experience related to the successful mitigation of risk-important action consequences similar to the B&W mPower design. Due to the iterative nature of the HRA, the design is re-evaluated after incorporation of design changes.

3.2.2 Collection

Operating experience is obtained from several different sources, including internal and external databases, operator interviews, and special case studies. Reports from INPO and NRC websites are reviewed for applicability. System and component specific reports are generated for inclusion into the design. These individual reports are developed by the OEPC or individual responsible engineers. The report includes data from reviews of reasonably obtained information sources. This process starts with the collection of relevant OE.

3.2.2.1 Internal Databases

Internal databases may include corrective action programs and lessons learned databases that can be accessed in order to search internal information relevant to the design process. Selected event topics may include:

- Nuclear, public, radiological, and personnel safety
- Power generation capability
- Events with important generic implications
- Events for which a comprehensive root cause investigation was performed
- Events required to be reported according to INPO Event Report Level 1 recommendations
- Risk-important human actions
- Related HSI technology
- HFE issues

3.2.2.2 External Databases

The majority of information is derived from searchable databases maintained by the NRC and INPO. Other industry databases can be used for alternative data that can include, but are not limited to, the nuclear industry. Typical sources are:

- SEE-IN Program (Significant Event Evaluation and Information Network) (e.g., SERS [safety evaluation report]/IERs [INPO event report]/SENs [significant event notice]/SOERs [significant operating experience report]/TRs [technical reports], etc.)
- Nuclear network
- World Association of Nuclear Operators event reports (available through INPO)
- Licensee event reports
- NRC event associated reports – daily power reactor status, plant event notification, Part 21, preliminary notification of event or unusual occurrence, and morning reports
- NRC generic communications – bulletins, generic letters, information notices, and regulatory issue summary
- Vendor information – vendor supplied service bulletins, letters, and other reports that pertain to issues and problems associated with systems or components. These often include recommendations on how to fix a particular problem.
- International regulatory reports – incident reporting system reports from the International Atomic Energy Agency and the Nuclear Energy Agency reports from the Organization for Economic Co-operation and Development Agency
- Other industries (e.g., petroleum, chemical) – OE related to advanced HSI technology that is being considered for use in the B&W mPower design.

The following databases may be utilized for the individual component level problem identification, reliability problems, and trends.

- Equipment Performance and Information Exchange System: This program was developed by INPO for component level information exchange and is documented through INPO 98-001 (Rev. 11).
- Nuclear Experience Report Tracking System

3.2.2.3 Operations Interviews and Feedback

Operations feedback can inform certain parts of the design process. Feedback can be obtained from operator interviews when sufficient information is not obtained from the basic databases. Interviewees are normally personnel with applicable experience from operating plants.

3.2.2.4 Special Case Study

For cases that do not fall into the above categories, independent review studies may be appropriate. These studies are limited to first-of-a-kind engineering projects that are not used in commercial nuclear power plants and include review of the technology, relevance, and feasibility to the overall design.

3.2.3 Operating Experience Analysis

Initial information is screened for two purposes. The first purpose is to determine significance of the information and applicability to the design process for the B&W mPower reactor. The actual or potential causes and consequences of the documented events should be related to the appropriate systems being designed. Significant precursors to an event are considered in the same manner. The second purpose of the screening process is to tag the information retrieved through application of searchable code words and assign the OE to the appropriate databases for later retrieval.

Analyzing operating experience events creates a better understanding of the extent to which hardware, software, or human performance contributed to the event. Control system and HSI engineering decisions use this insight to enhance safe and efficient plant operation by reducing human error in both frequency and significance.

Analysis of OE content is performed by the applicable system, process, or HFE engineer. The adaptation of HFE issues into design solutions is accomplished though the joint efforts of the HFE and systems engineering departments. Care must be taken when reviewing material associated with components that do not exist in the B&W mPower reactor design. Design engineers are careful not to overlook an event if material component similarities do not exist, but functional similarities do (i.e., different components but same function). These events should be considered for relevancy to the applicable system or component.

3.2.3.1 Determining Applicability to the HFE Design Process

Operating experience reports that are deemed relevant to the B&W mPower design are screened for applicable HFE issues. Applicable HFE issues may fall into one or more of the following categories:

- Alarm or annunciation issues
- Job aid issues including instances where job aids were present and contributed to an event, and instances where the absence of appropriate job aids contributed to an event
- Ergonomic issues associated with control room layout or HSI design or usage
- Human errors associated with HSI usage, procedures usage, or training
- Communication issues that may include availability, coverage problems, or usability
- Display issues that may include accessibility, hierarchy, content, and usability
- Automation issues that include either too little or too much machine control or lack of transparency in automated actions
- Accidents, injuries, or plant events caused by human error associated with control room layout
- HSI issues including content, layout, mimicking, color coding, labeling, or other HFE design issues
- Procedural issues associated with HFE design process
- Training issues associated with HFE design process
- Staffing issues affected by HSI or control room design

3.2.3.2 Determine Priority of OE

In addition to relevancy, it is important to prioritize the OE in order to ensure that the critical items are properly addressed and given ample time and consideration for analysis and design incorporation.[

] **[CCI per Affidavit 4(a)-(d)]**

3.2.3.3 Analysis of Issues

Issues should be analyzed with regard to the specific HFE aspect of design they affect. Sources of human error and performance issues are identified as well as the corresponding design elements that support or detract from the human performance. When a successful solution has been developed by others, it is important to determine applicability of the solution to the B&W mPower design. If applicable, the engineer may then decide to implement the proven solution or provide a basis for developing an alternative solution.

3.3 Operating Experience Feedback

3.3.1 Operating Experience Tracking and Storage

Issues associated with the HFE program are entered in the B&W HFE issue tracking system. Reports developed by employees or subcontractors are delivered to the OEPC for inclusion into the B&W mPower design process and, as necessary, into the HFE issue tracking system.

3.3.2 Operating Experience Database

The OE database is accessible to all members of the project and structured in a simplified and user-friendly format. Database entries are organized into a particular group or subject area and contain searchable keywords for easy location and retrieval. Minimum downtime and regular maintenance is expected to keep the database accessible to the highest extent possible. Backups for the database are used to maintain the information.

3.3.3 Operating Experience Distribution

OER reports can contain any number of issues for design consideration. The OEPC distributes the reports to the appropriate discipline for incorporation into the design process. When the report is generated by the individual HFE engineer, the report writer discusses the report with the responsible engineer and appropriately turns over the information involved. The individual discipline leads then distribute these reports to the appropriate system engineers. The recommendations from any OE generated reports are part of the design considerations.

3.3.4 Operating Experience Design Incorporation

The OE that is reviewed by the individual engineers is determined to be applicable or not applicable. Solutions for OE inclusion are developed by the system engineer and incorporated. The design review team functions as a multi-discipline team for review of the inclusions during the individual design reviews. Acceptance is made through the design review board for these design changes. Final report documentation describes where the

design applicable OE has been incorporated. System requirements documents are updated to reflect the incorporation of applicable OE.

4. SUMMARY REPORTS

Summary reports are developed for each system. An overall OEP summary report is made for the entire B&W mPower design. Management directed summary reports, and Inspections, Tests, Analysis, and Acceptance Criteria closure reports are expected to be available at the end of the design process.

5. DEFINITIONS, ABBREVIATIONS, AND ACRONYMS

5.1 Definitions

Term	Definition
Function Allocation (FA)	The process of assigning responsibility for function accomplishment to human or machine resources, or to a combination of human and machine resources.
Functional Requirements Analysis (FRA)	The examination of system goals to determine what functions are needed to achieve them.
Human-System Interface (HSI)	A human-system interface is that part of the system through which personnel interact to perform their functions and tasks. This interaction includes the alarms, displays, controls, and job performance aids (e.g., procedures, instructions, etc.).
Task Analysis	A method for determining and describing what plant personnel must do to achieve the purposes or goal of their tasks. The description can be in terms of cognitive activities, actions, and supporting equipment.

5.2 Abbreviations and Acronyms

B&W	Babcock & Wilcox
HFE	human factors engineering
HRA	human reliability assessment
HSI	human-system interface
IEEE	Institute of Electrical and Electronics Engineers
INPO	Institute of Nuclear Power Operations
INSAG	International Nuclear Safety Group
NRC	U.S. Nuclear Regulatory Commission
OE	operating experience
OEF	operating experience feedback
OEP	operating experience program
OEPC	operating experience program coordinator
OER	operating experience review

6. REFERENCES

6.1 Code of Federal Regulations

6.1.1 10 CFR 50.34(f)(3)(i), Contents of Applications; Technical Information, United States Nuclear Regulatory Commission

6.2 U.S. Nuclear Regulatory Guidance

6.2.1 NUREG-0711, Human Factors Engineering Program Review Model, United States Nuclear Regulatory Commission, Rev.2, February 2004

6.2.2 NUREG/CR-6400, Human Factors Engineering (HFE) Insights for Advanced Reactors Based Upon Operating Experience, United States Nuclear Regulatory Commission, January 1997

6.2.3 NUREG-0800, Standard Review Plan, Section 18.0, "Human Factors Engineering," United States Nuclear Regulatory Commission

6.2.4 NUREG-0933, A Prioritization of Generic Safety Issues, United States Nuclear Regulatory Commission, September 2007

6.3 U.S. Industry Guidance

6.3.1 IEEE Standard 1023, IEEE Recommended Practice for the Application of Human Factors Engineering to Systems, Equipment, and Facilities of Nuclear Power Generating Stations and Other Nuclear Facilities, 2004

6.3.2 INPO 97-011, Guidelines for the Use of Operating Experience, Rev.1, 2006

6.3.3 INPO 98-001, Equipment Performance and Information Exchange System, Rev. 11

6.3.4 INPO 06-001, Operating Experience to apply to Advanced Light Water Reactor Designs, March 2006 and Addendum, September 2007

6.3.5 INPO 10-006, Operating Experience Program and Construction Experience Program Descriptions, Rev. 2, November 2011

6.3.6 INSAG-12, Basic Safety Principles for Nuclear Power Plants, 75-INSAG-3 Rev 1

6.3.7 INSAG-23, Improving the international System for Operational Experience Feedback