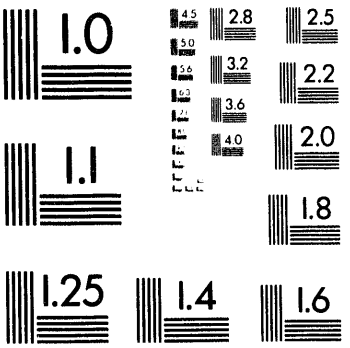
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SRTC
Savannah River Technology Center

Selecting the Seismic HRA Approach for Savannah River Plant PRA Revision 1 (U)

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SAFETY • RESPONSIBILITY • SECURITY
SRS
SAVANNAH RIVER SITE

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Approvals

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The attached report was prepared by the Human Affairs Research Center of the Pacific Northwest Laboratories for Westinghouse Savannah River Company to assist in the selection of the approach to use for the human reliability analysis in the seismic probabilistic risk assessment of core damage for the K Reactor.

Performance of the reactor system when subjected to an earthquake is greatly affected by the response of the operating crew, both immediately after the seismic event and for extended periods until the reactor can be placed in a safe and stable condition. The response of reactor operating crews to earthquake challenges has been recognized as an important component of seismic risk assessments, and various studies have been conducted in an attempt to quantify such actions, although no original research using actual data is known to exist.

For further information contact H. E. Wingo, H. C. Benhardt, or C. M. van Buijtenen.

Contents

Attachment

Table

Abstract

The Westinghouse Savannah River Company (WSRC) has prepared a level 1 probabilistic risk assessment (PRA), Rev. 0 of reactor operations for externally-initiated events including seismic events. The SRS PRA, Rev. 0 Seismic HRA received a critical review that expressed skepticism with the approach used for human reliability analysis because it had not been previously used and accepted in other published PRAs.

This report provides a review of published probabilistic risk assessments (PRAs), the associated methodology guidance documents, and the psychological literature to identify parameters important to seismic human reliability analysis (HRA). It also describes a recommended approach for use in the Savannah River Site (SRS) PRA. The SRS seismic event PRA performs HRA to account for the contribution of human errors in the accident sequences. The HRA of human actions during and after a seismic event is an area subject to many uncertainties and involves significant analyst judgment. The approach recommended by this report is based on seismic HRA methods and associated issues and concerns identified from the review of these referenced documents that represent the current state-of-the-art knowledge and acceptance in the seismic HRA field.

Executive Summary

The objective of this report is to identify and describe the recommended approach for performing the Seismic HRA for Rev. 1 to the SRS PRA. The approach used in Rev. 0 of the SRS PRA was criticized by the SRS PRA Senior Review Panel because it has not been widely used and accepted in other published PRAs. The approach identified for use in Rev. 1 of the SRS PRA will be consistent with that used in referenced PRAs, which have received a broad level of acceptance.

The report describes the review of seismic HRA methods and related information found in the following:

- Savannah River Site PRA Rev. 0 Seismic HRA, NUREG/CR-4910, "Relay Chatter and Operator Response after a Large Earthquake," R. J. Budnitz, H. E. Lambert, and E. E. Hill (August 1987)
- NRC Generic Letter 88-20, Supplement 4, "Individual Plant Examination for Externally-Initiated Events"
- NUREG-1150, USNRC, Reactor Risk Reference Document
- NUREG/CR-4550, Volume 3, Revision 1, Part 3, "Analysis of Core Damage Frequency: Surry Power Station, Unit 1 External Events"
- NUREG/CR-4550, Volume 4, Rev. 1, Part 3, "Analysis of Core Damage Frequency: Peach Bottom Unit 2, External Events"
- NUREG/CR-4840, "Procedures for External Event Core Damage Frequency Analyses for NUREG-1150," M. P. Bonn and J. A. Lambright (November 1990)
- NUREG/CR-4772, "Accident Sequence Evaluation Program Human Reliability Analysis Procedure," A. D. Swain, III (February 1987)
- NUREG/CR-3428, "Application of the SSMRP Methodology to the Seismic Risk at Zion Nuclear Power Plant," M. P. Bonn, et al. (January 1984)
- Diablo Canyon PRA, NUREG-0675, Supplement 34, "Safety Evaluation Report Related to the Operation of Diablo Canyon Nuclear Power Plant Units 1 and 2" (June 1991) and the White Paper, "Human Action under Seismic Events," H. F. Perla (May 4, 1992)
- TANSAO 65-1-580, "Human Reliability Assessment in the Evaluation of External Events," E. M. Dougherty and G. W. Hannaman, Volume 65, pp. 100-101 (1992)

This report also describes the results of the review of psychological and human factors literature from searches of

- Operator Workload (OWL) based on the comprehensive review of Lysaght et al. (1989), the review of workload and modeling methods by Bittner and Morrissey (1990), and the summary of research comparing subjective OWL methods by Hill et al. (1992)
- Seismic and Life Event Stress based on a DIALOG search of the psychological literature (PSYCHSCAN) over the last eight years aimed at seismic stress and augmented by summaries of ongoing life event stress research (Miller 1989) as well as a classical reviews of stress research (Goldberger and Breznitz 1982)

- Performance Shaping Factors (PSF) based on a DIALOG search of the Emergency Science and Technology (EST) and National Technical Information System (NTIS) literature over the last eight years that addressed "performance shaping factors"

The review and evaluation of the reference documents described above indicate that the common attributes and current trends for seismic HRA include consideration for the following parameters:

- consistency with the internal events analysis including nonseismic component failures and nonseismic human errors
- detailed task analysis
- operator stress
- time available
- personnel resource availability and allocation
- earthquake intensity
- multiple operator actions
- multiple abnormal events
- uncertainty bounds
- diagnosis errors and recovery
- location of operator actions and potential impact of secondary failures
- data sources and bases for use

Sufficient information was gathered from the psychological and human factors literature review to determine that the state-of-the-art in predicting human performance is achievable using standard THERP HRA analysis, as modified to account for the severity of a seismic event. The data and results reported in these and other ongoing efforts should therefore be used as additional information when making qualitative decisions to adjust the HEP value derived by standard techniques, rather than as an attempt to replace the tabled values themselves. The seismic HRA should consider the above parameters together in the evaluation and describe the process used to determine their combined impact on the HEP.

The recommended approach for the Seismic HRA for SRS PRA Rev. 1 is to use the THERP methodology following guidance of NUREG/CR-1278 and NUREG/CR-2254 and also to incorporate the updates, modifications, enhancements, and corrections provided in NUREG/CR-4772. This approach has the following benefits:

- It is compatible with the internal events HRA THERP method.
- It addresses the important parameters identified above.
- It has received a very broad level of acceptance through the NRC's NUREG-1150 program.
- It allows flexibility in the level of detail/rigor in focusing on risk-significant human actions and in refining HEP values with excessive conservatism to yield more realistic results.

1.0 Introduction

The Savannah River Site (SRS) Probabilistic Risk Assessment (PRA), Rev. 0, Seismic HRA uses human error probabilities from the internal events analysis (modified THERP technique) and applies the methodology of NUREG/CR-4910 (Budnitz, Lambert, and Hill) to account for the stress, number of operators, time available, and uncertainty considerations in the event of an earthquake. This approach was criticized by the SRS PRA Senior Review Panel because it has not been widely used and accepted in other published PRAs. This report responds to the Senior Review Panel's and other review groups' concerns by reviewing published PRA documentation to identify an alternate approach for assessing Seismic HRA for the SRS PRA. The approach identified for use will be consistent with that used in referenced PRAs that have received a broad level of acceptance.

This effort involves a review of existing, state-of-the-art methodologies for HRA and for modifying human error probabilities (HEPs) to account for seismic characteristics (e.g., multiple failures, time stress, workload, equipment condition uncertainty). It involves identifying seismic HRA issues, evaluating the options available, and selecting the proposed approach for application to the SRS Seismic HRA.

This report documents the review of published PRA information on methodologies for assessing and/or modifying HEPs in seismic events. Important seismic HRA considerations for quantifying HEPs from these documents are identified, and an approach for the Seismic HRA for the SRS K-Reactor PRA is proposed.

2.0 Approach

The approach used for this effort was to

- Review the referenced published PRA information and psychological information on the topic of seismic HRA, related human factors issues, and psychological stress information.
- Evaluate these documents to identify important seismic HRA issues and concerns and the general approaches, common attributes, specific techniques, special considerations, and current trends of the approaches for addressing these issues and concerns.
- Describe important attributes for a seismic HRA that are most relevant and significant for application in the SRS PRA based on the above review and evaluation.
- Recommend the seismic HRA methodology best suited to incorporating these seismic HRA attributes into the SRS PRA. This provides the approach for establishing and for modifying HEPs for operator actions in the seismic event.

3.0 Summary and Evaluation of Documents Reviewed

3.1 Review of General HRA Methodologies

NUREG/CR-4835, "Comparison and Application of Quantitative Human Reliability Analysis Methods for the Risk Methods Integration and Evaluation Program (RMIEP)," L. N. Haney, et al., January 1989, provides comparisons of HRA techniques using relevant data collected from the RMIEP. The NUREG/CR-4835 evaluation was performed for the following reasons:

- to identify, evaluate and select HRA methods that have the potential to improve HRA inputs to PRAs.
- to apply selected HRA methods to specific PRA accident sequences and compare the results.
- to provide guidelines for future use of selected HRA methods.

NUREG/CR-4835 was based on the following general activities:

- Searching the literature including references and descriptions of 20 HRA models.
- Screening the HRA methodologies through two criteria sets that identified 12 HRA methods appropriate for PRA and for further evaluation.
- Applying and quantifying comparisons of three representative HRA methods including an analysis of quantitative differences observed among the models.
- Providing further attribute descriptions and utility ratings of the 12 methods in the form of an HRA selection tool (tables and an example).
- Explaining the approach used for the HRA system analysis for RMIEP.
- Describing the steps of the Systematic Human Action Reliability Procedure (SHARP) for performing a traceable and scrutable HRA for PRA.

General findings from NUREG/CR-4835 include the following:

- A task analysis shall be performed early in the PRA effort to identify important human actions.
- Complete and traceable data collection with the supporting documentation should be made when performing the HRA.
- There should be clear, open, and frequent communication between the HRA and PRA analysts.
- HRA models can explicitly consider function-based procedures though they are usually used for rule-based procedures.

NUREG/CR-4835 also found that the various HRA methods yield different quantitative estimate. These differences were attributed to differences in the consideration of recovery actions, the level of detail modeled, variations in the consideration given for performance shaping factors, and analysts' abilities, skills, and

judgments. The final finding of the NUREG/CR-4835 report is provided in the summary that describe the various attributes of the HRA methodologies. These methodologies form a useful base of information as criteria to consider when selecting an HRA method for a PRA.

Since the SRS PRA uses the THERP technique, this report focuses on the findings that NUREG/CR-4835 has for THERP. The HRA methodology review provided in NUREG/CR-4835 indicates that the THERP technique is a viable approach for HRA in a PRA. The various attributes of the THERP methodology considered and evaluated are generally as favorable as they are for any of the other methodologies reviewed, and in many respects the THERP methods are superior. The review does not identify any compelling concern with the THERP methodology to prompt a change to an alternate methodology for the SRS PRA, including the seismic HRA.

3.2 Review of Referenced Documentation Related to Current Seismic HRA Evaluations

In addition to the review of general HRA methodologies presented in NUREG/CR-4835 there are several other documents specifically related to HRA methods that might be employed to evaluate seismic events. The descriptions provided below address the seismic HRA-related information from each of the documents reviewed during this project. The reference documents reviewed include the following:

- Savannah River Site PRA Rev. Seismic HRA, References NUREG/CR-4910, "Relay Chatter and Operator Response after a Large Earthquake", R. J. Budnitz, H. E. Lambert, and E. E. Hill (August 1987)
- NRC Generic Letter 88-20, Supplement 4, "Individual Plant Examination for Externally-Initiated Events"
- NUREG-1150, USNRC, Reactor Risk Reference Document
- NUREG/CR-4550, Volume 3, Rev. 1, Part 3, "Analysis of Core Damage Frequency; Surry Power Station, Unit 1 External Events"
- NUREG/CR-4550, Volume 4, Rev. 1, Part 3, "Analysis of Core Damage Frequency; Peach Bottom Unit 2, External Events"
- NUREG/CR-4840, "Procedures for External Event Core Damage Frequency Analyses for NUREG-1150," M. P. Bonn and J. A. Lambright (November 1990)
- NUREG/CR-4772, "Accident Sequence Evaluation Program Human Reliability Analysis Procedure," A. D. Swain, III (February 1987)
- NUREG/CR-3428, "Application of the SSMRP Methodology to the Seismic Risk at Zion Nuclear Power Plant," M. P. Bonn, et al. (January 1984)
- Diablo Canyon PRA, NUREG-0675, Supplement 34, "Safety Evaluation Report Related to the Operation of Diablo Canyon Nuclear Power Plant Units 1 and 2," June 1991, and the White Paper, "Human Action under Seismic Events," H. F. Perla (May 4, 1992)
- TANSAO 65-1-580, "Human Reliability Assessment in the Evaluation of External Events," E. M. Dougherty and G. W. Hannaman, Volume 65, pp. 100-101 (1992)

3.2.1 Savannah River Site PRA Revision 0 Seismic HRA, Referencing NUREG/CR-4910, Budnitz and Hill

The SRS PRA Rev. 0 seismic HRA base-case analysis is described in SRS PRA Section 2.7, pages 2-35 through 2-38, and is based on the methodology of NUREG/CR-4910, "Relay Chatter and Operator Response after a Large Earthquake," R. J. Budnitz, H. E. Lambert, and E. E. Hill, August 1987. This method adjusts HEP values from the internal events analysis for various procedural actions (EAPs, MCPs, and DPSOLs) to account for stress, number of operators, time available for actions, and an uncertainty allowance for errors. The internal events analysis HRA used the Technique for Human Error Rate Prediction (THERP) methodology (NUREG/CR-1278, "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," A. D. Swain and H. E. Guttman, August 1983 and NUREG/CR-2254, "A Procedure for Conducting a Human Reliability Analysis for Nuclear Power Plants," B. J. Bell and A. D. Swain, May 1983).

NUREG/CR-4910 developed a model to generate HEPs for use in seismic PRA. HEPs generated using the NUREG/CR-4910 methodology are for application to high stress life-threatening conditions. The first step of this approach is to perform a detailed task analysis for the various human actions to be evaluated assuming non-stress conditions. This task analysis provides the data used as input for calculating the non-stress HEPs for each task and also provides information for each task concerning the time required, as well as the number of operators available, as necessary input for the adjustments of the non-stress HEPs. The information used in applying the NUREG/CR-4910 methodology adjustments to the non-stress HEPs includes

- the stress factor (a number between one and ten; one recommended for no stress, five recommended for medium stress, and ten recommended for high stress)
- the number of operators available for the task under consideration
- the time duration for the task under consideration
- the time that the task under consideration will be started

The NUREG/CR-4910 methodology provides an equation for using this information to adjust the non-stress HEPs and yield the high-stress HEPs. These high-stress HEPs are used as the task-by-task input values in the HRA event tree developed in the detailed task analysis. NUREG/CR-4910 presents an example application that yields high-stress total failure probabilities for a procedure (i.e., eight-step feed-and-bleed procedure) calculated at 10- to 30-times higher than the no-stress values. In comparison, the NUREG/CR-1278 methodology yields high stress total failure probabilities of 50- to 500-times higher than the no-stress values for this example.

The NUREG/CR-4910 methodology includes consideration for the following parameters:

- consistency with the internal events analysis
- operator's stress
- number of operators

- time available
- uncertainty to account for errors
- performance of a detailed task analysis

The Westinghouse PRA for the upgraded state K Reactor includes consideration for the following parameters:

- consistency with the internal events analysis
- earthquake intensity
- location of operator action

3.2.2 NRC Generic Letter 88-20, Supplement 4 and NUREG-1407

NRC Generic Letter 88-20, Supplement 4, "Individual Plant Examination for Externally-Initiated Events" states—the NRC staff considers the procedures described in NUREG/CR-2300, "PRA Procedures Guide," American Nuclear Society and Institute of Electrical and Electronic Engineers, January 1983, NUREG/CR-2815, "Probabilistic Safety Assessment Procedures Guide," Brookhaven National Laboratory, August 1985, and NUREG/CR-4840, "Procedures for External Event Core Damage Frequency Analyses for NUREG-1150," M. P. Bonn and J. A. Lambright, November 1990, to be adequate for performing the seismic IPEEE, provided the enhancements discussed in Appendix 1 of this generic letter are also included. These requested enhancements are also discussed in NUREG-1407, "Procedural and Submittal Guidance for the Individual Plant Examination of External Events (IPEEE) for Severe Accident Vulnerabilities," May 1991.

These enhancements request that the seismic PRA methodology include a discussion of nonseismic failures and human actions that are significant contributors or that have an impact on results. It is an option to submit estimated High Confidence of Low Probability of Failure (HCLPF) values for the plant, dominant sequences, and components with and without nonseismic failures and human actions. The NRC will estimate these if they are not submitted.

NUREG-1407 likewise identifies NUREG/CR-2300, NUREG/CR-2815, Vol. 2, and NUREG/CR-4840 as methodologies considered acceptable for performing seismic PRAs. NUREG-1407 identifies NUREG/CR-5477 for evaluation of the reliability and usefulness of the results and insights obtained from external event PRAs. Human actions in PRAs are to be addressed as follows:

1. Seismic PRA methodology enhancements described in NUREG-1407 include reporting HCLPF values both with and without the effects of nonseismic failures and human actions.

2. Use of an existing PRA should consider that in several PRAs, nonseismic failures (e.g., failures of the auxiliary feedwater system and failure of feed-and-bleed mode of core cooling, battery depletion, power-operated relief valve failures) and human actions (e.g., delays or failures in performing specified actions or operator misdiagnoses a situation and takes an improper action that is not related to the actual, current plant situation) have been important

contributors to seismically-induced core damage frequencies or risk indices. Unless nonseismic failures are considered, improper decisions may be made regarding plant modifications or procedural changes. The scope of nonseismic failures and human interactions that might affect seismic sequences should be based on internal events analysis.

3. Documentation and reporting guidelines for the seismic PRA methodology include providing a description of the consideration given for nonseismic failures, human actions, dependencies, etc. The documentation is also to include a list of important nonseismic failures with a rationale for the assumed failure rate given a seismic event.

The NRC Generic Letter 88-20, Supplement 4, and NUREG-1407, requires that nuclear power plant licensees include consideration for the following parameters in their seismic PRAs:

- nonseismic failures and human actions
- HRA insights from previous seismic PRAs that may be relevant, including delay in human actions, failure to take actions, and misdiagnosis and associated improper actions
- consistency with sequences from internal events analysis
- bases for failure rates used

3.2.3 NUREG-1150, USNRC, Reactor Risk Reference Document

- NUREG/CR-4550, Volume 3, Rev. 1, Part 3, "Analysis of Core Damage Frequency: Surry Power Station, Unit 1 External Events," Sandia National Laboratories (December 1990)
- NUREG/CR-4550, Volume 4, Rev. 1, Part 3, "Analysis of Core Damage Frequency: Peach Bottom Unit 2, External Events," Sandia National Laboratories (December 1990)

The seismic risk-assessment methodology used in NUREG-1150 is based in part on the results of two earlier NRC-sponsored programs. The first is the Seismic Safety Margins Research Program (SSMRP), which culminated in a detailed evaluation of the seismic risk at the Zion Nuclear Power Plant (M. P. Bonn, et al.)"Application of the SSMRP Methodology to the Seismic Risk at Zion Nuclear Power Plant," NUREG/CR-3428, 1983). The second is The NRC-sponsored Eastern Seismic Hazard Characterization Program (D. L. Bernreuter, et al., "Seismic Hazard Characterization of the Eastern United States: Methodology and Interim Results for Ten Sites", NUREG/CR-3756, April 1984). The results from these two programs formed the basis

for a number of simplifications used in the NUREG-1150 seismic risk assessments in comparison to a detailed seismic PRA. The resulting methodology involves the following seven steps to calculate the seismic risk at a nuclear power plant.

- Determine the local earthquake hazard (hazard curves and site spectra).
- Identify accident scenarios for the plant that lead to radioactive release (initiating events and event trees).
- Determine failure modes for the plant safety and support systems (fault trees).
- Determine the responses (accelerations or forces) of all structures and components (for each earthquake level).
- Determine fragilities (probabilistic failure criteria) for the important structures and components.
- Compute the probability of core damage using the information from Steps 1 through 5 above.
- Estimate uncertainty in the core damage frequencies.

This NUREG-1150 seismic risk-assessment approach was used in the external events analysis for two nuclear power plants, Peach Bottom (BWR) and Surry (PWR). Other reports published in association with NUREG-1150 related to the external event seismic and HRA methodology that were used as referenced in NUREG/CR-4550, Volumes 3 and 4 are:

1. NUREG/CR-4840, "Procedures for External Event Core Damage Frequency Analyses for NUREG-1150," M. P. Bonn and J. A. Lambright (November 1990)

2. NUREG/CR 4772, "Accident Sequence Evaluation Program Human Reliability Analysis Procedure," A. D. Swain, III (February 1987)

3. NUREG/CR-3428, "Application of the SSMRP Methodology to the Seismic Risk at the Zion Nuclear Power Plant," M. P. Bohn, et al. (January 1984)

Seismic HRA approach, methodology, and considerations from each of these documents are described below.

3.2.3.1 NUREG-1150, NUREG/CR-4550, Volumes 3 and 4

The NUREG-1150 seismic analyses as described in NUREG/CR-4550, Volumes 3 and 4 include evaluation of human error potential in assessing the overall seismic risk by applying the guidance from the NUREG/CR-4840 and NUREG/CR-4772 methodologies. For the NUREG-1150 seismic analyses, the initiating events and event trees from the internal events analyses were simplified, removing considerations that would not apply under seismic events. This enables comparison of final core damage frequencies due to seismic and internal events on a common basis. The fault trees included failures of mechanical or electrical components due to all causes routinely considered in internal events analysis such as structural failure, human error, maintenance outage, etc. For the seismic analysis, basic event failures included the contributions due to seismic ground motions, random failures, human errors, and test

and maintenance outages. This includes considerations of system dependencies that would be due to the seismic event itself. The main difference between an internal event fault tree for a safety system and an external event fault tree is that consideration must be given to the physical location of the components because the physical location determines to what extent secondary failures become important. Examples of this would be secondary failures due to local masonry wall collapse or due to a high temperature/steam environment from a broken steam line. Hence, in performing the seismic analyses, the locations of all important pieces of equipment must be determined and a systematic examination for secondary failure possibilities must be made during the plant walkdown.

3.2.3.2 NUREG/CR-4840

NUREG/CR-4840 presents the methods used to perform the assessment of risk due to external events of Peach Bottom and Surry nuclear power plants under the NRC-sponsored NUREG-1150 program. The methods described make full use of the power plants', systems logic models developed in the internal events analyses. This leads to external events analysis that is consistent both in nomenclature and in level of detail with the internal events analyses, and in addition, includes the appropriate random and tests/maintenance unavailabilities. The description of the seismic methodology provided in NUREG/CR-4840 has essentially been reiterated in the NUREG-1150 external events seismic analyses as described in NUREG/CR-4550, Volumes 3 and 4, such that NUREG/CR-4840 provides no further detail guidance for performing the HRA for seismic events.

3.2.3.3 NUREG/CR-4772

NUREG/CR-4772 provides a shortened version of the procedure, models, and data for human reliability analysis from that presented in the "Handbook of Human Reliability Analysis with Emphasis on Nuclear Power Plant Applications," NUREG/CR-1278, A. D. Swain and H. E. Guttman, August 1983. This shortened version of THERP is called the Accident Sequence Evaluation Program (ASEP). The intent of this ASEP HRA procedure is to enable systems analysts, with minimal support from experts in HRA, to make estimates of human error probabilities and other human performance characteristics that are sufficiently accurate for many PRA applications. This ASEP HRA procedure consists of

- Screening pre-accident HRA
- Nominal pre-accident HRA
- Screening post-accident HRA
- Nominal post-accident HRA

The trial applications of this ASEP HRA methodology were performed for the Surry, Sequoyah, Peach Bottom, and Grand Gulf nuclear power plants as part of the NUREG-1150 program.

As an abbreviated HRA procedure, this ASEP HRA procedure omits some aspects of performance shaping factors, the central raw material in applying a full-scale HRA using the THERP handbook approach described in NUREG/CR-1278 and NUREG/CR-2254, "A Procedure for Conducting a Human Reliability Analysis for Nuclear Power Plants," B. J. Bell and A. D. Swain, December 1981. The NUREG/CR-4772 ASEP HRA procedure therefore results in more conservative estimates of HEPs than the THERP approach. In some cases, differences between the ASEP HRA and THERP HRA procedures resulted in differences in the estimated HEPs as large as a factor of ten. However, in cases in which stress levels could be assessed as extremely high, there were no material differences in the results obtained from the ASEP HRA and THERP HRA procedures. This is due to increased uncertainty and analysts' pessimism concerning success under high stress conditions. The ASEP HRA procedure also concludes that a PRA must include a specialist in HRA as part of the PRA team to properly consider the impact of human errors.

The NUREG/CR-4772 ASEP HRA procedure provides some guidance not found in NUREG/CR-1278 and NUREG/CR-2254, including

- Assessment of the effects of symptom-oriented emergency operating procedures and memorized immediate actions
- Post-accident HRA using the nominal diagnosis model
- The new set of definitions of technical terms
- The pre-accident and post-accident screening procedures
- The uncertainty bounds propagation computer program
- The treatment of multiple abnormal events
- Appendix C to NUREG/CR-4772 also contains corrections to NUREG/CR-1278 and NUREG/CR-2254.

Because of the additional guidance provided in NUREG/CR-4772, a full-scale HRA using the THERP handbook should also consult the ASEP HRA procedure for these considerations.

3.2.3.4 NUREG/CR-3428

NUREG/CR-3428, "Application of the SSMRP Methodology to the Seismic Risk at the Zion Nuclear Power Plant," published in January 1984, is referenced in NUREG-1150 and in NUREG/CR-4840 as providing a detailed evaluation of the seismic risk at the Zion Nuclear Power Station. The methods used for and the results obtained from the SSMRP seismic assessment for the Zion plant form the basis for many of the simplifications used in the NUREG-1150 seismic PRA procedures described in NUREG/CR-4840. In the area of HRA for seismic events, NUREG/CR-3428 treats human error in the system fault tree models as failures that are not further reducible, that is, basic events. Human errors in the system fault trees are modeled as independent, random basic events with failure probabilities selected from a distribution defined for each human error. A number of human error basic events were included on the fault trees. These events represent errors committed by plant personnel before, during, and after the earthquake. They include operator, calibration, and maintenance errors. The human errors were assigned failure probabilities based on available data,

with corrections made to account for earthquake-induced operator stress. For simplicity, it was assumed that the probability is not a function of the earthquake level. The maintenance errors this assumption is acceptable since these errors occur before the earthquake. The operator errors such as inadvertent closure of a safety injection flow control valve would be dependent on operator stress level and would result in increased estimation of human error probability values for larger earthquake levels. However, this error may take place prior to the earthquake, such that the HEP estimation is not influenced by the earthquake level. Due to this and other complicating factors, it was assumed that human error basic events are independent of earthquake magnitude.

The NUREG-1150 PRAs and referenced documents include consideration for the following parameters:

- consistency with the internal events analysis
- location of operator actions and impact of secondary failures
- operator stress
- multiple abnormal events
- uncertainty bounds
- symptom-oriented emergency procedures and memorized emergency actions
- time available for diagnosis and response actions
- diagnosis errors and recovery
- detailed task analysis

3.2.4 Diablo Canyon PRA, NUREG-0675, Supplement 34, NRC SER and White Paper by Harold F. Perla (PLG), May 4, 1992

3.2.4.1 NUREG-0675, Supplement 34

NUREG-0675, Supplement 34, "Safety Evaluation Report Related to the Operation of Diablo Canyon Nuclear Power Plant Units 1 and 2," June 1991, documents the NRC's review and acceptance of the Diablo Canyon final report for the Long Term Seismic Plan (LTSP), license condition 2.C.(7), "Seismic Design Basis Re-evaluation Program (SSER 27 Section IV.5)." This license condition required that Pacific Gas and Electric develop and implement a program to re-evaluate the seismic design bases used for the Diablo Canyon Nuclear Power Plant including performing a seismic Probabilistic Risk Assessment (PRA). The NRC staff selected Brookhaven National Laboratory (BNL) as the primary contractor for the PRA review. BNL concentrated its review on the internal events and overall risk integration and subcontracted with others to review specific areas. Seismic hazard, HRA-methodology only, fire analysis, and other external events were reviewed primarily by the NRC staff. The detailed technical evaluation produced through the staff and contractor efforts is reported in NUREG/CR-5726 (Bozoki and others, in process). On the basis of its review experience, the NRC staff concludes that the Diablo Canyon PRA represents an advanced state-of-the-art. Advanced and novel features of the PRA includes enhanced human actions analysis discussed in NUREG/CR-5726 (Bozoki and others, in process). The NRC review gave special attention to the novel approach to HRA in the Diablo Canyon PRA. This review focused on the credibility of modeling methods, source data, and human factors assessment instruments employed in assessing the comprehensiveness of analyses

performed for human actions. The scope of this review included precursors, initiators, mediators, and recovery for each PRA accident sequence, allowing the NRC to judge the reasonableness of the results. The Diablo Canyon PRA HRA used the following six step process:

1. Use event sequence diagrams as task analysis tools to identify pertinent human actions that would be analyzed as part of the event and fault trees.

2. Categorize identified pertinent human task actions as skill-, rule-, or knowledge-based using Electric Power Research Institute's (EPRI's) Human Cognitive Response (HCR) criteria.

3. Identify Performance Shaping Factors (PSFs) by means of a nominal group technique for each human task action selected for analysis.

4. Evaluate identified PSFs by surveying operators using a survey instrument that was developed and pre-tested by the HRA team.

5. Calculate error probability, recovery, and uncertainty estimates employing the NRC's Success Likelihood Index Method (SLIM) as the quantification tool and using the Three Mile Island PRA human error data as bounding values.

6. Document HRA results consistent with other published PRAs, especially the Three Mile Island PRA.

Specific details on this review are found in Section 3.8 of NUREG/CR-5726. The NRC staff concludes that the HRA team conducted a state-of-the-art knowledge analysis using event sequence diagrams, systematic scaling of PSFs with plant personnel input, and the application of real PSF data in quantification of human errors using an otherwise expert-judgement SLIM approach. The quantification results (point estimates and uncertainty bounds) were reasonable when compared to data from other PRAs.

3.2.4.2 H. F. Perla White Paper

The White Paper, "Human Action Under Seismic Events," H. F. Perla, May 4, 1992, discusses an approach for analyzing human actions during and subsequent to a seismic event that is considered to be acceptable based on

- Application in the Diablo Canyon PRA for the LTSP and associated NRC acceptance
- Application in the PRA performed for the DOE's HFIR facility at Oak Ridge National Laboratory and accepted by the DOE based on the findings of a peer review group

This approach is based on the premise that proper information will be available to the operator from seismically designed and qualified instrumentation. Given appropriate instrumentation, the operator actions in the control room for an earthquake need to

consider the impact of increased emotional stress on the operators in an adjustment factor to the HEPs determined from the internal events HRA. The approach used is to estimate the factor to be applied from a linear model that shows no chance of failure for a very mild earthquake and guaranteed failure for a very severe earthquake. This model is based on reference research that studied the general response of people in historical earthquakes of various intensities and correlation to the associated peak ground accelerations (reference Modified Mercalli Intensity Scale and Dr. Charles Richter's correlations). The estimation of the adjustment factors to be used also takes into consideration the design capabilities of the facility and the training of the operations staff for earthquake events. This results in an estimation of what intensity of earthquake will not cause any increase in operator action failure rates and what intensity of earthquake will have a large adjustment factor, including what that adjustment factor should be to approximate a near certain failure likelihood. The approach makes special provisions for operator actions with critical time limitations by directly assigning HEP values that also vary with earthquake intensity.

Outside control room operator actions must consider the impact the earthquake may have on accessibility for executing these actions. The approach includes detailed walkthroughs and talkthroughs to identify alternate access paths, potential earthquake hazards for each path, the added difficulties associated with communication between the control room and the personnel performing actions in the plant, and the increased emotional stress for personnel in both locations. These considerations were evaluated to arrive at an estimation of the likelihood of success for the outside control room actions considered to be likely for an earthquake scenario.

Finally, consideration is given to estimate the impact of multiple operator actions both in control room and outside control room in the likelihood of success for these operator actions. This evaluation requires review of procedures, practices, and policies with experienced plant staff to understand the issues associated with resource allocation and direction under emergency plant conditions.

The Diablo Canyon LTSP seismic PRA includes considerations for the following parameters:

- consistency with the internal events analysis
- detailed task analysis
- operator stress
- earthquake intensity
- location of operator actions
- time available
- multiple operator actions

3.2.5 Paper by E. M. Dougherty and G. W. Hannaman

The paper, "Human Reliability Assessment on the Evaluation of External Events," E. M. Dougherty (SAIC, Clearwater Office), and G. W. Hannaman (SAIC, San Francisco Office) describes the treatment given to Human Reliability Assessment (HRA) in external event PRAs as not having the level of sophistication given to HRA in internal events PRA. The lower level of sophistication is attributed primarily to the inability to predict with sufficient certainty the conditions that the operators will face and the impact this will have on the operators' performance. In a seismic event, for example, the survivability of equipment and structures becomes uncertain, the plant conditions may present physical threats to the operators in performing response and recovery actions, and operators' concerns may be diverted to their families. These issues result in a lack of psychological bases for HRA. Consequently, published external events PRAs either give no credit to operator intervention, or base their estimates of human failure probabilities on simple adjustments to human error estimates from the internal events HRA in order to account for high stress or low clarity of control room indications.

This paper proposes that, consistent with the approach of NUREG/CR-4840, HRA for external events requires a thorough walkdown to identify the influences, burdens, access, hazards, timing, and personnel allocation considerations for inside and outside control room actions to support a full risk and accident management program. This paper distinguishes between core damage prevention actions (described as risk management) and action to mitigate further damage (described as accident management). Uncertainty, although considered to be high for these external events HRA evaluation considerations, may be bounded by extensive audits adapted to the specific external event. These audits for seismic event evaluations must include the indications, procedures, and training provided. Considerations include physical hazards, such as fallen superstructures, adequate lighting, and communication availability. Having built-in assumptions about the number of operating crew members tends to reduce the evaluation insights. Screening analyses are suggested for focusing the evaluations on the significant risk locations. Simulator sequences can be developed to test control room crews in response to the events including walkdowns of the outside control room actions.

The E. M. Dougherty and G. W. Hannaman paper suggests the approach for seismic HRAs should include considerations for the following parameters:

- location of operator actions and potential secondary failures
- time available
- allocation of personnel resources
- detailed task analysis
- simulator exercise data

3.3 Review of Human Performance Literature

The basis for HRA techniques is the application of knowledge concerning human performance under a variety of conditions. Since the state-of-the-art of HRA in general, and seismic HRA in particular, is relatively undeveloped, advances in the understanding of human performance may not have been included in the HRA literature to date. To check against such a possibility, a review was made of the more general psychological and human factors literature for the following:

- Operator Workload (OWL)—This area was overviewed based on the comprehensive review of Lysaght et al. (1989), the review of workload and modeling methods by Bittner and Morrissey (1990), and the summary of research comparing subjective OWL methods by Hill et al. (1992).
- Seismic and Life Event Stress—This was based on a DIALOG search of the psychological literature (PSYCHSCAN) over the last eight years aimed at seismic stress and was augmented by summaries of ongoing life event stress research (Miller 1989) as well as a classical review of stress research (Goldberger and Breznitz 1982).
- Performance Shaping Factors (PSF)—This was based on a DIALOG search of the Emergency Science and Technology (EST) and National Technical Information System (NTIS) literature over the last eight years that addressed "performance shaping factors."

The results of overviewing these bodies of literature are presented in the following sections.

3.3.1 Operator Workload (OWL)

This Lysaght et al. (1989) comprehensive review indicated potential contributions of the OWL literature to seismic HEP. First, it summarized research supporting the potential importance of time stress and the consequent potential of classical "time stress modeling methods." These methods and their extensions are more broadly considered in the review of the (Bittner and Morrissey paper). Second, Lysaght et al. summarized studies of the subjective workload methods that may be applied prospectively to estimate the OWL effects of various stressors. Dimensions of subjective OWL and potential PSFs are also described. Hill et al. (1992) identifies one of the subjective methods as having the greatest potential for seismic HEP considerations. Lysaght et al. (1989) provides a framework for addressing seismic HEPs from the viewpoint of OWL.

Bittner and Morrissey (1990) generally review members of the family of task-analytic workload and performance modeling methods, excepting classical PRA methods (e.g., THERP). They identify traditional timestress modeling methods (including MMPS) and point out concerns with these conventional methods that are generally based on ratios of task "times required" (TRs) and "times available" (TAs) during critical periods (e.g., TR/TA<0.7). They also point out largely-ignored methodological issues including

- TR and TA Uncertainty—These are both impacted by equipment condition uncertainty following the disruption of a seismic event as well as the number of operators available after such an event.
- Conventional methods do not address potential "underload"—This has been identified as a growing problem in automated systems (e.g., NPP). In these systems, automation increases reducing excessive operator workload have paradoxically led to longer periods of operator under utilization and to a different set of problems. These underload problems include vigilance decrements and difficulties in crew transition to high workload or emergency conditions (e.g., seismic event).

Bittner and Morrissey (1990) described a number of modeling methods that address timestress and associated factors such as equipment condition uncertainty and numbers of operators.

Hill et al. (1992) provided a comparative review of subjective OWL methods that have not been widely applied in NPP settings. These methods, however, can be employed prospectively and have been strongly related to performance (Lysaght et al., 1989; Hill et al., 1992). One of the methods, the Task Load Index (TLX), is shown to best capture subjective OWL by Hill et al. Based upon a body of previous research (Hart and Staveland, 1988), TLX has six dimensions that could be influence by a seismic event. These are

- Mental Demand—this could be increased by the complexities generated by multiple system failures and/or equipment uncertainty after a seismic event
- Physical Demand—this could be increased by having to work around fallen structures or with marginal lighting
- Temporal Demand—this is analogous to time stress, which would be increased by failures requiring near-term actions (loss of river pumping)
- Performance—this would be increased by the ambiguity of judging self performance in the complexities after a seismic event
- Effort—this could be increased to meet a given level of performance because of the shock and dismay to an individual from a seismic event
- Frustration—this could be increased after a seismic event by competing concerns for family

Hill et al. (1990) support the potential of TLX as a method of integrating six performance-shaping dimensions

3.3.2 Seismic and Life Event Stress

The DIALOG search of the seismic stress psychological literature (PSYCHSCAN) identified several salient reports. These included

- Aptekar (1990)—This participant observational study indicated longer-lasting confusion following an earthquake, with its aftershock potential, than for following a hurricane (questioning the assumption that disasters have common times for recovery).

- Nolen-Hoeksema and Morrow (1991)—This study of seismic stress response indicated that persons having elevated levels of depression and stress symptoms before an event continued to have elevated symptoms following the event with highest levels if the event were personally dangerous (indicating that seismic and other stresses are at least additive).
- Tyllio and Ancona (1987)—This study discusses the emotional impact of disasters (e.g., earthquakes and bombings) and identifies reactions during then to include helplessness, avoidance, as well as survival-targeted strategies (not all of these appear to be addressed in seismic HEP evaluations).

These reports are not inconsistent with classical stress research (Goldberger and Breznitz, 1982). Not included in the life-events literature (e.g., Miller 1989), however, is the substantial stress that accompanies concerns about family who might have been injured or killed by the seismic event. The seismic and other psychological literature consequently points to

- the importance of the unexpectedness of the seismic event
- preexisting and personal stresses accompanying such events
- individual responses that are not well-addressed in current HEP evaluations.

3.3.3 Performance Shaping Factors (PSF)

The DIALOG search of EST and NTIS revealed a body of PSF literature not covered above (or as part of the parallel examination of NRC estimation guidance). Several of these articles appeared to have potential but could not be fully evaluated at this time. Examples of these include

- NUCLARR (1990),[a] Nuclear Computerized Library for Assessing Reactor Reliability (NUCLARR), Data Manual, Part 2, Human Error Probability (HEP) Data (NTIS PB91-157065/XAB)
- Hiei, S. (1990), Human reliability data collection and modelling. In: Human reliability modeling for nuclear power plants: Current status and future prospects, Vienna, Austria: International Atomic Energy Agency

The references identified from the EST and NTIS documents are listed in Attachment A of this report.

3.3.4 Discussion Relevant to the Psychological and Human Factors Literature

This literature review has revealed a wealth of information addressing the estimation of seismic event HEPs. In keeping with its goals, it identified both

- State-of-the-art methods that could potentially be used by experts to estimate post seismic HEPs, and
- Salient PSFs that could modify HEPs expected after seismic events.

Not all potential methods identified in Emergency Science and Technology (EST) and National Technical Information System (NTIS) searches could be overviewed because

[a] This was part of a set of reports addressing both HEP and other types of system reliability.

of the mass of documents that were revealed and resource limitations. Likewise, PSFs contained in the relevant EST and NTIS reports could not be extracted.

Sufficient information was gathered from this review; however, to determine that the state-of-the-art in predicting human performance, as indicated by ongoing research efforts in both psychology and human factors, does not include sufficient evidence that the HEP and EF figures used in standard THERP HRA analysis (as modified to account for the severity of a seismic event) should be replaced. The data and results reported in these and other ongoing efforts should therefore be used as additional information when making qualitative decisions to adjust the HEP value derived by standard techniques, rather than as an attempt to replace the tabled values themselves.

4.0 Conclusions and Recommendations

4.1 Conclusions

The seismic HRA information contained in the referenced documents reviewed above identifies seismic HRA treatment, issues, requirements, and results. This information is used to concisely identify all the salient parameters that are used in evaluating the seismic HRA approach alternatives. These parameters include the issues, concerns, approaches, attributes, techniques, and considerations related to seismic HRA. The parameters identified from review of all these reference documents are shown along with the position of each reference document for these parameters in Table 4.1 below. None of the seismic HRA features identified from these documents was specifically excluded from these identified parameters. Those that are not identified in Table 4.1 should be included as appropriate when addressing one or more of the items that are identified. These parameters are used as input in establishing the recommended approach for the SRS PRA Seismic HRA as described below.

Table 1. Seismic HRA Parameters Identified from Reference Documentation

	Reference Documentation					
Parameters	NUREG/CR-4910	NUREG-1150	NRC GL 88-20	W K-Rx PRA	Diablo	SAIC Paper
Internal Events Compatible	Yes	Yes	Yes	Yes	Yes	Yes
Detailed Task Analysis	Yes	Yes	Yes	No	Yes	Yes
Operator Stress	Yes	Yes	Not explicitly	No	Yes	Yes
Time Dependencies	Yes	Yes	Not explicitly	No	Yes	Yes
Number of Operators	Yes	Not explicitly	Not explicitly	No	Not explicitly	Yes
Earthquake Intensity	No	Not explicitly	Yes	Yes	Yes	Yes
Multiple Actions	No	Yes	Yes	No	Yes	Yes
Multiple Events	No	Yes	No	No	Yes	Yes
Uncertainty	Yes	Yes	Yes	No	Yes	Yes
Diagnostic Errors and Recovery	No	Yes	Yes	No	No	Yes
Location of Actions	No	Yes	Yes	Yes	Yes	Yes
Acceptance	None	NRC	NRC	None	NRC and DOE	None

As indicated in Table 4.1, the review and evaluation of the reference documents described above indicate that the common attributes and current trends for seismic HRA include consideration for the following parameters:

- consistency with the internal events analysis including nonseismic component failures and nonseismic human errors
- detailed task analysis
- operator stress
- time available
- personnel resource availability and allocation
- earthquake intensity
- multiple operator actions
- multiple abnormal events
- uncertainty bounds
- diagnosis errors and recovery
- location of operator actions and potential impact of secondary failures
- data sources and bases for use

The means for addressing each of these considerations is described below.

4.1.1 Consistency with the Internal Events Analysis Including Nonseismic Component Failures and Nonseismic Human Errors

This consideration is addressed by using the existing THERP approach and associated event and fault trees from the internal events analysis with appropriate modifications for the seismic event. This approach supports overall consistency of modeling nomenclature and level of detail and compatibility of results and their interpretation. This allows appropriate nonseismic component failures and nonseismic human errors used in the internal events analysis to be carried through to the seismic PRA where seismic-related failure (primary and secondary) considerations can be incorporated. The sources of data and bases for use for nonseismic failures should be available from internal events analysis.

4.1.2 Detailed Task Analysis

This consideration is already a part of the existing THERP approach and is addressed for seismic HRA in the same manner with inclusion of the appropriate corrections and enhancements of NUREG/CR-4772. This will include additional consideration for seismic event operator action PSFs as indicated in the considerations described below. For example, considerations that may require additional PSF adjustments include: the procedure type (symptom or rule based) and quality of the procedures, memorized immediate actions, impact of secondary failures on operator access, higher stress levels dependent on earthquake magnitude, multiple events and actions and impact on time available, and clarity of indications for proper diagnosis.

4.1.3 Operator Stress

This consideration is addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. The detailed task analysis (DTA) will determine and document the bases for selection of the appropriate operator stress conditions as an input to the PSFs.

4.1.4 Time Available

This consideration is addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. The DTA will determine and document the bases for selection of the appropriate time constraints and limitations as an input to the PSFs. The analyst will include consideration of other appropriate parameters when assessing time requirements and time availability and will provide documentation for these assessments.

4.1.5 Personnel Resource Availability and Allocation

This consideration can be addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. The DTA will determine and document the bases for selection of the appropriate personnel resource availability and allocation concerns as an input to the PSFs and the impact on time availability considerations.

4.1.6 Earthquake Intensity

This consideration can be addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. A bounding case analysis and/or a variety of earthquake levels can be considered and evaluated. The DTA for operator actions under various earthquake levels will result in changes in the seismic and operator action failures considered and in the PSF values used in estimating the HEPs for these actions. For example, operator access and the impact of secondary failures may be a negligible concern for a minor earthquake and would have minimal impact on the associated PSF. Alternately a large earthquake would necessitate addressing most or all of the considerations described in Table 4.1 including appropriate documentation of the analysts' bases for decisions/judgments. Where increased probabilities of operator action failures are determined to be appropriate beyond the adjustments made for the other considerations, an earthquake intensity adjustment factor could be applied. Such adjustments and documentation of their bases is an outcome of the DTA. NUREG/CR-4772 screening techniques should be used, if appropriate, to focus the effort on the dominant sequences and operator actions.

4.1.7 Multiple Operator Actions

This consideration can be addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. The DTA will determine and document the bases for analysis of

the impact of multiple operator actions as an input to the PSFs for operator error likelihood and the impact on personnel resource availability and allocation along with time availability considerations.

4.1.8 Multiple Abnormal Events

This consideration will be addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. The treatment of multiple abnormal events as described in NUREG/CR-4772 should be incorporated into the THERP methodology, as appropriate for the existing SRS THERP process.

4.1.9 Uncertainty

This consideration is addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. The uncertainty values from the THERP and NUREG/CR-4772 documents can be propagated using the program provided in NUREG/CR-4772 or an equivalent technique.

4.1.10 Diagnosis Error and Recovery

This consideration is addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. Equipment qualification concerns and potential conflicting or misleading indications should be considered for impact on proper diagnosis and recovery. When this concern is viewed as a real threat, analyst judgment may be necessary in providing the appropriate HEP input value with documentation of the judgment and bases.

4.1.11 Location

This consideration is addressed within the context of the existing THERP approach with incorporation of appropriate modifications and corrections from NUREG/CR-4772. The DTA will evaluate and document the impact that location and the associated accessibility and secondary failure considerations have on operator actions and their PSFs. The evaluation may need to include analysis of alternate paths for performing the remote action and the associated communication needs.

4.1.12 Data Source and Basis for Use

This is addressed by thorough documentation of the HRA process including the choice of the data sources used and discussion of the basis for use in the seismic HRA.

4.2 Recommendations

A state-of-the-art Seismic HRA should specifically consider each of these parameters in the evaluation and describe the process used for these considerations. It is possible that one or more of these considerations can be combined under a specific HRA task, as indicated in the above description of the means to address these parameters.

The recommended approach for the Seismic HRA for SRS PRA Rev. 1 is to use the THERP methodology following the guidance of NUREG/CR-1278 and NUREG/CR-2254, incorporate the updates, modifications, enhancements, and corrections provided in NUREG/CR-4772. This approach has the following benefits:

- compatible with internal events HRA THERP method
- addresses the important parameters identified above
- has received a very broad level of acceptance through the NRCs NUREG-1150 program
- allows flexibility in level of detail/rigor in focusing on risk-significant human actions and in refining HEP values with excessive conservatism to yield more realistic results

In performing the seismic HRA, the recommended approach considers the parameters described above and reviews, evaluates, and documents their input in quantifying the HEP values of each operator action within the context of the THERP technique. Many of these parameters are related, and their impact on the HEP should be considered together so that the quantitative influence of a related set of parameters is counted only once. The documentation, however, should clearly indicate the constituents of the sets of parameters evaluated and the bases for the data or judgments used.

5.0 References

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14. NUREG/CR-4550, Volume 4, Revision 1, Part 3, "Analysis of Core Damage Frequency; Peach Bottom Unit 2, External Events."

15. NUREG/CR-4840, "Procedures for External Event Core Damage Frequency Analyses for NUREG-1150", M. P. Bonn and J. A. Lambright (November 1990).
16. NUREG/CR-4772, "Accident Sequence Evaluation Program Human Reliability Analysis Procedure", A. D. Swain, III (February 1987).
17. NUREG/CR-3428, "Application of the SSMRP Methodology to the Seismic Risk at Zion Nuclear Power Plant", M. P. Bonn, et al. (January 1984).
18. Diablo Canyon PRA, NUREG-0675, Supplement 34, "Safety Evaluation Report Related to the Operation of Diablo Canyon Nuclear Power Plant Units 1 and 2" (June 1991).
19. The White Paper, "Human Action Under Seismic Events", H. F. Perla, May 4, 1992.
20. Paper by E. M. Dougherty and G. W. Hannaman, "Human Reliability Assessment in the Evaluation of External Events," TANSAO 65-1-580, 1992 Volume 65, pp. 100-101.
21. NUREG/CR-1278, "Handbook of Human Reliability Analysis With Emphasis on Nuclear Power Plant Applications," A. D. Swain, III, and H. E. Guttman (August 1983).
22. NUREG/CR-2254, "A Procedure for Conducting a Human Reliability Analysis for Nuclear Power Plants", B. J. Bell, and A. D. Swain (December 1981).

Attachment A. Performance Shaping Factor Literature Search Results

35/6/1 (Item 1 from file: 6)
1584320 NTIS Accession Number: DE91641297/XAB
Case study on the use of PSA methods: Human reliability analysis
U.S. Sales Only.
NTIS Prices: PC A04/MF A01

35/6/2 (Item 2 from file: 6)
1445447 NTIS Accession Number: DE90002055/XAB
Model for Measuring Complex Performance in an Aviation Environment
NTIS Prices: PC A02/MF A01

35/6/3 (Item 3 from file: 6)
1403541 NTIS Accession Number: TIB/B89-81319/XAB
ESAT (Expert System for Applied Task-Taxonomy): An expert system as a cockpit design tool based on a taxonomy of tasks performed during operation or maintenance of man-machine systems
NTIS Prices: PC E07

35/6/19 (Item 1 from file: 103)
03285572 DEN-92-003612; EDB-92-048329
Title: Quantification of human errors in level-1 PSA studies in NUPEC/JINS
Title: Proceedings of the OECD/BMU-workshop on special issues of level 1 PSA

35/6/20 (Item 2 from file: 103)
03285511 DEN-92-003608; EDB-92-048268
Title: Issue paper: Human errors
Title: Proceedings of the OECD/BMU-workshop on special issues of level 1 PSA

35/6/21 (Item 3 from file: 103)
03179276 AIX-22-063698; EDB-91-106712
Title: Performance comparison of two methods for human reliability analysis
Title: Balancing automation and human action in nuclear power plants
Original Series Title: Proceedings series ?t35/5/all

35/5/1 (Item 1 from file: 6)
1584320 NTIS Accession Number: DE91641297/XAB
Case study on the use of PSA methods: Human reliability analysis
International Atomic Energy Agency, Vienna (Austria).
Corp. Source Codes: 014014000; 3294000
Report No.: IAEA-TECDOC-592
Apr 91 69p
Languages: English
Journal Announcement: GRAI9208
U.S. Sales Only.
NTIS Prices: PC A04/MF A01
Country of Publication: Other

The overall objective of treating human reliability in a probabilistic safety analysis is to ensure that the key human interactions of typical crews are accurately and systematically incorporated into the study in a traceable manner. An additional objective is to make the human reliability analysis (HRA) as realistic as possible, taking into account the emergency procedures, the man-machine interface, the focus of training process, and the knowledge and experience of the crews. Section 3 of the paper describes an overview of this analytical process which leads to three more detailed example problems described in Section 4. Section 5 discusses a peer review process. References are presented that are useful in performing HRAs. In addition appendices are provided for definitions, selected data and a generic list of performance shaping factors. 35 refs, figs and tabs. (Atomindex citation 22:066744)
Descriptors: *Human Factors; *Safety; IAEA; International Cooperation; Man-Machine Systems; Member States; Nuclear Power Plants; Probabilistic Estimation; Reactor Operators
Identifiers: *Foreign technology; EDB/210000; NTISINIS
Section Headings: 77H (Nuclear Science and Technology--Reactor Engineering and Nuclear Power Plants); 97Q (Energy--Selected Studies In Nuclear Technology)

35/5/2 (Item 2 from file: 6)
1445447 NTIS Accession Number: DE90002055/XAB
Model for Measuring Complex Performance in an Aviation Environment Hahn, H. A.
EG and G Idaho, Inc., Idaho Falls.
Corp. Source Codes: 046580000; 9507781
Sponsor: Department of Energy, Washington, DC.
Report No.: EGG-M-88271; CONF-881058-5
1988 5p
Languages: English Document Type: Conference proceeding
Journal Announcement: GRAI9010; NSA0000
Human Factors Society annual meeting, Anaheim, CA, USA, 24-28 Oct 1988,
Portions of this document are illegible in microfiche products.
NTIS Prices: PC A02/MF A01
Country of Publication: United States
Contract No.: AC07-76ID01570

An experiment was conducted to identify models of pilot performance through the attainment and analysis of concurrent verbal protocols. Sixteen models were identified. Novice and expert pilots differed with respect to the models they used.

Models were correlated to performance, particularly in the case of expert subjects. Models were not correlated to performance shaping factors (i.e. workload). 3 refs., 1 tab.
Descriptors: Aircraft; Reactor Operators; Decision Making; Human Factors; Human Factors Engineering; Man-Machine Systems; Research Programs; Speech
Identifiers: ERDA/420200; *Pilots(Personnel); *Performance evaluation; NTISDE
Section Headings: 85A (Transportation--Air Transportation); 70D (Administration and Management--Personnel Management, Labor Relations, and Manpower Studies)

35/5/3 (Item 3 from file: 6)
1403541 NTIS Accession Number: TIB/B89-81319/XAB
ESAT (Expert System for Applied Task-Taxonomy): An expert system as a cockpit design tool based on a taxonomy of tasks performed during operation or maintenance of man-machine systems
Seifert, R.; Brauser, K.
Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.).
Unternehmensbereich Hubschrauber und Flugzeuge.
Corp. Source Codes: 064776011
Report No.: MBB-LKE315-S/PUB-320
15 Dec 87 23p
Languages: English
Journal Announcement: GRAI8918
Conference on expert systems and their applications, Avignon (France), 30 May - 3 June 1988.
NTIS Prices: PC E07
Country of Publication: Germany, Federal Republic of

An Expert System for Applied Task-taxonomy (ESAT) has been developed to be used as a cockpit-design tool during definition, specification and review phases of new aircraft. This expert system is based on a task taxonomy method elaborated recently in order to assess and classify arbitrary human performance reliability of tasks performed during operation and maintenance of man-machine systems. The goal of the task taxonomy method is to achieve predictions of performance data like human reliability or error probability depending on many "performance shaping factors" (PSF) such as task time budget, task difficulty, man-machine-interface characteristics, system characteristics, environmental conditions, and, last but not least, operator characteristics. A taxonomy databank has been designed which is filled with carefully analyzed and weighted facts which in most cases have been drawn from literature but also from own performance measurements, and is used as knowledge base for ESAT. Predictions of reliability data for tasks designed to be performed in new man-machine-systems shall be gained from ESAT in order to optimize the system design. (orig.). (Copyright (c) 1989 by FIZ. Citation no. 89:081319.)
Descriptors: *Expert systems; *Cockpits; Aircraft design; Man-machine systems; Human performance; *Design analysis
Identifiers: *Foreign technology; NTISTFFIZ
Section Headings: 51C (Aeronautics and Aerodynamics--Aircraft); 41A (Manufacturing Technology--Computer Aided Design [CAD])

35/5/4 (Item 4 from file: 6)
1315347 NTIS Accession Number: TIB/B88-80251/XAB
Computer simulation studies on human control reliability in manual aircraft control: The origin of PIO
Brauser, K.; Seifert, R.
Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Information und Dokumentation.
Corp. Source Codes: 064776008
Report No.: MBB-LKE301-S/PUB-208
20 Aug 85 28p
Languages: English
Journal Announcement: GRAI8812
67. AGARD/FMP symposium on flight simulation, Cambridge (UK), 30 Sep - 3 Oct 1985.
Microfiche only.
NTIS Prices: MF E07
Country of Publication: Germany, Federal Republic of

Pilot Induced Oscillations usually are defined as a sensitive indication of bad handling qualities. In the view of human performance reliability, PIO's are related to input errors with respect to the control characteristics of the controlled system. It has been learnt that this is a special aspect of the general rule that man will make errors while performing an arbitrary task under the influence of possible "performance shaping factors" (PSF's). A recently developed "Task Taxonomy Method" is used as a tool for the assessment of Human Error Probabilities (HEP) depending quantitatively on the effects of performance shaping factors (PSF) like task dimensions and characteristics, operator characteristics, system characteristics, and environment factors. Using this Task Taxonomy procedure, HEP values for the manual aircraft control task have been calculated. HEP values are drastically increased (0.5-0.9) by the influence of bad handling qualities, while good handling qualities may only reduce the HEP value to 0.1 because other PSF's may remain still active. Therefore PIO incidents remain possible, even in aircraft with good handling qualities. This has been demonstrated by means of SAINT computer simulations using appropriate HEP values. (orig.).

Descriptors: Pilot performance; Computerized simulation; Pilot error; Task complexity; Taxonomy; Performance prediction; *Manual control; *Aircraft control; Pilot induced oscillations; Man-machine systems; Reliability analysis
Identifiers: *Foreign technology; NTISTFFIZ
Section Headings: 51E (Aeronautics and Aerodynamics--Avionics); 95D (Biomedical Technology and Human Factors Engineering--Human Factors Engineering)

35/5/5 (Item 5 from file: 6)
1308996 NTIS Accession Number: TIB/B88-80113/XAB
Task taxonomy method: A basis for an expert system on human reliability
Seifert, R. ; Brauser, K.
Messerschmitt-Boelkow-Blohm G.m.b.H., Munich (Germany, F.R.). Information und Dokumentation.
Corp. Source Codes: 064776008

Report No.: MBB-LKE301-S/PUB--229
20 Feb 86 9p
Languages: English
Journal Announcement: GRAI8810
AGARD/AMP symposium on information management and decision making in advanced airborne weapon systems, Toronto (Canada), 15-18 Apr 1986.
Microfiche only.
NTIS Prices: MF E07
Country of Publication: Germany, Federal Republic of

A survey of human error (HE), its definition, nature of HE and the categorization of HE's, causes and prevention measures is described. Then a HE rating scale is introduced, which allows the assignment of HE probability (HEP) values measured into 10 "reliability classes" (RC). Based on HEP values measured for a number of human performances a "Task Taxonomy Method" is developed. This method allows to assign a relative weight to all task factors and to all performance shaping factors (PSF) involved in the task performance. The task taxonomy method is a tool to predict the HEP and RC of tasks allocated to man. Such a predictive tool is used for analysis, definition and design of man-machine systems. Finally rules of an expert system are described which facilitates the application and use of the task taxonomy method. (orig.). (Copyright (c) 1988 by FIZ. Citation no. 88:080113.)
Descriptors: *Pilot performance; Computerized simulation; *Pilot error; Task complexity; Taxonomy; Performance prediction; Reliability analysis; Man-machine systems
Identifiers: *Foreign technology; NTISTFFIZ
Section Headings: 51B (Aeronautics and Aerodynamics--Aeronautics); 85A (Transportation--Air Transportation); 95D (Biomedical Technology and Human Factors Engineering--Human Factors Engineering)

35/5/6 (Item 6 from file: 6)
1298144 NTIS Accession Number: TIB/B87-81572/XAB
Entwicklung einer Checkliste mit zugehoerigem Katalog von Empfehlungen zur ergonomisch optimierten Belegung von Kraftwerkswarten. (Optimizing the human engineering design of control panels in nuclear power plant control rooms)
Behrendt, V. ; Krehbiehl, T.
Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.).
Corp. Source Codes: 088412000
Report No.: BMU--1987-151
Dec 86 341p
Languages: German
Journal Announcement: GRAI8806
In German,
NTIS Prices: PC E99
Country of Publication: Germany, Federal Republic of
Contract No.: SR 318
The study contains two parts. In the first part an analytical procedure is developed to logically and reproducibly subdivide the control room personnel tasks resulting in a list of the elements (operations) and the structure (operations scheme) of a task. The second part lists together all knowledge of and influences on human engineering which

are known at this time and which should be taken into account in designing control rooms. The content of this catalogue can best be used and presented by using a personal computer. Two fundamental different ways are possible to use the catalogue. Designing new control rooms or new parts of control rooms the results of the task analysis which should be done first, should guide the search in the catalogue to find the right human engineering factors. For assessing existing control room panels the performance shaping factors which are establishing the table of content, permit a quick access to the catalogue. Both the specific procedure of the task analysis and the different ways of access to the catalogue of human engineering knowledge for designing nuclear power plant control rooms have been proven by experienced system engineers and safety experts. The results are presented. They have been considered in this version of the study. (orig.). (Copyright (c) 1987 by FIZ. Citation no. 87:081572.)
Descriptors: *Nuclear power plants; *Human factors engineering; *Control rooms; Human factors; Reactor operators; Reactor accidents; Reactor safety; Catalogs; Documentation; Display devices; Computer graphics; Man-machine systems; Information; Signals; Biological stress; Communications
Identifiers: *Foreign technology; NTISTFFIZ
Section Headings: 77H (Nuclear Science and Technology--Reactor Engineering and Nuclear Power Plants); 97Q (Energy--Selected Studies In Nuclear Technology)

35/5/7 (Item 7 from file: 6)
1214242 NTIS Accession Number: NUREG/CR-4600/XAB
Human Factors Study Conducted in Conjunction with a Mini-Round Robin Assessment of Ultrasonic Technician Performance (Technical rept.)
Wheeler, W. A., W. L. Rankin, J. C. Spanner, R. V. Badalamente, T. T. Taylor
Battelle Pacific Northwest Labs., Richland, WA.
Corp. Source Codes: 048335000;
Sponsor: Battelle Human Affairs Research Centers, Seattle, WA.; Nuclear Regulatory Commission, Washington, DC. Office of Nuclear Reactor Regulation.
Report No.: PNL-5757
Aug 86 97p
Languages: English
Journal Announcement: GRAI8624
Also pub. as Battelle Human Affairs Research Centers, Seattle, WA. rept. no. BHARC-400/86/001. Prepared in cooperation with Battelle Human Affairs Research Centers, Seattle, WA. Sponsored by Nuclear Regulatory Commission, Washington, DC. Office of Nuclear Reactor Regulation.
NTIS Prices: PC A05/MF A01
Country of Publication: United States

The report describes the findings from a limited human factors (HF) study conducted in conjunction with a Mini-Round Robin (MRR) held at the Pacific Northwest Laboratory. The purpose of the HF evaluation was to acquire preliminary data on performance shaping factors that affect ultrasonic testing (UT) reliability; to test the efficacy of relative operating characteristic analysis for representing UT accuracy; and to determine the direction of future HF efforts in the NDT area. The purpose of the MRR was to evaluate the ability of nondestructive testing (NDT) technicians to detect intergranular stress corrosion cracking (IGSCC) using UT techniques. A further purpose was to measure improvements in technician

performance following implementation of I&E Bulletin 83-02 and qualification for IGSCC detection at the EPRI-NDE Center.
Descriptors: *Personnel; *Performance evaluation; Inspection; Ultrasonic tests; Human factors engineering; Nondestructive tests; Reliability
Identifiers: NTISNUREG; NTISDE
Section Headings: 5I (Behavioral and Social Sciences--Personnel Selection, Training, and Evaluation); 92A (Behavior and Society--Job Training and Career Development)

35/5/8 (Item 8 from file: 6)
1207853 NTIS Accession Number: PB86-218815/XAB
Reliability of In-Service Inspection of Transport Aircraft Structures (Final rept.)
Lock, M.W.B., J. E. Strutt
Civil Aviation Authority, London (England).
Corp. Source Codes: 078399000
Report No.: CAA/PAPER-85013; ISBN-0-86039-251-1
c1985 121p
Languages: English
Journal Announcement: GRAI8621
NTIS Prices: PC E06/MF E06
Country of Publication: United Kingdom

A study has been made of the reliability of structural inspection of transport aircraft with particular emphasis being laid on the influence of human factors on the performance of inspection. Data for the study was obtained from various sources: discussions with and visits to operators; mandatory occurrence reports; a questionnaire circulated amongst selected aircraft operating companies and by detailed task analysis at shop floor level. The importance of various performance-shaping factors to the inspection activity has been established.
Descriptors: *Transport aircraft; Structural analysis; Inspection; Reliability; Errors; Aircraft
Identifiers: *Foreign technology; NTISTFCAA
Section Headings: 1C (Aeronautics--Aircraft); 14D (Methods and Equipment--Reliability); 51C (Aeronautics and Aerodynamics--Aircraft); 94B (Industrial and Mechanical Engineering--Quality Control and Reliability)

35/5/9 (Item 9 from file: 6)
1188709 NTIS Accession Number: NUREG/CR-4436-V1/XAB
Human Reliability Impact on Inservice Inspection. Phase 1 Summary Report (Technical rept.)
Spanner, J. C., R. V. Badalamente, W. L. Rankin, T. J. Triggs
Battelle Human Affairs Research Centers, Seattle, WA.
Corp. Source Codes: 057602000;
Sponsor: Battelle Pacific Northwest Labs., Richland, WA.; Nuclear Regulatory Commission, Washington, DC. Office of Nuclear Regulatory Research.
Report No.: PNL-5641-VOL-1; BHARC-400/85/016-VOL-1
Mar 86 113p
Languages: English

Journal Announcement: GRAI8613
See also NUREG/CR-4436-V2. Also pub. as Battelle Pacific Northwest Labs., Richland, WA. rept. no. BHARC-400/85/016-V1. Prepared in cooperation with Battelle Pacific Northwest Labs., Richland, WA. Sponsored by Nuclear Regulatory Commission, Washington, DC. Office of Nuclear Regulatory Research.

NTIS Prices: PC A06/MF A01
Country of Publication: United States

The report documents a feasibility study conducted to identify, characterize, and evaluate the human reliability aspects of ultrasonic testing/inservice inspection (UT/ISI). During the study, the following four inter-dependent tasks were completed: (a) perform a literature survey to identify significant human performance factors and develop a better measure of performance for the UT/ISI process; (b) develop task element description for a typical UT/ISI process; (c) prepare a test plan to conduct a human performance evaluation in conjunction with a mini-round robin study; and (d) prepare a project plan for conducting the needed follow-on work identified during the feasibility study. The report includes an assessment of UT applications in the nuclear industry, emphasizing the UT/ISI system (personnel, equipment, and procedures). A man-machine system model is used to describe the UT/ISI process, and the Relative Operating Characteristic (ROC) analysis approach for analyzing NDT performance is discussed. The five basic performance shaping factors (variables) are evaluated with respect to potential impact on UT/ISI performance.
Descriptors: *Nuclear power plants; Reliability; Inspection; Performance evaluation; Stress corrosion; Pipes(Tubes)
Identifiers: *Nuclear industry; *Ultrasonic testing; *Human factors; Task analysis; NTISNUREG; NTISDE
Section Headings: 18I (Nuclear Science and Technology--Reactor Engineering and Operation); 14B (Methods and Equipment--Laboratories, Test Facilities, and Test Equipment); 5E (Behavioral and Social Sciences--Human Factors Engineering); 77H (Nuclear Science and Technology--Reactor Engineering and Nuclear Power Plants); 95D (Biomedical Technology and Human Factors Engineering--Human Factors Engineering)

35/5/10 (Item 10 from file: 6)
1114079 NTIS Accession Number: DE85004778/XAB
Simulator Experiments: Effects of Experience of Senior Reactor Operators and of Presence of a Shift Technical Advisor on Performance in a Boiling Water Reactor Control Room
Beare, A. N. ; Dorris, R. E. ; Gray, L. H.
Oak Ridge National Lab., TN.
Corp. Source Codes: 021310000; 4832000
Sponsor: General Physics Corp., Atlanta, GA.; Department of Energy, Washington, DC.
Report No.: ORNL/TM-9327
Dec 84 171p
Languages: English

Journal Announcement: GRAI8510; NSA1000
Portions are illegible in microfiche products. Original copy available until stock is exhausted.
NTIS Prices: PC A08/MF A01
Country of Publication: United States
Contract No.: AC05-84OR21400

This report describes the first experiment in a Nuclear Regulatory Commission-sponsored program of training simulator experiments and field data collection to evaluate the effects of selected performance shaping factors on the performance of nuclear power plant control room operators. The factors investigated were the experience level of the Senior Reactor Operator (SRO) and the presence of a Shift Technical Advisor (STA). Data were collected from 16 two-man crews of licensed operators (one SRO and one RO). The crews were split into high and low SRO-experience groups on the basis of the years of experience of the SROs as SROs. One half (4 of the 8 crews in each group) of the high- and low-SRO experience groups were assisted by an STA or an SRO acting as an STA. The crews responded to four simulated plant casualties which ranged in severity from an uncomplicated turbine trip to an anticipated transient without scram (ATWS). No significant differences in overall performance were found between groups led by high (25 to 114 months licensed as an SRO) and low (1 to 17 months as an SRO) experience SROs. However, crews led by low experience SROs tended to have shorter task performance times than crews led by high experience SROs. Although a tendency for the STA-assisted groups to score higher on four of the five measures was observed, the presence of the STA had no statistically significant effect on overall team performance. The correlation between individual performance, as measured by four of the task performance measures, and experience, measured by months as a licensed operator, was not statistically significant, nor was the correlation between task performance and recency of simulator training. 18 references, 5 figures, 13 tables. (ERA citation 10:008654)
Descriptors: *Reactor Operators; Behavior; *Control Rooms; Human Factors; *Performance Testing; Reactor Accidents; Reactor Safety Experiments; Reactor Simulators
Identifiers: ERDA/220900; NTISDE
Section Headings: 5I (Behavioral and Social Sciences--Personnel Selection, Training, and Evaluation); 18I (Nuclear Science and Technology--Reactor Engineering and Operation); 70D (Administration and Management--Personnel Management, Labor Relations, and Manpower Studies); 77H (Nuclear Science and Technology--Reactor Engineering and Nuclear Power Plants)

35/5/11 (Item 11 from file: 6)
1027197 NTIS Accession Number: NUREG/CR-3458
Evaluation of the Nuclèar Power Plant Operator Licensing Examination (Final rept. Oct 81-May 82)
Fullerton, A. M., E. Peelle, J. H. Reed, G. W. Morrison, and S. J. Liebowitz
Oak Ridge National Lab., TN.
Corp. Source Codes: 021310000
Sponsor: Nuclear Regulatory Commission, Washington, DC.; Department of Energy, Washington, DC.

Report No.: ORNL/TM-8895
Oct 83 169p
Languages: English
Journal Announcement: GRAI8404
NTIS Prices: PC A08/MF A01
Country of Publication: United States
Contract No.: W-7405-eng-26

The report contains findings and conclusions about the Nuclear Regulatory Commission's nuclear power plant operator licensing examination based on six months of field work in late 1981 and early 1982. This report includes chapters which describe and evaluate the examination systems as they existed at the time of the field work. There are also discussions of the concepts of validity and reliability as they relate to the control room operator examination, operator performance measures, and performance-shaping factors. The last half of the report focuses on what could and should be done to the operator licensing system. The report argues that any new examination must be based on task analysis and should incorporate methods for measuring operators' problem solving ability in ill-defined situations. It is argued that the NRC needs to clarify whether their licensing examination is to be a test of minimal competence or a master test, whether the examination system is to serve the selection function, and whether separate licensing tests are needed for ROs and SROs. The last chapter details a model of a new licensing process. Features of the process include validated selection procedures, a computerized basic knowledge examination, an apprenticeship period with documentation of performance, and a computerized, tailored test to assess problem-solving ability and system understanding.
Descriptors: *Operators(Personnel); *Licenses; *Nuclear reactors; Examination; Validation; Problem solving; Performance evaluation; Job analysis
Identifiers: NTISNUREG; NTISDE
Section Headings: 5I (Behavioral and Social Sciences--Personnel Selection, Training, and Evaluation); 5J (Behavioral and Social Sciences--Psychology [Individual and Group Behavior]); 70D (Administration and Management--Personnel Management, Labor Relations, and Manpower Studies); 92B (Behavior and Society--Psychology)

35/5/12 (Item 12 from file: 6)
1021429 NTIS Accession Number: NUREG/CR-3414
Evaluation of Training Programs and Entry Level Qualifications for Nuclear Power Plant Control Room Personnel Based on the Systems Approach to Training
Haas, P. M. D. L. Selby, M. J. Hanley, R. T. Mercer
Oak Ridge National Lab., TN.
Corp. Source Codes: 021310000;
Sponsor: Eclectech Associates, Inc., North Stonington, CT.; Nuclear Regulatory Commission, Washington, DC.; Department of Energy, Washington, DC.
Report No.: ORNL/TM-8848
Sep 83 123p
Languages: English
Journal Announcement: GRAI8402
Prepared in cooperation with Eclectech Associates, Inc., North Stonington, CT.
NTIS Prices: PC A06/MF A01
Country of Publication: United States

Contract No.: W-7405-eng-26

The report summarizes results of research sponsored by the U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Regulatory Research to initiate the use of the Systems Approach to Training in the evaluation of training programs and entry level qualifications for nuclear power plant (NPP) personnel. Variables (Performance shaping factors) of potential importance to personnel selection and training are identified, and research to more rigorously define an operationally useful taxonomy of those variables is recommended. A high-level "model" of the Systems Approach to Training for use in the nuclear industry, which could serve as a model for NRC evaluation of industry programs, is presented. The model is consistent with current publically stated NRC policy, with the approach being followed by the Institute for Nuclear Power Operations, and with current training technology. Checklists to be used by NRC evaluators to assess training programs for NPP control-room personnel are proposed which are based on this model. In an appendix, a "typical" media selection model is illustrated which might be used in the design of training systems for NPP control-room personnel. Further assessment of the proposed checklists to assure practicality, utility and acceptability is recommended. In addition, other issues related to training-effectiveness evaluation are identified, and a comprehensive research approach to address them is outlined.
Descriptors: *Specialized training; *Nuclear power plants; *Personnel selection; Qualifications; Job analysis; Evaluation; Performance standards; Models
Identifiers: NTISNUREG; NTISDE
Section Headings: 5I (Behavioral and Social Sciences--Personnel Selection, Training, and Evaluation); 92A* (Behavior and Society--Job Training and Career Development)

35/5/13 (Item 13 from file: 6)
1021416 NTIS Accession Number: NUREG/CR-2986
Use of Performance Shaping Factors and Quantified Expert Judgement in the Evaluation of Human Reliability: An Initial Appraisal
Embrey, D. E.
Brookhaven National Lab., Upton, NY.
Corp. Source Codes: 004545000;
Sponsor: Human Reliability Associates Ltd., Dalton (England).; Nuclear Regulatory Commission, Washington, DC.; Department of Energy, Washington, DC.
Report No.: BNL-NUREG-51591
May 83 80p
Languages: English
Journal Announcement: GRAI8402
Prepared in cooperation with Human Reliability Associates Ltd., Dalton (England).
NTIS Prices: PC A05/MF A01
Country of Publication: United States
Contract No.: DE-AC02-76CH00016

The first part of the report considers the nature of human reliability assessment, and the techniques currently employed. It is concluded that most approaches are limited by the availability of data. Approaches to the subjective assessment of error are surveyed. A particular technique which has been developed, the Success Likelihood Index Methodology (SLIM), is described in detail, together with the practical steps for its implementation. The results from a trial application of a questionnaire designed to elicit judges' perceptions of the relative importance of performance shaping factors

in determining human reliability are analyzed. A revised form of the questionnaire is presented for future use. A pilot experiment to investigate the relationship between subjectively derived indices of success for six tasks and their objective probability of success is described. The results indicate that the SLIM has potential value as a predictive technique. Some requirements for a program of research to produce a generally applicable methodology are set out.
Descriptors: *Personnel; *Reliability; Methodology; Assessment; Judgment; Human behavior; Operators(Personnel); Nuclear power plants; Failure
Identifiers: NTISNUREG; NTISDE
Section Headings: 5J (Behavioral and Social Sciences--Psychology [Individual and Group Behavior]); 5I (Behavioral and Social Sciences--Personnel Selection, Training, and Evaluation); 92B* (Behavior and Society--Psychology); 70D (Administration and Management--Personnel Management, Labor Relations, and Manpower Studies)

35/5/14 (Item 14 from file: 6)
1018444 NTIS Accession Number: DE83009292
Approach to Modeling of Human Performance for Purposes of Probabilistic Risk Assessment
Swain, A. D.
Sandia National Labs., Albuquerque, NM.
Corp. Source Codes: 068123000; 9511100
Sponsor: Department of Energy, Washington, DC.
Report No.: SAND-83-0447C; CONF-830902-1
1983 29p
Languages: English Document Type: Conference proceeding
Journal Announcement: GRAI8402; NSA0800
NATO human factors meeting on the theory and nature of human error, Bellagio, Italy, 5 Sep 1983.
Portions are illegible in microfiche products.
NTIS Prices: PC A03/MF A01
Country of Publication: United States
Contract No.: AC04-76DP00789

This paper describes the general approach taken in NUREG/CR-1278 to model human performance in sufficient detail to permit probabilistic risk assessments of nuclear power plant operations. To show the basis for the more specific models in the above NUREG, a simplified model of the human component in man-machine systems is presented, the role of performance shaping factors is discussed, and special problems in modeling the cognitive aspect of behavior are described. (ERA citation 08:049202)
Descriptors: *Nuclear Power Plants; *Reactor Operators; *Risk Assessment; Reactor Safety; Performance; Reactor Operation; Reactor Maintenance; Human Factors; Human Factors Engineering
Identifiers: ERDA/220900; ERDA/210000; NTISDE
Section Headings: 5I (Behavioral and Social Sciences--Personnel Selection, Training, and Evaluation); 70D (Administration and Management--Personnel Management, Labor Relations, and Manpower Studies); 77GE (Nuclear Science and Technology--General)

35/5/15 (Item 15 from file: 6)
961253 NTIS Accession Number: NUREG/CR-2534
Criteria for Safety-Related Nuclear Power Plant Operator Actions: Initial Boiling Water Reactor (BWR) Simulator Exercises
Beare, A. N., D. S. Crowe, E. J. Kozinsky, D. B. Barks, P. M. Haas
Oak Ridge National Lab., TN.
Corp. Source Codes: 021310000
Sponsor: Department of Energy, Washington, DC.; Nuclear Regulatory Commission, Washington, DC.
Report No.: ORNL/TM-8195
Oct 82 109p
Languages: English
Journal Announcement: GRAI8309
Prepared in cooperation with General Physics Corp., Chattanooga, TN.
NTIS Prices: PC A06/MF A01
Country of Publication: United States
Contract No.: W-7405-eng-26

The primary objective of the Safety-Related Operator Action Program at Oak Ridge National Laboratory is to provide a data base to support development of criteria for safety-related action by nuclear power plant operators. This report presents initial data obtained from ten exercises conducted in a boiling water reactor power plant control room simulator. The ten exercises were performed by 24 groups of operators from three utilities. Operator performance was recorded automatically by a program called the Performance Measurement System run on the simulator's computer. Data tapes were subsequently analyzed to extract operator response time (RT) and error rate information. In addition, demographic and subjective data were collected and analyzed in an attempt to identify and evaluate the possible effects of selected performance-shaping factors on operator performance. The data collected will be compared to field data being collected on similar malfunctions. That comparison will provide a basis for extrapolation of simulator data to actual operating conditions. A base of operator performance data developed from simulator experiments can then be used to establish criteria and standards, evaluate the effects of performance-shaping factors, and support safety/risk assessment analyses.
Descriptors: *Nuclear reactor safety; *Human factors engineering; Operators(Personnel); Time studies; Standards; Performance; Errors
Identifiers: NTISNUREG; NTISDE
Section Headings: 13L (Mechanical, Industrial, Civil, and Marine Engineering--Safety Equipment); 5E (Behavioral and Social Sciences--Human Factors Engineering); 77F (Nuclear Science and Technology--Radiation Shielding, Protection, and Safety); 95D (Biomedical Technology and Human Factors Engineering--Human Factors Engineering)

35/5/16 (Item 16 from file: 6)
956300 NTIS Accession Number: DE82018771
Modeling of Response to Nuclear-Power-Plant Transients for Probabilistic Risk Assessment
Swain, A. D.
Sandia National Labs., Albuquerque, NM.
Corp. Source Codes: 068123000; 9511100

Sponsor: Department of Energy, Washington, DC.
Report No.: SAND-82-0594C; CONF-820831-1
1982 9p
Languages: English Document Type: Conference proceeding
Journal Announcement: GRAI8308; NSA0700
Congress of International Ergonomics Association, Tokyo, Japan, 23 Aug 1982.
Portions of document are illegible.
NTIS Prices: PC A02/MF A01
Country of Publication: United States
Contract No.: AC04-76DP00789

There are many qualitative and quantitative models of human performance. Most of these models either were not intended for current application to the probabilistic risk assessment (PRA) of nuclear power plant (NPP) operations, or they depend on data which are not yet available. This limitation is especially true in the area of cognitive behavior in complex systems. This paper briefly describes a general qualitative model (paradigm) of human performance in complex systems, the role of performance shaping factors in PRA, and model for one type of cognitive behavior of NPP personnel. The key to the models is that they contain no more information than is necessary and available for PRA; they are not intended to describe in detail the underlying dynamics of human behavior. (ERA citation 07:054032)
Descriptors: *Nuclear power plants; *Risk assessment; Reactor safety; Reactor accidents; Reactor operators; Human factors; Performance
Identifiers: ERDA/220900; ERDA/210000; NTISDE
Section Headings: 18E (Nuclear Science and Technology--Nuclear Power Plants); 77F (Nuclear Science and Technology--Radiation Shielding, Protection, and Safety); 77H (Nuclear Science and Technology--Reactor Engineering and Nuclear Power Plants)

35/5/17 (Item 17 from file: 6)
914714 NTIS Accession Number: NUREG/CR-2255
Expert Estimation of Human Error Probabilities in Nuclear Power Plant Operations: A Review of Probability Assessment and Scaling
Stillwell, W. G., D. A. Seaver, J. P. Schwartz
Sandia National Labs., Albuquerque, NM.
Corp. Source Codes: 068123000
Sponsor: Nuclear Regulatory Commission, Washington, DC.
Report No.: SAND-81-7140
May 82 65p
Languages: English
Journal Announcement: GRAI8223
Prepared in cooperation with Decision Science Consortium, Inc., Falls Church, VA.
NTIS Prices: PC A04/MF A01
Country of Publication: United States

This report reviews probability assessment and psychological scaling techniques that could be used to estimate human error probabilities (HEPs) in nuclear power plant operations. The techniques rely on expert opinion and can be used to estimate HEPs where data do not exist or are inadequate. These techniques have been used in various other contexts and have been shown to produce reasonably accurate probabilities. Additional topics covered include methods for combining estimates from multiple experts, the effects of training on probability estimates, and some ideas on structuring

the relationship between performance shaping factors and HEPs. Preliminary recommendations are provided along with cautions regarding the costs of implementing the recommendations. Additional research is required before definitive recommendations can be made.
Descriptors: *Human factors engineering; *Nuclear power plants; *Errors; Probability theory; Estimating; Specialized training; Human behavior
Identifiers: NTISNUREG; NTISDE
Section Headings: 5J (Behavioral and Social Sciences--Psychology [Individual and Group Behavior]); 5E (Behavioral and Social Sciences--Human Factors Engineering); 18E (Nuclear Science and Technology--Nuclear Power Plants); 92B* (Behavior and Society--Psychology); 95D* (Biomedical Technology and Human Factors Engineering--Human Factors Engineering); 77H (Nuclear Science and Technology--Reactor Engineering and Nuclear Power Plants)

35/5/18 (Item 18 from file: 6)
877095 NTIS Accession Number: NUREG/CR-1908
Criteria for Safety-Related Nuclear Power Plant Operator Actions: Initial Pressurized Water Reactor (PWR) Simulator Exercises
Bott, T. F., E. Kozinsky, C. Crowe, P. M. Haas
Oak Ridge National Lab., TN.
Corp. Source Codes: 021310000
Sponsor: Nuclear Regulatory Commission, Washington, DC. Div. of Reactor Safety Research.; Department of Energy, Washington, DC.
Report No.: ORNL/NUREG/TM-434
Sep 81 104p
Languages: English
Journal Announcement: GRAI8203
NTIS Prices: PC A06/MF A01
Country of Publication: United States
Contract No.: W-7405-eng-26

Nuclear plant control room simulator exercises for seven pressurized water reactor (PWR) events were conducted with ten control room teams. Operator performance was recorded by an automatic Performance Measurement System (PMS) and by subjective evaluation. Response times and error probabilities were estimated for selected actions. The effect of some experimental variables on operator performance is discussed. Application of the response time data to ANSI Standard N660 is included. The data collected will later be compared to field data being collected for similar events in order to provide a basis for extrapolation of simulator data to actual operating conditions. Ultimately, a base of human performance data will be developed from simulator experiments which can be used to establish criteria and standards, evaluate effects of key performance-shaping factors, and support safety/risk assessment analyses.
Descriptors: *Nuclear reactor safety; Pressurized water reactors; Operators(Personnel); Skilled workers; Performance evaluation; Data acquisition; Nuclear reactor accidents; Reaction time
Identifiers: Loss of coolant; NTISNUREG; NTISDE
Section Headings: 18I (Nuclear Science and Technology--Reactor Engineering and Operation); 77H (Nuclear Science and Technology--Reactor Engineering and Nuclear Power Plants)

35/5/19 (Item 1 from file: 103)
03285572 DEN-92-003612; EDB-92-048329
Title: Quantification of human errors in level-1 PSA studies in NUPEC/JINS
Author(s): Hirano, M.; Hirose, M.; Sugawara, M.; Hashiba, T. (Japan Inst. of Nuclear Safety, Nuclear Power Engineering Center, Tokyo [Japan])
Title: Proceedings of the OECD/BMU-workshop on special issues of level 1 PSA
Author(s)/Editor(s): Hauptmanns, U. (comp.)
Corporate Source: Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany) (Code: 2795680)
Conference Title: OECD/CSNI/BMU workshop on special issues of level 1 PSA
Conference Location: Cologne (Germany) Conference Date: 27-29 May 1991
Publication Date: Jul 1991 p 260-278 (407 p)
Report Number(s): GRS-86 CONF-9105244--
ISBN: 3-923875-36-3
Document Type: Analytic of a Report; Conference Literature; Special Availability
Language: In English
Journal Announcement: EDB9208
Availability: Available from FIZ Karlsuhe
Subfile: ERA (Energy Research Abstracts); ETD (Energy Technology Data Exchange). DEN (Federal Republic of Germany [sent to DOE from])
US DOE Project/NonDOE Project: NP
Country of Origin: Japan
Country of Publication: Germany, Federal Republic of
Abstract: THERP (Technique for Human Error Rate Prediction) method is mainly adopted to evaluate the pre-accident and post-accident human error rates. Performance shaping factors are derived by taking Japanese operational practice into account. Several examples of human error rates with calculational procedures are presented. The important human interventions of typical Japanese NPPs are also presented. (orig./HP).
Major Descriptors: *REACTOR ACCIDENTS--REACTOR OPERATORS; *REACTOR OPERATORS--RELIABILITY
Descriptors: BWR TYPE REACTORS; HUMAN FACTORS; JAPAN; PROBABILISTIC ESTIMATION; PWR TYPE REACTORS; REACTOR SAFETY; RISK ASSESSMENT
Broader Terms: ACCIDENTS; ASIA; DEVELOPED COUNTRIES; ENRICHED URANIUM REACTORS; PERSONNEL; POWER REACTORS; REACTORS; SAFETY; THERMAL REACTORS; WATER COOLED REACTORS; WATER MODERATED REACTORS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety 210100--Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled 210200--Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled 220400--Nuclear Reactor Technology--Control Systems

35/5/20 (Item 2 from file: 103)
03285511 DEN-92-003608; EDB-92-048268
Title: Issue paper: Human errors
Author(s): Mertens, J. (Forschungszentrum Juelich GmbH, Inst. fuer Sicherheitsforschung und Reaktortechnik [Germany])

Title: Proceedings of the OECD/BMU-workshop on special issues of level 1 PSA
Author(s)/Editor(s): Hauptmanns, U. (comp.)
Corporate Source: Gesellschaft fuer Reaktorsicherheit mbH (GRS), Koeln (Germany) (Code: 2795680)
Conference Title: OECD/CSNI/BMU workshop on special issues of level 1 PSA
Conference Location: Cologne (Germany) Conference Date: 27-29 May 1991
Publication Date: Jul 1991 p 202-208 (407 p)
Report Number(s): GRS-86 CONF-9105244--
ISBN: 3-923875-36-3
Document Type: Analytic of a Report; Conference Literature; Special Availability
Language: In English
Journal Announcement: EDB9208
Availability: Available from FIZ Karlsruhe
Subfile: ERA (Energy Research Abstracts); ETD (Energy Technology Data Exchange). DEN (Federal Republic of Germany [sent to DOE from])
US DOE Project/NonDOE Project: NP
Country of Origin: Germany, Federal Republic of
Country of Publication: Germany, Federal Republic of
Abstract: Regarding to the quantitative assessment of human errors needed in PSA's, the knowledge of all relevant influences on human reliability is important. Typical "performance shaping factors" are training, control room quality and design, stress, available time, personal redundancy, dependencies between different tasks and personal dependencies. There are several models for human reliability analysis (HRA) which have been used in PSA/PRA mainly concerning planned actions. Such HRA methods provide useful techniques to identify the potential for important human errors and to design complex systems considering human factors. (orig.).
Major Descriptors: *HUMAN FACTORS--RISK ASSESSMENT; *REACTOR OPERATORS--RELIABILITY
Descriptors: MAN-MACHINE SYSTEMS; NUCLEAR POWER PLANTS; PROBABILISTIC ESTIMATION; REACTOR SAFETY
Broader Terms: NUCLEAR FACILITIES; PERSONNEL; POWER PLANTS; SAFETY; THERMAL POWER PLANTS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety 210000--Nuclear Power Plants 220400--Nuclear Reactor Technology--Control Systems

35/5/21 (Item 3 from file: 103)
03179276 AIX-22-063698; EDB-91-106712
Title: Performance comparison of two methods for human reliability analysis
Author(s): E. A. Eisawy, and N. M. Shehata, (Nuclear Regulatory and Safety Centre, Cairo [Egypt]); A. A. Omar, and F. A. Mohammed, (Nuclear Research Centre, Cairo [Egypt])
Title: Balancing automation and human action in nuclear power plants
Original Series Title: Proceedings series
Corporate Source: International Atomic Energy Agency, Vienna (Austria) Nuclear Energy Agency, 75 - Paris (France) (Code: 3294000; 4796200)
Conference Title: IAEA symposium on balancing automation and human action in nuclear power plants
Conference Location: Munich (Germany) Conference Date: 9-13 Jul 1990

Publisher: Vienna (Austria) IAEA
Publication Date: 1991 p 491-494 (599 p)
Report Number(s): CONF-900710--
ISBN: 92-0-020091-5
Document Type: Analytic of a Book; Conference Literature
Language: In English
Journal Announcement: EDB9117
Subfile: ETD (Energy Technology Data Exchange). INIS (non-US Atomindex input AIX)
US DOE Project/NonDOE Project: NP
Country of Origin: Egypt
Country of Publication: International Atomic Energy Agency <IAEA>
Abstract: To minimize the human errors, three main items must be studied: (1) operator performance shaping factors; (2) the man-machine interface and (3) the man-man interface. This presentation concerns the second item and part of the third, i.e. the relationship between the NPP operation crew members, especially between the operator engineer and the assistant engineer and considers the technology for human error rate prediction and the detailed block diagram analysis. 2 refs, 3 figs.
Major Descriptors: *REACTOR OPERATORS--HUMAN FACTORS
Descriptors: ERRORS; FORECASTING; MAN-MACHINE SYSTEMS; MINIMIZATION; REACTOR CONTROL SYSTEMS
Broader Terms: CONTROL SYSTEMS; PERSONNEL
Subject Categories: 220400*--Nuclear Reactor Technology--Control Systems

35/5/22 (Item 4 from file: 103)
02898924 NOV-90-020295; INS-90-023177; EDB-90-116166; ERA-15-040814
Title: Human reliability impact on in-service inspection
Author(s): J. C. Spanner, Sr. (Pacific Northwest Lab., Richland, WA [USA])
Title: Proceedings of the 8th international conference on NDE in the nuclear industry
Author(s)/Editor(s): Stahl, D.
Conference Title: 8. international conference on NDE in the nuclear industry
Conference Location: Kissimmee, FL (USA) Conference Date: 17-19 Nov 1986
Publisher: Metals Park, OH (USA) American Society for Metals
Publication Date: 1986 p 89-96 (683 p)
Report Number(s): CONF-8611147--
Contract Number (DOE): AC06-76RL01830
Document Type: Analytic of a Book; Conference Literature
Language: In English
Journal Announcement: EDB9016
Availability: American Society for Metals, Metals Park, OH 44073 (USA)
Subfile: ERA (Energy Research Abstracts); ETD (Energy Technology Data Exchange); INS (US Atomindex input). NOV (DOE contractor)
US DOE Project/NonDOE Project: P
Country of Origin: United States
Country of Publication: United States
Abstract: This paper describes a study conducted to identify, characterize, and evaluate the human reliability aspects of ultrasonic testing/inservice inspection (UT/ISI). Recent measurements of UT/ISI system effectiveness have revealed wide variations in performance; suggesting that insufficient emphasis is being placed on the human

reliability aspects of nondestructive examination. It appears that NDE performance can be improved through application of the human factors principles relating to the task, training, procedure, environmental, and individual difference variables. These variables are collectively referred to as performance-shaping factors. A man-machine systems model was developed to describe the UT/ISI process using functional task descriptors. The relative operating characteristic (ROC) analysis method, which is derived from signal detection theory, offers unique attributes for analyzing NDT performance. The results of a limited human factors evaluation conducted in conjunction with a mini-round robin test are also described.
Major Descriptors: *NONDESTRUCTIVE TESTING--HUMAN FACTORS; *REACTOR COMPONENTS--NONDESTRUCTIVE TESTING
Descriptors: IN-SERVICE INSPECTION; MAN-MACHINE SYSTEMS; MEASURING INSTRUMENTS; REACTOR SAFETY
Broader Terms: INSPECTION; MATERIALS TESTING; SAFETY; TESTING
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
420500--Engineering--Materials Testing
INIS Subject Categories: E1700* -- Materials Testing

35/5/23 (Item 5 from file: 103)
02331206 AIX-20-042321; EDB-89-077000
Title: Quantification of human performance in nuclear tasks
Author(s): A. M. Metwally, F. A. Mohammed, and A. A. Omar
Affiliation: Alexandria Univ. (Egypt). Faculty of Engineering Atomic Energy Authority, Cairo (Egypt). Nuclear Regulatory and Safety Centre
Title: Nuclear power performance and safety. V.4.: Safety technology. Proceedings of an international conference held in Vienna, 28 September - 2 October 1987
Series/Collection Title: Proceedings series
Corporate Source: International Atomic Energy Agency, Vienna (Austria)
Conference Title: International conference on nuclear power performance and safety
Conference Location: Vienna, Austria Conference Date: 28 Sep 1987
Publisher: IAEA, Vienna, Austria
Publication Date: 1988 p v. 4
Report Number(s): CONF-8709263-
Document Type: Analytic of a Book; Conference literature
Language: English
Journal Announcement: ETD8900
Subfile: ETD (Energy Technology Data Exchange). INIS (non-US Atomindex input AIX)
Country of Origin: International Atomic Energy Agency <IAEA>
Country of Publication: International Atomic Energy Agency <IAEA>
Abstract: The paper discusses how performance shaping factors (PSFs) can be quantitatively assessed. PSFs are those factors that affect human reliability in situations such as power plant operation, maintenance and testing. The study suggests the classification of the PSFs into qualitative and quantitative groups. Multi-attribute utility theory is then used to represent the PSFs as utility functions which need to be optimized. The Simplex method is suggested for use in optimizing the utility functions expressing the PSFs. The quantitative group of PSFs is formulated in a general analytical form. A trial was made to find the optimum characterization of

some members in the quantitative group of PSFs and their effect on operator performance. (author). 6 refs, 2 figs, 1 tab.
Major Descriptors: *REACTOR OPERATORS--PERFORMANCE
Descriptors: HUMAN FACTORS; NUCLEAR POWER PLANTS; REACTOR SAFETY
Broader Terms: NUCLEAR FACILITIES; PERSONNEL; POWER PLANTS; SAFETY; THERMAL POWER PLANTS
Subject Categories: 210000*--Nuclear Power Plants
INIS Subject Categories: E3000*--Specific Fission Reactor Types & Their Associated Plants

35/5/24 (Item 6 from file: 103)
02249172 GBN-88-005320; EDB-88-191917
Title: Task analysis-linked approach for integrating the human factor in reliability assessments of nuclear power plants
Author(s): T. G. Ryan, G. E. Apostolakis, P. Kafka, G. Mancini, (eds.)
Affiliation: Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research
Title: Accident sequence modeling: human actions, system response, intelligent decision support. Papers presented at the international seminar on accident sequence modeling held in conjunction with the 9. international conference on structural mechanics in reactor technology in Munich, FRG, on 24-25 August 1987
Series/Collection Title: Reliability Engineering and System Safety. v. 22(1-4)
Conference Title: International post-SMIRT seminar on accident sequence modelling: human actions, system response, intelligent decision aids
Conference Location: Munich, F.R. Germany Conference Date: 24 Aug 1987
Publisher: Elsevier Applied Science,London, GB
Publication Date: 1988 p 219-234
Report Number(s): CONF-870818-
Document Type: Analytic of a Book; Conference literature
Language: English
Journal Announcement: ETD8812
Subfile: ETD (Energy Technology Data Exchange). GBN (United Kingdom [sent to DOE from])
Country of Origin: United States
Country of Publication: United Kingdom
Abstract: This paper describes an emerging Task Analysis-Linked Evaluation Technique (TALENT) for assessing the contributions of human error to nuclear power plant systems unreliability and risk. Techniques such as TALENT are emerging as a recognition that human error is a primary contributor to plant safety, however, it has been a peripheral consideration to data in plant reliability evaluations. TALENT also recognizes that involvement of persons with behavioral science expertise is required to support plant reliability and risk analyses. A number of state-of-knowledge human reliability analysis tools are also discussed which support the TALENT process. The core of TALENT is comprised of task, timeline and interface analysis data which provide the technology base for event and fault tree development, serve as criteria for selecting and evaluating performance shaping factors, and which provide a basis for auditing TALENT results. Finally, programs and case studies used to refine the TALENT process are described along with future research needs in the area.

Major Descriptors: *NUCLEAR POWER PLANTS--RELIABILITY; *REACTOR SAFETY--HUMAN FACTORS; *SYSTEM FAILURE ANALYSIS--HUMAN FACTORS
Descriptors: COMPUTER CODES; ERRORS; EVALUATION; RISK ASSESSMENT
Broader Terms: NUCLEAR FACILITIES; POWER PLANTS; SAFETY; SYSTEMS ANALYSIS; THERMAL POWER PLANTS
Subject Categories: 220900*--Nuclear Reactor Technolog--Reactor Safety
220400--Nuclear Reactor Technology--Control Systems
INIS Subject Categories: E2200*--Reactor Components & Accessories
E2400--Reactor Control Systems

35/5/25 (Item 7 from file: 103)
02178802 INS-88-023260; EDB-88-121537
Title: Evaluation of operational safety at Babcock and Wilcox plants
Author(s): D. J. Hanson, H. S. Blackman, P. D. Wheatley, O. R. Meyer, W. R. Nelson, C. B. Davis, and A. J. Weiss, (comp.)
Affiliation: EG and G Idaho, Inc., Idaho Falls (USA)
Title: Proceedings of the US Nuclear Regulatory Commission fifteenth water reactor safety information meeting: Volume 4, Separate effects/experiments and analyses, Source term uncertainty analysis, Integral systems testing, 2D/3D research
Corporate Source: Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research Brookhaven National Lab., Upton, NY (USA)
Conference Title: 15. water reactor safety information meeting
Conference Location: Gaithersburg, MD, USA Conference Date: 26 Oct 1987
Publication Date: Feb 1988 p 481-506
Report Number(s): NUREG/CP-0091-Vol.4; CONF-8710111-Vol.4
Order Number: TI88007181
Document Type: Analytic of a Report; Conference literature
Language: English
Journal Announcement: ERA8807
Availability: NTIS, PC A99/MF A01 - GPO.
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input). JMT (DOE contractor)
Country of Origin: United States
Country of Publication: United States
Abstract: A methodology was developed to assess the operational performance of nuclear power plants through an integration of thermal-hydraulic, human factors, and risk analysis techniques. This methodology was applied to evaluate the effectiveness of plant systems and operator actions in lessening the severity of selected transients for Babcock and Wilcox (B and W) plants. Comparisons were also performed to assess differences in operational performance capabilities and limitations between selected Combustion Engineering, Westinghouse, and B and W plants. For the selected B and W plant, the results show the probability that an operating crew would not respond within the times available (the non-response probability) is estimated to be relatively small for the three transients studied. Results also show a strong correlation between operator performance and the influence of eight performance shaping factors (PSFs). Comparison of results from the Oconee, Calvert Cliffs, and H. B. Robinson plants indicate that the likelihood operators would take the proper actions to return Oconee to

a safe stable state is not judged to be significantly different than the likelihood operators at Calvert Cliffs or H. B. Robinson would recover their plants for the transients investigated. The validity of this conclusion depends on the assumption that the performance shaping factors at all three plants are essentially equivalent. Recommendations are made that influence performance shaping factors positively and thereby influence operator performance positively.
Major Descriptors: *BW STANDARD REACTOR--OPERATION; *BW STANDARD REACTOR--REACTOR SAFETY
Descriptors: AUXILIARY WATER SYSTEMS; CALVERT CLIFFS-1 REACTOR; CE STANDARD REACTOR; COMPARATIVE EVALUATIONS; ECCS; EVALUATION; FAILURES; HUMAN FACTORS; HYDRAULICS; LOSS OF COOLANT; NUCLEAR POWER PLANTS; OCONEE-1 REACTOR; PERFORMANCE; PERSONNEL; RECOMMENDATIONS; RISK ASSESSMENT; ROBINSON-2 REACTOR; STEAM GENERATORS; THERMODYNAMICS; TRANSIENTS; WESTINGHOUSE STANDARD REACTOR
Broader Terms: ACCIDENTS; AUXILIARY SYSTEMS; BOILERS; ENGINEERED SAFETY SYSTEMS; ENRICHED URANIUM REACTORS; FLUID MECHANICS; MECHANICS; NUCLEAR FACILITIES; POWER PLANTS; POWER REACTORS; PWR TYPE REACTORS; REACTOR ACCIDENTS; REACTOR PROTECTION SYSTEMS; REACTORS; SAFETY; THERMAL POWER PLANTS; VAPOR GENERATORS; WATER COOLED REACTORS; WATER MODERATED REACTORS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
210200--Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled
INIS Subject Categories: C5240*--Environmental safety of nuclear installations
E3200--Power Reactors, Nonbreeding, Light Water Moderated, Non-Boiling Water Cooled (PWR, etc types)

35/5/26 (Item 8 from file: 103)
02050042 DEN-87-015034; ERA-13-003448; EDB-87-178001
Author(s): V. Behrendt, T. Krehbiehl, H. D. Hartfiel, H. R. Mannhaupt, W. Preuss, D. B. Thomas
Title: Optimizing the human engineering design of control panels in nuclear power plant control rooms
Original Title: Entwicklung einer Checkliste mit zugehoerigem Katalog von Empfehlungen zur ergonomisch optimierten Belegung von Kraftwerkswarten
Corporate Source: Bundesministerium fuer Umwelt, Naturschutz und Reaktorsicherheit, Bonn (Germany, F.R.) Dornier-System G.m.b.H., Friedrichshafen (Germany, F.R.) Kraftwerk Union A.G., Muelheim an der Ruhr (Germany, F.R.) Technischer Ueberwachungs-Verein Bayern e.V., Muenchen (Germany, F.R.). Inst. fuer Biomedizin und Ergonomie Technischer Ueberwachungs-Verein Rheinland e.V., Koeln (Germany, F.R.). Inst. fuer Unfallforschung
Publication Date: Dec 1986 p 341
Report Number(s): BMU-1987-151
Document Type: Report
Language: German
Journal Announcement: EDB8711

Availability: GRM Werbeberatung - Werbemittlung - PR, Eggenstein-Leopoldshafen, Germany, F.R.
Subfile: ERA (Energy Research Abstracts). DEN (Federal Republic of Germany [sent to DOE from])
Country of Origin: Germany, Federal Republic of
Country of Publication: Germany, Federal Republic of
Abstract: The study contains two parts. In the first part an analytical procedure is developed to logically and reproducibly subdivide the control room personnel tasks resulting in a list of the elements (operations) and the structure (operations scheme) of a task. The second part lists together all knowledge of and influences on human engineering which are known at this time and which should be taken into account in designing control rooms. The content of this catalogue can best be used and presented by using a personal computer. Two fundamental different ways are possible to use the catalogue. Designing new control rooms or new parts of control rooms the results of the task analysis which should be done first, should guide the search in the catalogue to find the right human engineering factors. For assessing existing control room panels the performance shaping factors which are establishing the table of content, permit a quick access to the catalogue. Both the specific procedure of the task analysis and the different ways of access to the catalogue of human engineering knowledge for designing nuclear power plant control rooms have been proven by experienced system engineers and safety experts. The results are presented. They have been considered in this version of the study.
Major Descriptors: *CONTROL ROOMS--HUMAN FACTORS ENGINEERING; *NUCLEAR POWER PLANTS--HUMAN FACTORS ENGINEERING
Descriptors: BIOLOGICAL STRESS; CATALOGS; COMMUNICATIONS; COMPUTER GRAPHICS; DISPLAY DEVICES; DOCUMENTATION; HUMAN FACTORS; INFORMATION; MAN-MACHINE SYSTEMS; REACTOR ACCIDENTS; REACTOR OPERATORS; REACTOR SAFETY; SIGNALS
Broader Terms: ACCIDENTS; DOCUMENT TYPES; ENGINEERING; NUCLEAR FACILITIES; PERSONNEL; POWER PLANTS; SAFETY; THERMAL POWER PLANTS
Subject Categories: 220400*--Nuclear Reactor Technology--Control Systems

35/5/27 (Item 9 from file: 103)
01959725 NOV-87-056719; EDB-87-087390
Title: Estimation of performance shaping factors for overtime and shift length using expert judgment based on related assessments
Author(s): S. C. Vickroy
Affiliation: Pacific Northwest Lab., P.O. Box 999, Richland, WA 99352
Title: Proceedings of the international topical meeting on advances in human factors in nuclear power systems
Conference Title: International topical meeting on advances in human factors in nuclear power systems
Conference Location: Knoxville, TN, USA Conference Date: 21 Apr 1986
Publisher: American Nuclear Society,La Grange Park, IL
Publication Date: 1986 p 135-142
Report Number(s): CONF-860415-
Document Type: Analytic of a Book; Conference literature
Language: English

Journal Announcement: ERA8706
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input). NOV (DOE contractor)
Country of Origin: United States
Country of Publication: United States
Abstract: This paper presents the results of a study to estimate human performance and error rate under several amounts of overtime and different shifts without the use of human subjects. Ten chronobiology, fatigue, and shift scheduling experts were administered a questionnaire to rate the effects that several shifts and overtime amounts might have on the performance of individuals working under their constraints. The data from the ratings were transformed to generate performance shaping factors used for sensitivity analyses on three previously published probabilistic risk assessments. This procedure was performed to determine the effect that different shift schedules and amounts of overtime would have on overall plant performance. The results of the analysis suggest that the risk due to human errors caused by the shift scheduling and overtime could increase the risk of accidents at a nuclear power plant caused by humans by up to a factor of five. This could increase the chance for an accident at a nuclear power plant by a factor of about three.
Major Descriptors: *REACTOR OPERATION--HUMAN FACTORS; *REACTOR OPERATORS--BIOLOGICAL FATIGUE; *REACTOR OPERATORS--PERFORMANCE; *REACTOR OPERATORS--WORKING CONDITIONS
Descriptors: DATA ANALYSIS; ERRORS; PROBABILITY; REACTOR ACCIDENTS; REACTOR SAFETY; RISK ASSESSMENT; SCHEDULES
Broader Terms: ACCIDENTS; OPERATION; PERSONNEL; SAFETY
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: C5240*--Environmental safety of nuclear installations

35/5/28 (Item 10 from file: 103)
01959723 NOV-87-056716; EDB-87-087388
Title: A shortened version of the THERP/Handbook approach to human reliability analysis for probabilistic risk assessment
Author(s): A. D. Swain
Affiliation: Statistics, Computing, and Human Factors Div. 7223, Sandia National Labs., P.O. Box 5800, Albuquerque, NM 87185
Title: Proceedings of the international topical meeting on advances in human factors in nuclear power systems
Conference Title: International topical meeting on advances in human factors in nuclear power systems
Conference Location: Knoxville, TN, USA Conference Date: 21 Apr 1986
Publisher: American Nuclear Society, La Grange Park, IL
Publication Date: 1986 p 163-164
Report Number(s): CONF-860415-
Contract Number (DOE): AC04-76DP00789
Document Type: Analytic of a Book; Conference literature
Language: English
Journal Announcement: ERA8706
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input). NOV (DOE contractor)

Country of Origin: United States
Country of Publication: United States
Abstract: The approach to human reliability analysis (HRA) known as THERP/Handbook has been applied to several probabilistic risk assessments (PRAs) of nuclear power plants (NPPs) and other complex systems. The approach is based on a thorough task analysis of the man-machine interfaces, including the interactions among the people, involved in the operations being assessed. The idea is to assess fully the underlying performance shaping factors (PSFs) and dependence effects which result either in reliable or unreliable human performance.
Major Descriptors: *MAN-MACHINE SYSTEMS--RISK ASSESSMENT; *REACTOR OPERATION--MAN-MACHINE SYSTEMS; *REACTOR OPERATORS--ERRORS; *REACTOR OPERATORS--RELIABILITY; *REACTOR OPERATORS--RISK ASSESSMENT
Descriptors: COMPUTERIZED CONTROL SYSTEMS; CONTROL ROOMS; FAILURES; HUMAN FACTORS; PERFORMANCE; PROBABILITY; REACTOR ACCIDENTS; REACTOR SAFETY
Broader Terms: ACCIDENTS; CONTROL SYSTEMS; OPERATION; PERSONNEL; SAFETY
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
220400--Nuclear Reactor Technology--Control Systems
INIS Subject Categories: C5240*--Environmental safety of nuclear installations
E2400--Reactor Control Systems

35/5/29 (Item 11 from file: 103)
01793656 NOV-85-013703; EDB-86-117375
Title: The adequacy of human reliability data for addressing risk reduction issues at commercial nuclear power plants
Author(s): T. G. Ryan, J. N. O'Brien, C. M. Spettell, E. W. Hagen
Affiliation: Div. of Risk Analysis and Operations, U.S. Nuclear Regulatory Commission, Washington, DC 20555
Title: Conference record for 1985 IEEE third conference on human factors and nuclear safety
Conference Title: 3. IEEE conference on human factors and power plants
Conference Location: Monterey, CA, USA Conference Date: 23 Jun 1985
Publisher: IEEE Service Center,Piscataway, NJ
Publication Date: 1985 p 321-328
Report Number(s): CONF-8506100-
Document Type: Analytic of a Book; Conference literature
Language: English
Journal Announcement: ERA8607
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input). NOV (DOE contractor)
Country of Origin: United States
Country of Publication: United States
Abstract: This paper describes the results of an assessment of how well currently available Probabilistic Risk Assessment (PRA) data address a representative set of human risk issues of current concern to the U.S. Nuclear Regulatory Commission (NRC). A three-step process was used to make that assessment. First, all Human Reliability Analysis (HRA) data included in 19 PRAs were identified, collected, and

stored on a computer. For each HRA/PRA datum identified, a data record was compiled into which all descriptive information presented in the PRA was catalogued including, when available, the (1) personnel, (2) actions, (3) performance shaping factors (PSFs), (4) situation, and (5) systems involved. This resulted in the collection of 1,976 individual HRA/PRA data records. Only 193 of these data records were complete with respect to all five types of descriptive information. Second, a list of human risk "working level issues" of concern to NRC was compiled. This was done by reviewing (1) Generic Safety Issues, (2) NRC planning documents, and (3) conducting interviews with cognizant NRC staff. This resulted in a list of 175 working level issues which reflect the data needed by NRC to address the human performance aspects of the Generic Safety Issues. This list was then analyzed using a method which identified data needed in terms of (1) personnel, (2) actions, (3) PSFs, (4) situations, and (5) systems. Using all reasonable combinations of these five information categories a total of 30,292 individual data needs were identified. Finally, the HRA/PRA data which were collected from 19 PRAs were compared to the data needs to access the extent to which currently available PRA data are useful in addressing human risk issues of concern to NRC. Less than 1% of the data needs were determined to be addressed by currently available PRA data.
Major Descriptors: *NUCLEAR POWER PLANTS--REACTOR SAFETY; *NUCLEAR POWER PLANTS--RISK ASSESSMENT; *REACTOR OPERATORS--RELIABILITY
Descriptors: DATA ACQUISITION; DATA BASE MANAGEMENT; DOCUMENTATION; HUMAN FACTORS; INFORMATION NEEDS; PERFORMANCE; POWER REACTORS; PROBABILITY; US NRC
Broader Terms: MANAGEMENT; NATIONAL ORGANIZATIONS; NUCLEAR FACILITIES; PERSONNEL; POWER PLANTS; REACTORS; SAFETY; THERMAL POWER PLANTS; US ORGANIZATIONS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: E3000*--Specific Fission Reactor Types & Their Associated Plants

35/5/30 (Item 12 from file: 103)
01748495 ERA-11-025613; EDB-86-072184
Author(s): J. C. Spanner, R. V. Badalamente, W. L. Rankin, T. J. Triggs
Title: Human reliability impact on inservice inspection. Phase 1, summary report. Volume 1
Corporate Source: Pacific Northwest Lab., Richland, WA (USA) Battelle Human Affairs Research Center, Seattle, WA (USA)
Publication Date: Mar 1986 p 113
Report Number(s): NUREG/CR-4436-Vol.1; PNL-5641-Vol.1; BHARC-400/85/016-Vol.1
Order Number: TI86008834
Contract Number (DOE): AC06-76RL01830
Document Type: Report
Language: English
Journal Announcement: INS8604
Availability: NTIS, PC A06/MF A01 - GPO.
Subfile: INS (US Atomindex input); ERA (Energy Research Abstracts). TIC (Technical Information Center)

Country of Origin: United States
Country of Publication: United States
Abstract: This report documents a feasibility study conducted to identify, characterize, and evaluate the human reliability aspects of ultrasonic testing/inservice inspection (UT/ISI). During this study, the following four inter-dependent tasks were completed: (1) perform a literature survey to identify significant human performance factors and develop a better measure of performance for the UT/ISI process, (2) develop task element descriptions for a typical UT/ISI process, (3) prepare a test plan to conduct a human performance evaluation in conjunction with a mini-round robin study, and (4) prepare a project plant for conducting the needed follow-on work identified during the feasibility study. This report includes an assessment of UT applications in the nuclear industry, emphasizing the UT/ISI system (personnel, equipment, and procedures). A man-machine systems model is used to describe the UT/ISI process, and the Relative Operating Characteristic (ROC) analysis approach for analyzing NDT performance is discussed. The five basic performance-shaping factors (variables) are evaluated with respect to potential impact on UT/ISI performance. Conclusions are drawn based on this limited scope study, and recommendations are made for needed follow-on work toward improving UT/ISI reliability.
Major Descriptors: *IN-SERVICE INSPECTION--HUMAN FACTORS; *NUCLEAR FACILITIES--IN-SERVICE INSPECTION; *NUCLEAR FACILITIES--ULTRASONIC TESTING; *ULTRASONIC TESTING--HUMAN FACTORS
Descriptors: EVALUATION; PERFORMANCE; PERSONNEL; REACTOR COMPONENTS; RELIABILITY
Broader Terms: ACOUSTIC TESTING; INSPECTION; MATERIALS TESTING; NONDESTRUCTIVE TESTING; TESTING
Subject Categories: 210700*--Nuclear Power Plants--Regulation & Licensing
420500--Engineering--Materials Testing
INIS Subject Categories: F2200*--Nuclear Law--Nuclear Installations
E1700--Materials Testing

35/5/31 (Item 13 from file: 103)
01667785 AIX-16-075241; EDB-85-174566
Title: Assessment of human error rates using operational experience
Author(s): G. Apostolakis, (California Univ., Los Angeles (USA). School of Engineering and Applied Science)
Source: Reliab. Eng. (United Kingdom) v 12:2. Coden: RLEND
Publication Date: 1985 p 93-105
Document Type: Journal Article
Language: English
Journal Announcement: EDB8510
Country of Origin: United States
Abstract: The distributions of dynamic human error rates in nuclear plant risk assessments are assessed by comparing the errors with a reference error, namely, that "the operators fail to stabilize high-pressure injection." The comparison is achieved by considering as principal performance shaping factors the difficulty in diagnosis and the stress level on the operators. The distribution of the rate of the reference event is derived using operational experience and Bayesian methods.

Major Descriptors: *NUCLEAR POWER PLANTS--HUMAN FACTORS; *REACTOR OPERATORS--ERRORS
Descriptors: BIOLOGICAL STRESS; HIGH PRESSURE COOLANT INJECTION; MAN-MACHINE SYSTEMS; PERFORMANCE; PROBABILITY; REACTOR OPERATION; RISK ASSESSMENT; STATISTICS
Broader Terms: ECCS; ENGINEERED SAFETY SYSTEMS; MATHEMATICS; NUCLEAR FACILITIES; OPERATION; PERSONNEL; POWER PLANTS; REACTOR PROTECTION SYSTEMS; THERMAL POWER PLANTS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: E2400*--Reactor Control Systems

35/5/32 (Item 14 from file: 103)
01640539 EDB-85-147317
Author(s): A. N. Beare, M. D. Donovan, D. L. Lassiter, L. H. Gray
Title: Effects of supervisor experience and assistance of a Shift Technical Advisor (STA) on crew performance in control room simulators
Corporate Source: Oak Ridge National Lab., TN (USA)
Publication Date: Sep 1985 p 197
Report Number(s): NUREG/CR-4280; ORNL/TM-9660
Order Number: TI85017413
Contract Number (DOE): AC05-84OR21400
Document Type: Report
Language: English
Journal Announcement: ERA8510
Availability: NTIS, PC A09/MF A01 - GPO.
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input).
Country of Origin: United States
Country of Publication: United States
Abstract: This report describes the second experiment in a Nuclear Regulatory Commission-sponsored program of training simulator experiments to evaluate the effects of selected performance shaping factors on the performance of nuclear power plant control room operators. The factors investigated were the experience level of the Senior Reactor Operator (SRO) in the supervisor's role and the presence of a Shift Technical Advisor (STA) to assist the operating crew. The experiment was conducted in the plant-referenced training simulator for a 1100 MWe pressurized water reactor (PWR) plant. Data were collected from 20 three-man crews of licensed operators. The crews were split into "high" and "low" experience groups on the basis of the supervisor's years of experience as an SRO. One half of the high- and low-SRO experience groups were assisted by an STA. No significant differences in overall performance were found between groups led by "high" and "low" experience supervisors. The presence of the STA had no effect on overall team performance. These results were identical to the results of a similar experiment performed with BWR crews in 1983.
Major Descriptors: *PWR TYPE REACTORS--REACTOR OPERATORS; *REACTOR OPERATORS--PERFORMANCE

Descriptors: CONTROL ROOMS; DISPLAY DEVICES; HUMAN FACTORS; REACTOR ACCIDENTS; REACTOR SAFETY; REACTOR SIMULATORS
Broader Terms: ACCIDENTS; ANALOG SYSTEMS; FUNCTIONAL MODELS; PERSONNEL; REACTORS; SAFETY; SIMULATORS; WATER COOLED REACTORS; WATER MODERATED REACTORS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
210200--Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled
INIS Subject Categories: E3000*--Specific Fission Reactor Types & Their Associated Plants
E3200--Power Reactors, Nonbreeding, Light Water Moderated, Non-Boiling Water Cooled (PWR, etc types)

35/5/33 (Item 15 from file: 103)
01624953 INS-85-018980; ERA-10-041892; EDB-85-131729
Title: SLIM-MAUD - a computer based technique for human reliability assessment
Author(s): D. E. Embrey
Title: International topical meeting on probabilistic safety methods and applications: proceedings. Volume 2. Sessions 9-16
Corporate Source: Electric Power Research Inst., Palo Alto, CA (USA)
Conference Title: International ANS/ENS topical meeting on probabilistic safety methods and applications
Conference Location: San Francisco, CA, USA Conference Date: 24 Feb 1985
Publication Date: Feb 1985 p 94.1-94.10
Report Number(s): EPRI-NP-3912-SR-Vol.2; CONF-850206-Vol.2
Order Number: TI85920542
Document Type: Analytic of a Report; Conference literature
Language: English
Journal Announcement: EDB8508
Availability: Research Reports Center, P.O. Box 50490, Palo Alto, CA 94303 $125.00.
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input).
Country of Origin: United States
Country of Publication: United States
Abstract: The Success Likelihood Index Methodology (SLIM) is a widely applicable technique which can be used to assess human error probabilities in both proceduralized and cognitive tasks (i.e. those involving decision making, problem solving, etc.). It assumes that expert assessors are able to evaluate the relative importance (or weights) of different factors called Performance Shaping Factors (PSFs), in determining the likelihood of error for the situations being assessed. Typical PSFs are the extent to which good procedures are available, operators are adequately trained, the man-machine interface is well designed, etc. If numerical ratings are made of the PSFs for the specific tasks being evaluated, these can be combined with the weights to give a numerical index, called the Success Likelihood Index (SLI). The SLI represents, in numerical form, the overall assessment of the experts of the likelihood of task success. The SLI can be subsequently transformed to a corresponding human error probability (HEP) estimate. The latest form of the SLIM technique is implemented using a microcomputer based system called MAUD (Multi-Attribute Utility Decomposition), the resulting technique being called SLIM-MAUD. A detailed description of the

SLIM-MAUD technique and case studies of applications are available. An illustrative example of the application of SLIM-MAUD in probabilistic risk assessment is given.
Major Descriptors: *NUCLEAR POWER PLANTS--REACTOR SAFETY; *REACTOR SAFETY--HUMAN FACTORS; *REACTOR SAFETY--RISK ASSESSMENT
Descriptors: DECISION MAKING; ERRORS; MAN-MACHINE SYSTEMS; PROBABILITY; RELIABILITY
Broader Terms: NUCLEAR FACILITIES; POWER PLANTS; SAFETY; THERMAL POWER PLANTS Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: E3000*--Specific Fission Reactor Types & Their Associated Plants

35/5/34 (Item 16 from file: 103)
01578194 INS-85-012850; EDB-85-084972
Title: SLIM-MAUD research program: development of a multi-attribute based methodology for human reliability evaluation
Author(s): E. A. Rosa, D. E. Embrey, P. Humphreys, S. A. Szawlewicz (comp.)
Affiliation: Brookhaven National Lab., Upton, NY
Title: Twelfth water reactor safety research information meeting: proceedings. Volume 6
Corporate Source: Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research
Conference Title: 12. water reactor safety research information meeting
Conference Location: Gaithersburg, MD, USA Conference Date: 23 Oct 1984
Publication Date: Jan 1985 p 54-60
Report Number(s): NUREG/CP-0058-Vol.6; CONF-8410142-Vol.6
Order Number: TI85900640
Document Type: Analytic of a Report; Conference literature
Language: English
Journal Announcement: ERA8506
Availability: NTIS, PC A22/MF A01 - GPO $9.50.
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input).
Country of Origin: United States
Country of Publication: United States
Abstract: The purpose of this paper is to describe the research program devoted to the development of SLIM-MAUD, a multi-attribute utility-based methodology for estimating human reliability in nuclear power plant. The SLIM-MAUD research program is one of two multiyear programs sponsored by the NRC to determine the applicability of expert judgment techniques to estimating human reliability. The basic rationale underlying SLIM (Success Likelihood Index Methodology) is that the likelihood of an error occurring in a particular situation depends on the combined effects of a relatively small set of performance shaping factors (PSFs). In brief, PSFs include both human traits and conditions of the work setting that are likely to influence an individual's performance. MAUD is a flexible, interactive computer-based system which can be used to implement SLIM.
Major Descriptors: *NUCLEAR POWER PLANTS--REACTOR SAFETY; *REACTOR SAFETY--HUMAN FACTORS

Descriptors: ERRORS; PERFORMANCE; PROBABILITY; RELIABILITY; RESEARCH PROGRAMS; TRAINING
Broader Terms: NUCLEAR FACILITIES; POWER PLANTS; SAFETY; THERMAL POWER PLANTS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: E3000*--Specific Fission Reactor Types & Their Associated Plants

35/5/35 (Item 17 from file: 103)
01352209 EDB-84-049888
Author(s): A. N. Beare, R. E. Dorris, C. R. Bovell, D. S. Crowe, E. J. Kozinsky
Title: Simulator-based study of human errors in nuclear power plant control room tasks
Corporate Source: General Physics Corp., Chattanooga, TN (USA)
Publication Date: Jan 1984 p 191
Report Number(s): NUREG/CR-3309; SAND-83-7095
Order Number: DE84008232
Contract Number (DOE): AC04-76DP00789
Note: Portions are illegible in microfiche products
Document Type: Report
Language: English
Journal Announcement: ERA8404
Availability: NTIS, PC A09/MF A01; 1.
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input); NTS (NTIS).
Country of Origin: United States
Country of Publication: United States
Abstract: The purposes of this study were to empirically establish error rates for control selection and operation during the performance of proceduralized tasks in nuclear power plant control rooms during simulated casualties, and to compare the observed error rates with the human error probabilities (HEPs) presented in NUREG/CR-1278. Data were collected at full-scale, high-fidelity simulators from licensed operators undergoing requalification training and students in the final stages of training prior to licensing. The data were collected using a Performance Measurement System (PMS), which records control manipulations and plant parameters. The basic HEPs in NUREG/CR-1278 were adjusted for the effects of selected performance shaping factors, such as stress and the improper use of procedures, as outlined in that document. The error rates obtained in this study were then compared with the adjusted HEPs, and were found to be largely in agreement.;
Major Descriptors: *BWR TYPE REACTORS--CONTROL ROOMS; *BWR TYPE REACTORS--REACTOR OPERATORS; *CONTROL ROOMS--HUMAN FACTORS; *NUCLEAR POWER PLANTS--CONTROL ROOMS; *NUCLEAR POWER PLANTS--REACTOR OPERATORS; *PWR TYPE REACTORS--CONTROL ROOMS; *PWR TYPE REACTORS--REACTOR OPERATORS; *REACTOR OPERATORS--PERFORMANCE
Descriptors: COMPARATIVE EVALUATIONS; ERRORS; REACTOR ACCIDENTS; REACTOR CONTROL SYSTEMS; REACTOR OPERATION; REACTOR SIMULATORS

Broader Terms: ACCIDENTS; ANALOG SYSTEMS; CONTROL SYSTEMS; FUNCTIONAL MODELS; NUCLEAR FACILITIES; OPERATION; PERSONNEL; POWER PLANTS; REACTORS; SIMULATORS; THERMAL POWER PLANTS; WATER COOLED REACTORS; WATER MODERATED REACTORS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety 210100--Power Reactors, Nonbreeding, Light-Water Moderated, Boiling Water Cooled 210200--Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled
INIS Subject Categories: E3000*--Specific Fission Reactor Types & Their Associated Plants E3100--Power Reactors, Nonbreeding, Light Water Moderated, Boiling Water Cooled (BWR, etc types) E3200--Power Reactors, Nonbreeding, Light Water Moderated, Non-Boiling Water Cooled (PWR, etc types)
35/5/36 (Item 18 from file: 103)
01352162 INS-84-006565; EDB-84-049841
Title: Human error analysis program
Author(s): W. J. Luckas, Jr., S. A. Szawlewicz, (comp.)
Affiliation: Brookhaven National Lab., Upton, NY
Title: Tenth water reactor safety research information meeting: proceedings. Volume 3
Corporate Source: Nuclear Regulatory Commission, Washington, DC (USA). Office of Nuclear Regulatory Research
Conference Title: 10. water reactor safety research information conference
Conference Location: Gaithersburg, MD, USA Conference Date: 12 Oct 1982
Publication Date: Jan 1983 p 52-54
Report Number(s): NUREG/CP-0041-Vol.3; CONF-821037-Vol.3
Order Number: DE83901307
Document Type: Analytic of a Report; Conference literature
Language: English
Journal Announcement: ERA8404
Availability: NTIS, PC A14/MF A01; 1 - GPO $8.50.
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input).
Country of Origin: United States
Country of Publication: United States
Abstract: The objective of this program has been to develop and apply realistic human performance data and models to help evaluate the human's role in nuclear power plant safety. To meet this objective, the major FY 82 effort was placed in several areas of investigation and accomplishment, namely: the further development of Human Error Rates; the use of Performance Shaping Factors and quantified expert judgement in the evaluation of human reliability - the Success Likelihood Index Method. The development of the Operator Action Tree/Time Reliability Correlation approach for post human decision errors. The publishing of the Conference Record for the 1981 Workshop on Human Factors and Nuclear Safety.;
Major Descriptors: *NUCLEAR POWER PLANTS--REACTOR SAFETY; *REACTOR SAFETY--HUMAN FACTORS
Descriptors: OPERATIONS RESEARCH

Broader Terms: NUCLEAR FACILITIES; POWER PLANTS; SAFETY; THERMAL POWER PLANTS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: E3000*--Specific Fission Reactor Types & Their Associated Plants

35/5/37 (Item 19 from file: 103)
01296392 EDB-83-196399
Author(s): A. M. Fullerton, E. Peelle, J. H. Reed, G. W. Morrison, S. J. Liebowitz
Title: Evaluation of the nuclear-power-plant operator-licensing examination. Final report
Corporate Source: Oak Ridge National Lab., TN (USA)
Publication Date: Oct 1983 p 166
Report Number(s): NUREG/CR-3458; ORNL/TM-8895
Order Number: DE84000210
Contract Number (DOE): W-7405-ENG-26
Note: Portions are illegible in microfiche products
Document Type: Report
Language: English
Journal Announcement: ERA8311
Availability: NTIS, PC A08/MF A01; 1 - GPO.
Subfile: ERA (Energy Research Abstracts); EPA (Energy Abstracts for Policy Analysis); NTS (NTIS); INS (US Atomindex input).
Country of Origin: United States
Country of Publication: United States
Abstract: The field work included interviews with operator licensing examiners, utility trainers, candidates, and plant management; interviews and discussions with professional; content analysis of the written portion of 24 control room operator examinations; observation of the conduct of examinations in plants; analysis of data obtained from NRC; and literature searches and reviews. The report includes chapters containing findings from a content analysis of 24 examinations, technical discussions of the concepts of validity and reliability, and the application of these concepts to the control room operator examination. Other chapters discuss the need to develop operator performance measures and the problems associated with this need including problems of influence of performance-shaping factors on control room operator performance. The last half of the report focuses on what could and should be done in the future. The report argues that any new examination must be based on a task analysis, most probably the INPO task analysis. It is also argued that attempts should be made to incorporate methods for measuring operators' problem solving ability in ill-defined situations. Further, it is pointed out that the NRC needs to clarify whether the licensing examination is to be a test of minimal competence or a mastery test, whether the examination system is to also serve the selection function, and whether separate licensing tests are needed for RO's and SRO's. The last chapter presents a model for a new licensing process.;
Major Descriptors: *NUCLEAR POWER PLANTS--REACTOR OPERATORS; *REACTOR OPERATORS--CERTIFICATION; *REACTOR OPERATORS--LICENSING
Descriptors: EVALUATION; US NRC

Broader Terms: NATIONAL ORGANIZATIONS; NUCLEAR FACILITIES; PERSONNEL; POWER PLANTS; THERMAL POWER PLANTS; US ORGANIZATIONS
Subject Categories: 210700*--Nuclear Power Plants--Regulation & Licensing
210801--Nuclear Power Plants--Economics--Construction & Operation--(-1987)
290600--Energy Planning & Policy--Nuclear Energy
INIS Subject Categories: F22*--Nuclear Law--Nuclear Installations
F11--Nuclear Power Economics

35/5/38 (Item 20 from file: 103)
01285151 INS-83-023408; EDB-83-185156
Author(s): A. M. Metwally
Title: Analysis and modeling of human performance in nuclear power plants
Corporate Source: Iowa State Univ. of Science and Technology, Ames (USA)
Publisher: Iowa State Univ., Ames, IA
Publication Date: 1982 p 282
Academic Degree: Thesis (Ph.D.)
Document Type: Dissertation
Language: English
Journal Announcement: EDB8309
Availability: University Microfilms Order No. 82-21,207.
Subfile: INS (US Atomindex input).
Country of Origin: United States
Country of Publication: United States
Abstract: This work investigates two important areas in human reliability engineering models for human performance analysis, and reliable data for these models. In the first area, the author addresses the two modeling techniques "THERP" and "SAINT" showing that the flexibility and nuclear relevance of the second give it the merit to be used in modeling and analyzing human tasks in complex man-machine systems such as nuclear systems. A case study is investigated and simulated by the "SAINT" to explore its dynamic capabilities. In the second area, the author evaluates all the available human data sources, develops a new description format for human related events with all the information matrices needed for human reliability analysis. A complete operations data bank for sixty-five commercial power plants in the U.S.A. over a period of ten years is constructed. Data analysis, with qualitative and quantitative evaluations using the information matrices provided in the operations data bank, is presented. Operator error probability computations are made for some operational tasks in selected nuclear engineered safety feature systems. Moreover, the assessment of the role of the performance shaping factors is discussed.
Major Descriptors: *HUMAN FACTORS--MATHEMATICAL MODELS; *NUCLEAR POWER PLANTS--HUMAN FACTORS ENGINEERING
Descriptors: PERFORMANCE TESTING; REACTOR OPERATORS; RELIABILITY
Broader Terms: ENGINEERING; NUCLEAR FACILITIES; PERSONNEL; POWER PLANTS; TESTING; THERMAL POWER PLANTS

Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
210801--Nuclear Power Plants--Economics--Construction & Operation--(-1987)
INIS Subject Categories: C52*--Radiation Hazards & Safety Evaluations of Nuclear Installations
F11--Nuclear Power Economics

35/5/39 (Item 21 from file: 103)
01249556 INS-83-019172; ERA-08-046454; EDB-83-149557
Title: Quantification of human performance using performance shaping factors
Author(s): D. E. Embrey, (Univ. of Aston, Birmingham, England); R. E. Hall
Title: Probabilistic risk assessment. Volume III
Conference Title: ANS/ENS topical meeting on probabilistic risk assessment
Conference Location: Port Chester, NY, USA Conference Date: 20 Sep 1981
Publisher: American Nuclear Society, Inc., La Grange Park, IL
Publication Date: 1982 p 1028-1035
Report Number(s): CONF-810905-
Document Type: Analytic of a Book; Conference literature
Language: English
Journal Announcement: EDB8307
Subfile: ERA (Energy Research Abstracts); INS (US Atomindex input).
Country of Origin: United Kingdom
Country of Publication: United States
Abstract: This paper considers the human reliability data needs for Probabilistic Risk Assessment, and concludes that some form of extrapolation will be needed to supplement the limited data resources currently available. A technique for quantifying expert subjective judgement is described, which can be used to systematically perform extrapolations. Some preliminary results from recent research in this area are presented.;
Major Descriptors: *RISK ASSESSMENT--HUMAN FACTORS
Descriptors: EXTRAPOLATION; PERFORMANCE; RELIABILITY
Broader Terms: NUMERICAL SOLUTION
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: C52*--Radiation Hazards & Safety Evaluations of Nuclear Installations

35/5/40 (Item 22 from file: 103)
01231936 ERA-08-041134; EDB-83-131984
Author(s): D. S. Crowe, A. N. Beare, E. J. Kozinsky, P. M. Haas
Title: Criteria for safety-related nuclear-power-plant operator actions: 1982 pressurized-water-reactor (PWR) simulator exercises
Corporate Source: General Physics Corp., Chattanooga, TN (USA) Oak Ridge National Lab., TN (USA)
Publication Date: Jun 1983 p 157
Report Number(s): NUREG/CR-3123; ORNL/TM-8626
Order Number: DE83014483
Contract Number (DOE): W-7405-ENG-26
Note: Portions are illegible in microfiche products
Document Type: Report
Language: English

Journal Announcement: NTS8307
Availability: NTIS, PC A08/MF A01; 1 - GPO.
Subfile: NTS (NTIS); INS (US Atomindex input); ERA (Energy Research Abstracts).
Country of Origin: United States
Country of Publication: United States
Abstract: The primary objective of the Safety-Related Operator Action (SROA) Program at Oak Ridge National Laboratory is to provide a data base to support development of criteria for safety-related actions by nuclear power plant operators. When compared to field data collected on similar events, a base of operator performance data developed from the simulator experiments can then be used to establish safety-related operator action design evaluation criteria, evaluate the effects of performance shaping factors, and support safety/risk assessment analyses. This report presents data obtained from refresher training exercises conducted in a pressurized water reactor (PWR) power plant control room simulator. The 14 exercises were performed by 24 teams of licensed operators from one utility, and operator performance was recorded by an automatic Performance Measurement System. Data tapes were analyzed to extract operator response times (RTs) and error rate information. Demographic and subjective data were collected by means of brief questionnaires and analyzed in an attempt to evaluate the effects of selected performance shaping factors on operator performance.;
Major Descriptors: *PWR TYPE REACTORS--REACTOR ACCIDENTS; *PWR TYPE REACTORS--REACTOR OPERATORS; *REACTOR ACCIDENTS--HUMAN FACTORS; *REACTOR OPERATORS--HUMAN FACTORS; *REACTOR OPERATORS--PERFORMANCE; *REACTOR OPERATORS--TRAINING
Descriptors: EDUCATION; REACTOR SAFETY; REACTOR SIMULATORS
Broader Terms: ACCIDENTS; ANALOG SYSTEMS; FUNCTIONAL MODELS; PERSONNEL; REACTORS; SAFETY; SIMULATORS; WATER COOLED REACTORS; WATER MODERATED REACTORS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
210200--Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled
INIS Subject Categories: C52*--Radiation Hazards & Safety Evaluations of Nuclear Installations
E32--Power Reactors, Nonbreeding, Light Water Moderated, Non-Boiling Water Cooled (PWR, etc types)

35/5/41 (Item 23 from file: 103)
01231861 ERA-08-041060; EDB-83-131909
Title: Impact of procedures on operator performance
Author(s): E. J. Kozinsky
Affiliation: General Physics Corp., Chattanooga, TN
Title: Proceedings of the international meeting on thermal nuclear reactor safety. Vol. 2 (PWR)
Corporate Source: American Nuclear Society, Chicago, IL
Conference Title: International meeting on thermal nuclear reactor safety (ANS topical meeting)
Conference Location: Chicago, IL, USA Conference Date: 29 Aug 1982
Publication Date: Feb 1983 p 1326-1333

Report Number(s): NUREG/CP-0027-Vol.2; CONF-820802-Vol.2
Order Number: DE83901494
Document Type: Analytic of a Report; Conference literature
Language: English
Journal Announcement: INS8307
Availability: NTIS, PC A99/MF A01; 1 - GPO $13.00.
Subfile: INS (US Atomindex input); ERA (Energy Research Abstracts).
Country of Origin: United States
Country of Publication: United States
Abstract: In our control room simulator research, procedures seem to be a powerful performance shaping factor effecting control room operator performance. Error probability is greatly increased by poor procedures. Narrative style procedures containing several actions cause omissions approaching 100% of later actions in a step. Listed steps which are inconsistent in format can be omitted more than 10% of the time. Wording is critical; a mismatch between procedure and control panel labeling can cause omission rates up to 33%. With procedures having such dramatic impact, the current emphasis on control panel revision and safety displays is misplaced. More risk reduction per dollar can be achieved, and more rapidly, by cleaning up the procedures.;
Major Descriptors: *CONSOLES--EFFICIENCY; *CONTROL ROOMS--CONSOLES; *NUCLEAR POWER PLANTS--CONTROL ROOMS; *NUCLEAR POWER PLANTS--REACTOR OPERATORS; *PWR TYPE REACTORS--CONTROL ROOMS; *PWR TYPE REACTORS--REACTOR OPERATORS; *PWR TYPE REACTORS--REACTOR SIMULATORS; *REACTOR OPERATORS--PERFORMANCE
Descriptors: REACTOR CONTROL SYSTEMS; REACTOR SAFETY
Broader Terms: ANALOG SYSTEMS; CONTROL SYSTEMS; FUNCTIONAL MODELS; NUCLEAR FACILITIES; PERSONNEL; POWER PLANTS; REACTORS; SAFETY; SIMULATORS; THERMAL POWER PLANTS; WATER COOLED REACTORS; WATER MODERATED REACTORS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
220400--Nuclear Reactor Technology--Control Systems
210200--Power Reactors, Nonbreeding, Light-Water Moderated, Nonboiling Water Cooled
INIS Subject Categories: C52*--Radiation Hazards & Safety Evaluations of Nuclear Installations
E24--Reactor Control Systems
E32--Power Reactors, Nonbreeding, Light Water Moderated, Non-Boiling Water Cooled (PWR, etc types)

35/5/42 (Item 24 from file: 103)
01175280 EDB-83-075314
Title: Human factor data in nuclear power plant application
Author(s): L. O. Lund
Affiliation: Lund Consult Inc, Mohegan Lake, NY, USA
Title: Technical papers - IEEE Power Engineering Society 1982 Winter Meeting
Conference Title: IEEE Power Engineering Society winter meeting
Conference Location: New York, NY, USA Conference Date: 30 Jan 1982
Publisher: IEEE, New York, NY

Publication Date: 1982 p 4p, Paper 82WM 11243
Report Number(s): CONF-820134-
Document Type: Analytic of a Book; Conference literature
Language: English
Journal Announcement: EDB8302
Country of Origin: United States
Country of Publication: United States
Abstract: Reliability modeling techniques have been developed for application to nuclear systems and are presently being considered by the Nuclear Regulatory Commission for licensing purposes. Three Mile Island demonstrated the need for the ability to now assess the human factor. This need is both qualitative and quantitative. Human behavior models need to be developed and tested; also human error rates need to be collected and analyzed. The paper discusses several ongoing efforts for developing these human performance models and proposed methods for human error rate data collection. This includes consideration of information to be found in the licensee event reports (LERs) as well as sources of human factor data from related operating nuclear plant records is mentioned and the use of human performance shaping factors in modeling and data collection process is discussed.;
Major Descriptors: *NUCLEAR POWER PLANTS--PROFESSIONAL PERSONNEL; *PROFESSIONAL PERSONNEL--BEHAVIOR; *REACTOR SAFETY--HUMAN FACTORS
Descriptors: FAILURE MODE ANALYSIS
Broader Terms: NUCLEAR FACILITIES; PERSONNEL; POWER PLANTS; SAFETY; SYSTEM FAILURE ANALYSIS; SYSTEMS ANALYSIS; THERMAL POWER PLANTS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
550100--Behavioral Biology

35/5/43 (Item 25 from file: 103)
01116140 EDB-83-016142
Title: Incorporating performance shaping factors into the assessment of human reliability
Author(s): E. Embrey
Affiliation: Univ of Aston-UK, Birmingham B4-7ET
Conference Title: ANS international conference
Conference Location: Washington, DC, USA Conference Date: 17 Nov 1980
Source: Trans. Am. Nucl. Soc. (United States) v 35. Coden: TANSA
Publication Date: 1980 p 162-163
Report Number(s): CONF-801107-
Document Type: Journal Article; Conference literature
Language: English
Journal Announcement: INS8208
Subfile: INS (US Atomindex input).
Country of Origin: United Kingdom
Abstract: None;
Major Descriptors: *NUCLEAR POWER PLANTS--PERSONNEL; *PERSONNEL--RELIABILITY
Descriptors: ERRORS; EVALUATION; HUMAN FACTORS ENGINEERING; PERFORMANCE TESTING; SAFETY; STRESSES

Broader Terms: ENGINEERING; NUCLEAR FACILITIES; POWER PLANTS; TESTING; THERMAL POWER PLANTS
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: C52*--Radiation Hazards & Safety Evaluations of Nuclear Installations

35/5/44 (Item 26 from file: 103)
01104578 ERA-08-002207; EDB-83-004578
Title: Remarks on the Assessment of Personnel Qualification in Nuclear Power Plants
Author(s): E. Bohr, F. R. Brigham
Title: Symposium on Personnel Organization and -Qualification in Construction and Operation of Nuclear Power Plants
Conference Title: Symposium on Personnel Organization and Qualification by Establishment and Operation of Nuclear Power Stations
Conference Location: Koeln, F.R. Germany Conference Date: 10 Jun 1980
Publication Date: Aug 1980 p 371-378
Report Number(s): GRS-17(8-80); CONF-8006131-
Order Number: DE81900391
Document Type: Analytic of a Report; Conference literature
Language: German
Journal Announcement: EDB8202
Availability: NTIS (US Sales Only), PC A19/MF A01.
Subfile: ERA (Energy Research Abstracts).
Country of Origin: Germany, Federal Republic of
Country of Publication: Germany, Federal Republic of
Abstract: The contribution of operator qualification to the efficiency and safety of nuclear power plants is discussed. The limitations of this contribution are demonstrated by a comparison with other performance shaping factors involving ergonomic, technical and organizational characteristics of the work situation. Work and task analyses are considered to be valid decision aids for determining the contents, objectives and procedures of operator qualification.;
Major Descriptors: *NUCLEAR POWER PLANTS--PERSONNEL; *PERSONNEL--EDUCATION
Descriptors: EFFICIENCY; REACTOR OPERATION; REACTOR SAFETY
Broader Terms: NUCLEAR FACILITIES; OPERATION; POWER PLANTS; SAFETY; THERMAL POWER PLANTS
Subject Categories: 210801*--Nuclear Power Plants--Economics--Construction & Operation--(-1987)

35/5/45 (Item 27 from file: 103)
00737369 INS-81-006035; EDB-81-045625
Title: Predicting and controlling variable performance shaping factors
Author(s): T. O. Sargent, R. B. Blum
Affiliation: ConServ, Hartford, CT
Conference Title: American Nuclear Society annual meeting
Conference Location: Las Vegas, NV, USA Conference Date: 8 Jun 1980
Source: Trans. Am. Nucl. Soc. (United States) v 34. Coden: TANSA
Publication Date: 1980 p 693-694

Report Number(s): CONF-800607-
Document Type: Journal Article; Conference literature
Language: English
Journal Announcement: EDB8104
Subfile: INS (US Atomindex input); TIC (Technical Information Center).
Country of Origin: United States
Abstract: None;
Major Descriptors: *NUCLEAR POWER--PUBLIC OPINION
Broader Terms: POWER
Subject Categories: 220900*--Nuclear Reactor Technology--Reactor Safety
INIS Subject Categories: C52*--Radiation Hazards & Safety Evaluations of Nuclear Installations

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