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LONG-TERM RESEARCH PLAN FOR HUMAN FACTORS AFFECTING SAFEGUARDS AT NUCLEAR POWER PLANTS

VOLUME I: SUMMARY AND USERS' GUIDE

John N. O'Brien and Anthony Fainberg

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ABSTRACT

This report presents a long-term research plan for addressing human factors which can adversely affect safeguards at nuclear power plants. It was developed in order to prioritize and propose research for NRC in regulating power plant safeguards.

In 1982, the Human Factors Society developed, under NRC contract, a long-term research plan for studying human factors in power plant operations. That plan, published in NUREG/CR-2833, specifically excluded from consideration fuel cycle, waste disposal, health physics, and plant security activities. The purpose of this report is to address human factors in plant security. This research effort did not address human factors associated NRC activities, such as the use of mandatory reporting systems, or areas of research outside of plant operation, such as probabilistic risk assessment (PRA). Instead, it focused on the performance of security activities by safeguards personnel at operating power plants. For the purposes of this research, the terms "safeguards" and "security" can be considered synonymous.

The first task was to identify and rank human factors affecting the quality of nuclear power plant safeguards in terms of their importance. The opinions of over 85 experts were solicited and 28 responses were received. These responses were rigorously analyzed to ascertain what human factors could be considered important to power plant safeguards. In addition, the Safeguards Summary Event List (NUREG-0525) was systematically analyzed for human factors influences. Also, relevant government and industry literature was reviewed. These data sources were then aggregated and an overall importance ranking of human factors issues was developed. This part of the research effort is fully documented and described in Chapter 2 of Volume II.

The second part of this effort involved determining the feasibility of conducting research in the areas found to be important to power plant safeguards. A determination of research feasibility was based on the practicality, usefulness, and acceptability of conducting research and using the results in a regulatory context. This part of the effort is fully documented in Chapter 3 of Volume II.

Research efforts addressing human factors in safeguards were then developed and prioritized according to the importance of human factors areas derived in the first part of the study and the feasibility of research determined in the second part. Research was also grouped to take advantage of common research approaches and data sources where appropriate. Chapter 4 of Volume II details the development of methodological groupings for optimizing resource use.

Four main program elements emerged from the analysis, namely (1) Training and Performance Evaluation, (2) Organizational Factors, (3) Man-Machine Interface, and (4) Trustworthiness and Reliability. Within each program element,

projects are proposed with results and information flowing between program elements where useful. An overall research plan was developed for a 4-year period and it would lead ultimately to regulatory activities including rule-making, regulatory guides, and technical bases for regulatory action. The entire plan is summarized in Volume I of this report.

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ACKNOWLEDGMENT

To acknowledge every individual who assisted in this project would be impossible because of the extensive participation of individuals from NRC, the nuclear industry, national laboratories, and contractor organizations. However, several individuals should be specifically acknowledged for their help. Kristina Z. Jamgochian, Phillip Ting, and Thomas G. Ryan of the NRC provided invaluable guidance and assistance in shaping the overall research approach and obtaining relevant information. We would also like to acknowledge the assistance of Jay B. Durst, John Mackie, R. J. Voyer, Donald Schurman, David Strohbar, the Atomic Industrial Forum, Jack W. Savage, Jennifer Gagnon, John Wreathal, and many scientists at Brookhaven National Laboratory all of whom significantly assisted.

1. INTRODUCTION

1.1 Purpose

The purpose of this report is to present a long-term research plan which addresses human factors affecting safeguards at nuclear power plants. In August of 1982 NRC published a long-term human factors research plan developed by the Human Factors Society under NRC contract.* That research plan specifically excluded from consideration fuel cycle, waste disposal, health physics, and plant security activities. The purpose of the plan contained in this report is to address plant security. For this report, which covers only the operation of nuclear power plants, the terms "security" and "safeguards" can be considered to be synonymous.

Brookhaven National Laboratory (BNL) was contracted by NRC to develop this plan according to a specific research sequence. First, the important issues in nuclear power plant safeguards were to be systematically identified and ranked. Second, the feasibility of researching those issues identified was to be assessed using practicality, usefulness, and acceptability as criteria. Third, research was to be grouped to take advantage of common research approaches and minimize resource requirements. Lastly, an integrated long-term research plan was to be developed.

This report is in two volumes. Volume I is a user's guide for, and summary of, the research plan to assist in understanding its technical basis and prepare statements of work for specific projects. Volume II presents the detailed analyses used to develop the research plan.

In Volume II, Chapter 1 is an introduction and Chapter 2 fully reviews the methods, data collected, and analyses leading to the ranking of human factors issues associated with safeguards according to their importance. The importance ranking effort is summarized in Section 2 of Volume I. Chapter 3 of Volume II fully describes how human factors issues were ranked in terms of the feasibility of research. In addition, research issues were grouped to minimize resources needed for studying them. Section 3 of Volume I summarizes that effort. Chapter 4 of Volume II is a review of research designs for studying human factors affecting safeguards which is also summarized in Section 2.3 of Volume I. Sections 4 and 5 of Volume I present the plan for NRC consideration.

1.2 Scope of Research

The focus of this research plan is on the performance of safeguards functions at nuclear power plants. Principal areas addressed are those associated with the quality of site security at operating, NRC-licensed power plants. These include personnel considerations (e.g., trustworthiness, reliability, training, etc.), organizational factors (e.g., staff interaction,

*C. O. Hopkins et al., "Critical Human Factors Issues in Nuclear Power Regulation and Recommended Comprehensive Human Factors Long-Range Plan," NUREG/CR--2833, August 1982.

attitude, etc.), response capabilities (e.g., format and wording of contingency plans, use of force, etc.), and use of security equipment (e.g., alarm station design, communications equipment, etc.). The functions and structure of NRC actions and personnel were not examined, nor were subjects such as NRC mandated reporting requirements, fuel cycle facility safeguards, and sabotage input for probabilistic risk assessment. These subjects should be fully examined in separate studies.

1.3 Human Factors in Safeguards

Since the accident at Three Mile Island, a great deal of attention has focused on how the inadequate performance of personnel can adversely affect the safety of plant operation and as a result, increase risk to the public. The response to this has been a large body of study on the performance of operational personnel at power plants and development of methods for better assessing, understanding, and improving their performance.

Previous research, principally conducted as part of an overall research effort called Probablistic Risk Assessment* (PRA), has revealed that human performance deficiencies can sometimes be dominant contributers to potentially significant nuclear power plant accidents. However, PRA research on human factors has been primarily aimed at the actions of operations personnel--mainly plant operators in the control room of the reactor. Relatively little research has focused on safeguards personnel. What human factors oriented safeguards research has been done has been generally conducted in an ad hoc manner dealing with isolated issues as they arose. Because of this, devel p-ment of a comprehensive, integrated research plan was viewed as necessary.

Safeguards at nuclear power plants are aimed at minimizing the potential for radiological sabotage, therefore minimizing risk. The acts of deterring, detecting, and defeating potential adversaries are aspects of the "defense-in-depth" concept of reactor safety developed by NRC for regulation of nuclear power plants. Defense-in-depth means requiring, as an overall regulatory philosophy, multiple obstacles against events that may compromise safety. As a result, more than one level of defense against potential accidents is always required. The general absence of significant sabotage events against nuclear power plants can be attributed to the deterrence aspect of safeguards in that potential adversaries have been deterred against assault of these well-protected facilities. To NRC's and industry's credit in this regard, there have been no reported acts of intrusion by dedicated outside adversaries aimed at radiological sabotage. However, industry and NRC have recognized the potential of knowledgeable insiders committing acts of sabotage as well as the potential for performance breakdowns if safeguards personnel are required to detect and defeat adversarial action. In other words, the deterrence function of nuclear power plant safeguards has proven to be substantial, but questions still exist concerning how to provide assurance that safeguards personnel can

*PRA involves the use of system reliability models to identify critical events in potential accidents and estimate probabilities of failure.

detect and defeat adversaries acting with or without the assistance of knowledgeable insiders if deterrence fails. The same lack of significant safeguard events that supports the conclusion that deterrence has worked well makes judgements about detect and defeat capabilities difficult to make with much certainty. A consideration in formulating this research plan was to develop means for assuring the adequacy of detect and defeat capabilities at NRC-licensed power plants through regulatory policies and actions.

This research plan represents an integrated, comprehensive research plan designed to emphasize important issues, consider the feasibility of alternative research approaches, make optimal use of results by factoring them into subsequent, related studies, and best allocate limited resources among issues. The results of the research efforts contained in this plan are specifically designed to support NRC efforts and needs. This will be done by recommending research program elements and related projects aimed at specific technical development, feasibility studies and procedures development.

1.4 Organization of this Document

Volume I of this report is organized as a user's guide to the human factors in nuclear power plant safeguards research plan. It documents the methods used to assess the importance and research feasibility of studying specific human factors issues associated with safeguards. Section 2 describes the method and results used to identify and rank human factors in terms of their importance to safeguards at nuclear power plants. Section 3 details the method and results used to establish the feasibility of research approaches which can be adopted to study how the human factors identified affect safeguards. At the end of Section 3, research approaches are grouped to form Program Elements. In Section 4, each Program Element is discussed and their interrelationships described. Section 5 contains the project descriptive statements which comprise the research projects in the research plan.

2. IDENTIFICATION AND RANKING OF HUMAN FACTORS ISSUES AFFECTING SAFEGUARDS*

The first part of the study leading to this research plan was aimed at identifying human factors issues affecting safeguards personnel and then rank them in order of importance. A comprehensive list of human factors issues which might affect safeguards performance was developed in consultation with NRC and a variety of safeguards and human factors professionals. All human factors issues which were believed to be relevant to safeguards and security at nuclear power plants were included in the initial list.

The human factors issues which affect plant operations have been well delineated in the study of reactor safety subsequent to the Three Mile Island accident. However, a similar consensus on what human factors affect the performance of safeguards at power plants was not found to exist at the initiation of this study. Instead, views of importance and approaches tended to vary somewhat according to personal views of safeguards and security.

In order to identify what human factors issues are important in the quality of safeguards at nuclear power plants, a consensus among professionals in safeguards and/or operational safety human factors research was sought. To accomodate bias among experts reported safeguards events at licensee plants, compiled in the Safeguards Summary Event List (SSEL, NUREG-0525), were examined for the importance of human factors in responding to actual safeguards events. A ranking of the same set of human factors issues the experts ranked was developed for reported events. Relevant literature was then reviewed and recommendations made for further research were ranked according to each human factors issue in terms of the strength and frequency of the recommendations. These rankings from three data sources were then integrated to arrive at a final ranking of human factors affecting safeguards according to their importance. The final ranking is shown in Table 2.1.

2.1 Consensus of Opinion Among Professionals

A means for collecting the opinions and views of a set of safeguards professionals and human factors experts was developed. A formal, scientific survey was ruled out because of time constraints and administrative requirements. In addition, it was recognized that a reliable set of respondents would include a broad variety of experts including safeguards professionals, human factors experts, and behavioral scientists. In order to effectively solicit expert opinions, a discussion paper which described safeguards at nuclear power plants and defined each human factor issue included on the original list was developed. A sample of 85 subjects was selected from attendance lists at safeguards professional meetings and human factors conferences, as well as from a list of authors who have performed research in these fields. A cover letter was attached asking relevent questions and the solicitations were mailed. (The discussion paper and cover letter are in Appendix B

*This analysis, including a comprehensive discussion and description of the method, data collected, and results, is contained in Volume II, Chapter 2.

Table 2.1 Final Importance Ranking.

Rank	1 Comments	2 X2	3 SSEL* Analysis	4 Literature Review	5 Weighted Total
Training	11	22	11	4	37
Trustworthiness	6	12	8	14	34
Format and Working of Contingency Plans	8	16	13	5	34
Communications Equipment	4	8	10	14	32
Human Reliability**	6	12	14	1	27
Attitude	8	16	6	5	27
CAS/SAS Design	6	12	7	4	23
Staff Coordination	6	12	6	3	21
Vigilance	3	6	10	5	21
Behavioral Observations	5	10	0	10	20
Organizational Communication	5	10	6	3	19
Shiftwork	3	6	1	11	18
Performance Evaluation**	7	14	3	0	17
Environmental Influence	3	6	6	4	16
Use of Force	4	8	1	5	14
Maintenance	4	8	0	5	13
Fitness for Duty	3	6	1	4	11
Nuisance and False Alarms**	2	4	0	7	11
Multiple-Man Rules	2	4	0	4	8

*Safeguards Summary Event List.
**Human factors not on the list before response.

of Volume II, Chapter 2. Twenty-eight responses were received and 23 subject to analysis. There were no follow-up calls and respondents were free to air their views to whatever extent they thought appropriate. Responses tended to be lenghty, detailed, and open.

Upon analysis, several more human factors, not previously on the list were added. These are indicated by asterisks on Table 2.1. Each human factors issue was "indexed" throughout each response and the perceived importance of each was derived by systematically examining the importance attached and frequency of discussion for each human factor. This was done by two independent reviewers and results combined to minimize rater bias. Each human factor received an overall weight and a ranking was developed. Column 1 on Table 2.1 lists the percent of total weight assigned from the responses for each human factors issue. (In addition, a topical analysis of all responses was conducted so that the specific comments on each human factors issue were described. It is contained on pages 2-9 to 2-19 of Volume II, Chapter 2).

2.2 Human Factors Analysis of the Safeguards Summary Event List (SSEL)

The SSEL (NUREG-0525) is a compilation of all safeguards events which are reported to NRC. Although the guidelines for what events must be reported have changed over time, many events of a diverse nature are listed and it represents a data source for attempting to make judgments about the importance of various human factors in power plant safeguards. While the SSEL cannot be considered a comprehensive data source, it should be considered along with others to provide diversified input.

In order to best conform the analysis of the SSEL with the analysis of the expert responses in the previous section, the same set of human factors issues were used. Specific criteria for the presence or absence of a human factor's impact on an event were developed and each intrusion event in the 5-1/2 year period from 1976 until June 1981 were analyzed. Intrusion events were chosen because they represent the most clear evidence of performance capabilities as opposed to events in the bomb-threats or transportation-related categories for example.

A weight was assigned for the presence of each human factor's impact in each event. Column 3 of Table 2.1 represents the findings of this analysis in terms of percent of total weight among all events analyzed.

Analysis of vandalism events was conducted, but only specific situational variables were examined. For instance, two of the situational variables considered were the potential or proof that knowledgeable insiders were involved and the situation that no fuel was on-site. Analysis showed that the potential involvement of insiders was considerable, but most events occurred at sites where fuel was not yet present (i.e., plants under construction). More recent additions to the SSEL have shown an increase in vandalism events so a potential trend toward more acts of vandalism may be occurring. This analysis of the vandalism events in the SSEL was not used in the importance ranking, but rather to assist in formulating the final research plan.

2.3 Review of Relevant Literature

There have been significant studies of human factors affecting safeguards and security done by the industry and government. However, a comprehensive review has not been located. Instead, human factors problems have tended to be addressed in the security context when automated compensatory measures were not possible or practical. For instance, much study has focussed on the problem posed by knowledgeable insiders sabotaging the plant. However, the problem of concealed weapons detection is effectively handled by using a magnetometer (metal detector) so relatively little attention to is paid to thwarting the problems posed by the use of concealed weapons beyond their detection. This is possible because of the availability of automated search techniques. A full complement of automated devices to assure trustworthiness does not exist so that human factors research in that area is being undertaken.

A literature search was conducted by two independent teams with somewhat different objectives. One team comprised of BNL personnel examined literature generated by government, government contractors, and industry. The primary goal of this review, besides providing an understanding of the state-of-knowledge in the field, was to compile the recommendations of the authors for further research. It was decided that these authors' recommendations provide an additional indicator of what research should be done to support an understanding of human factors in safeguards. Using the same set of human factors issues as used in analysis of the expert responses and SSEL research, recommendations were screened and weights assigned to each human factor in each piece of literature. Column 4 in Table 2.1 contains the weights for each human factors issue for the analysis of literature. Pages 2-31 to 2-41 of Volume II describe this search in detail.

The second team was composed of a sociologist, a psychologist, and an information specialist. Each had an understanding of nuclear power plant safeguards from previous research and was active in their particular research field. They set out to search the open and academic literature for studies that would be of use in performing research in these human factors in safeguards and to develop optimal research designs for studying important human factors issues. Literature was collected from an extensive set of computerized bibliographic data bases in the behavioral sciences, management, and private security. References and authors' other works in relevant literature were also examined. Optimal research designs are also recommended. This literature search is documented in Volume II, Chapter 4.

2.4 Aggregate Ranking by Importance

Many approaches to combining the results of these three data sources, expert responses, the SSEL, and the relevent literature, could be undertaken. However, overly rigorous analysis of the data shown in Table 2.1 would probably tend to obfuscate the results which are judgmental in nature. Instead, it was determined that expert response represented the best source of data for judgments because they were directly solicited from experts familiar with safeguards and human factors. However, those judgments could be corroborated and verified by using reported events and relevant literature. As a result, expert responses were weighted by a factor of two and the SSEL data and analysis of literature by one. Column 2 in Table 2.1 represents the weighted value given to expert responses and column 5 the resulting over all weights in terms of importance.

Training was determined to be the most important human factors issue in nuclear power plant safeguards followed by the issues of trustworthiness, format, and wording of contingency plans, communications equipment, human reliability, attitude, and alarm station design. A full ranking is given in Table 2.1.

3. EXAMINATION OF RESEARCH FEASIBILITY AND GROUPINGS*

While a particular type of research may be desirable because it involves an important human factors issue in safeguards performance, it is necessary to assess the practicality, usefulness, and acceptability of obtaining and using the results. This is necessary because of the constraints imposed by limited research resources for these studies. For instance, if certain types of research are overly expensive or results will be difficult to use in the regulation of safeguards, they are defined as less feasible than other research.

In order to determine the feasibility of researching these human factors a systematic method was developed. It is described and discussed in detail in Volume II, Chapter 3. To conform to the general method of this study, the same list of human factors issues as developed in Section 2 of this report was used and each examined separately. While this approach ignores many potentially useful ways of combining research, it does order the same set of human factors in terms of research feasibility to facilitate direct comparison. (Research is grouped later in this section to form Program Elements.)

3.1 Method for Determining Feasibility

The feasibility of research is dictated by the practicality, usefulness, and acceptability of conducting studies and using the results. In order to systematically examine these issues, each human factors issue was reviewed in terms of work done to date and the state-of-affairs in present regulations regulatory guidance, and licensee practices. A background statement on each human factors issue was developed to detail questions relevant to further research and regulatory actions.

Potential research approaches were then developed for each human factors issue along with graded judgments concerning the practicality, usefulness, and acceptability of each research approach. Table 3.1 contains the factors and criteria used to assess the feasibility of research for each human factor considered. The resulting ranking of human factors and research approaches is shown in Table 3.2. It must be emphasized that the judgments made concerning the valves in Table 3.2 were based on analysis and reason. As a result, this ranking is an "open judgment" process and not a rigorous empirical analysis.

3.2 Research Approaches

As can be seen in Table 3.1, the research approaches considered were experimental, data analysis, extrapolation, and further research formulation.

An experimental approach involves the use of a means for collecting and analyzing primary (new) data. The aim of an experiment is to model the human factor of interest in a controlled manner and collect data either through

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*This analysis, including a comprehensive discussion and description of the method, data collected, and results, is contained in Volume II, Chapter 3.

Table 3.1 Feasibility Index Measures.

Research Approaches:	A - Experimental B - Data analysis C - Extrapolation D - Further research formulation
Practicality:	
Cost	3 - 0-$75,000 2 - $75,000-200,000 1 - Over $200,000
Time	3 - 1/2 year to 1 year 2 - 1 to 2 years 1 - More than 2 years
Data availability	3 - Easily available or already obtained 2 - Obtainable but must be collected 1 - Not easily available
Equipment availability	3 - Easily available or not needed 2 - Significant procurement necessary 1 - Not easily available
Usefulness:	
Regulatory needs	3 - Currently needed 2 - Potentially useful 1 - No current regulatory need
Risk reduction	3 - Probable risk reduction 2 - Possible risk reduction 1 - Negligible risk reduction
Acceptability:	
Industry	3 - Requested or desired by industry 2 - Tacit acceptance by industry 1 - Opposition by industry

Table 3.2 Research Feasibility Analysis and Ranking.

Rank	Human Factor and Approach	1 Cost	2 Time	3 Data	4 Equipment	5 Need	6 Risk	7 Accept.	8 Total
1	Trustworthiness - D	3	3	3	3	3	2	3	20
1	Attitude - D	3	3	3	3	3	3	2	20
1	Contingency Plans - D	3	2	3	3	3	3	3	20
1	Use of Force - A	3	3	3	3	3	3	2	20
1	Performance Eval. - C	3	3	3	3	3	2	3	20
6	Staff Coordination - A	3	3	3	3	3	2	2	19
6	Staff Coordination - B	3	3	3	3	2	3	2	19
6	Performance of Eval. - B	3	3	3	3	3	2	2	19
6	Communication Eq. - B	3	3	3	3	2	2	3	19
10	Training - D	2	3	2	3	3	3	2	18
10	Maintenance - D	3	3	2	3	3	2	2	18
12	Human Reliability - B	2	2	3	2	2	3	2	17
12	Shiftwork - B	3	3	3	3	2	2	1	17
12	Use of force - D	3	3	2	3	1	3	2	17
12	Performance Eval. - D	3	3	3	3	2	1	2	17
12	CAS/SAS design - C	2	3	3	3	2	2	2	17
12	Maintenance - B	3	3	2	3	2	2	2	17
12	Environmental Influences - A	3	3	3	2	2	2	2	17
12	Nuisance Alarms - D	3	3	3	2	2	2	2	17
20	Organizational Comm. - B	2	3	2	3	2	3	2	16
20	Fitness-for-duty - B	2	2	2	2	2	3	3	16
20	Human Reliability - B	2	2	3	2	2	3	2	16
20	Human Reliability - C	2	1	3	3	2	3	2	16
20	Training - B	1	2	2	3	3	3	2	16
20	Nuisance Alarms - B	3	3	2	3	2	1	2	16
26	Behavioral Obser. - B	1	2	2	3	3	3	1	15
26	Trustworthiness - C	2	3	2	3	1	2	2	15
26	Vigilance - B	3	2	2	3	1	2	2	15
26	Vigilance - C	2	2	3	3	1	2	2	15
26	Attitude - A	1	2	3	3	2	3	1	15
26	Training - A	1	2	2	2	3	3	2	15
26	Performance Eval. - A	1	2	3	2	3	3	1	15
33	Two-man rule - A	2	3	2	3	1	2	1	14
33	Contingency Plans - A	1	1	2	1	3	3	3	14
35	Trustworthiness - B	2	2	1	3	1	2	2	13
35	Organizational Comm. - A	1	2	2	2	2	3	1	13
35	Contingency Plans - D	2	2	1	2	2	2	2	13
38	Vigilance - A	1	2	1	2	1	2	2	11

A - Experimental, B - Data analysis, C - Extrapolation, D - Further research formulation.

observation or more direct investigation (e.g., interviews). Data analysis, as a research approach involves the use of data which has already been collected for related or unrelated purposes. For example, inspection and enforcement records, safeguards procedures, the SSEL, license documents, and security studies done for DOD and DOE contain data which may be applicable to NRC licensee safeguards at nuclear power plants. Extrapolation characterizes a research approach which uses studies in contexts outside that of a directly nuclear-related or government activity. For instance, the effects of shiftwork have been extensively studied in the organizational studies literature, but not as it applies to nuclear power plant safeguards personnel. The use of these studies would represent extrapolation. Lastly, further research formulation involves human factors research problems which have not been sufficiently formulated from a research standpoint to conduct directly applied research. In such cases, more work is necessary to further formulate the issues to be addressed.

When more than one research approach could be used to address a single human factors issue, they are treated separately. As a result, some issues are subject to more than one research approach in this part of the analysis.

3.3 Practicality

The practicality of conducting research was assessed using the factors of cost, time required, and equipment and data availability. Costs were estimated on the basis of necessary equipment plus $100,000 per staff-year effort. If costs were above $200,000 for useful results it was considered expensive. If cost were below $75,000 it was considered desirable. Time required was considered excessive if research would take more than two years and desirable if one year or less. The availability of data required for the research approach and needed equipment was estimated by reviewing similar efforts and consulting with researchers in the field. Practicality values for each human factor and research approach are in columns 1-4 of Table 3.2. The reason for the assigned values in each cell is explained in detail in Section 2 of Volume II, Chapter 3.

3.4 Usefulness

The usefulness of research and its results were developed by considering regulatory need and potential for risk reduction. Regulatory need was ascertained from examining recent regulatory activity, current issues under consideration, and issues considered closed by NRC. In addition, when results could not be useful in a timely manner, for instance when relevent regulations have just recently been put in place, regulatory usefulness of research was considered lower. The potential for risk reduction was estimated using judgment about the current state-of-affairs and potential for improvement in safeguards performance. Usefulness values for each human factor are shown in columns 5 and 6 of Table 3.2.

3.5 Acceptability

Industry interests concerning each human factor were obtained by examining expect responses from Section 2.1 that came from industry. When industry has actively sought regulatory guidance, acceptability is deemed to be high and, conversely, when active opposition has been voiced, acceptability is deemed low. Acceptability values for each human factor are in column 7 of Table 3.2.

3.6 Determination of Research Feasibility Ranking

Table 3.2 is ordered according to a final ranking which was developed by the unweighted aggregation of totals shown in column 8 of Table 3.2. The cell values used are best estimates and are explicitly judgmental in nature. However, an important conclusion is that no research approach considered turned out to be "unresearchable," however, some approaches are more feasible than others.

3.7 Grouping Research

Many human factors research problems are related in terms of the issues involved, the data needed, and subsequent analysis. In addition, human factors are interrelated in their effects on performance. As a result, it is effective to combine studies into groups which take advantage of common research approaches and human factors considerations.

Based on an analysis of the importance of issues established in Section 2 and assessment of practicality, usefulness, and acceptability of research established in Section 3, research was grouped in order to minimize resource requirements. These groupings, which were also based on extensive discussions with behavioral scientists, safeguards experts, and human factors professionals as well as the research designs presented in Chapter 4 of Volume II, have resulted in four Program Elements. These are: (1) Training and Performance Evaluation, (2) Organizational Factors, (3) Man-Machine Interface, and (4) Trustworthiness and Reliability. These Program Elements and associated human factors issues are prestented in Table 3.3 and described in Section 4.

Table 3.3 Human Factors for Grouping of Research.

Training and performance evaluation program element:

- Training (1-10)*
- Performance evaluation (13-1)
- Environmental influences (14-12)

Trustworthiness and reliability program element:

- Trustworthiness (2-1)
- Human reliability (5-12)
- Behaviorial observation programs (10-26)
- Fitness-for duty (17-20)
- Two-man rule (19-33)

Organizational factors program element:

- Attitude (5-1)
- Staff coordination (8-6)
- Organizational communication (11-20)
- Shiftwork (12-12)
- Use of force (15-1)

Man-machine interface program element:

- Format and wording of contingency plans (2-1)
- Communications equipment (4-6)
- CAS/SAS design (7-12)
- Vigilance (8-26)
- Maintenance (16-10)
- Nuisance and false alarms (17-12)

*First number is importance ranking and second is the feasibility ranking.

4. PROGRAM ELEMENTS FOR THE HUMAN FACTORS IN SAFEGUARDS

4.1 Overview

Four main program elements (see Table 3.3) have been derived from the proceeding analysis. These elements have been developed to optimally capture the important human factors issues in power plant safeguards along with consideration of research feasibility, NRC regulatory interests, and resource requirements. The emphasis and directions of these projects has been shaped by the rankings and groupings developed in the proceeding section. These elements are (1) training and performance evaluation, (2) organizational factors, (3) man-machine interface, and (4) trustworthiness and reliability. They are discussed in the following sections and projects described in Section 5.0.

Tables 4.1 and 4.2 detail the milestones and resources for each project. References are made to Table 4.1 in this section to facilitate discussion. Table 4.1 also indicates regulatory actions including development of regulatory guides and rulemaking. This is done to facilitate an understanding of the reasons for projects and timing. Each of the projects discussed in this section are detailed project descriptive statements in Section 5. After each project title, the project descriptive statement section is parenthetically noted.

4.2 Training and Performance Evaluation Program Element

The goal of this program element is to support NRC regulatory activities having to do with assuring adequate qualifications, training, and staffing for safeguards personnel at nuclear power plants. In order to accomplish this goal, an examination of current training practices is recommended along with a study of developed and tested methods for training and performance evaluation techniques successfully used in other contexts. Project descriptive statements for this program element are in Section 5.2.

Training of safeguards personnel, as a safeguards human factors issue, ranks among the highest in terms of importance as a human factor affecting performance. In addition, training affects the performance of all safeguards functions so that results of other program elements should be used in designing optimal training programs. Presently, safeguards training programs vary significantly among licensees. Although no strong evidence of inadequacy has been put forth, the effectiveness of these programs cannot presently be measured in any rigorous, systematic manner. It is important to note that performance evaluation must be used as feedback to design training programs because of the lack of real events upon which to base judgments concerning training. As in any educational setting, testing must be used to measure progress and identify problems.

The first part of this program element is "The Literature Review and Industrial Survey Project" (Section 5.2.1) aimed at establishing a taxonomy of the critical constituents of safeguards training programs, highlighting those

FIGURE 4.1 PROJECTS, MILESTONES, AND REGULATORY ACTIONS

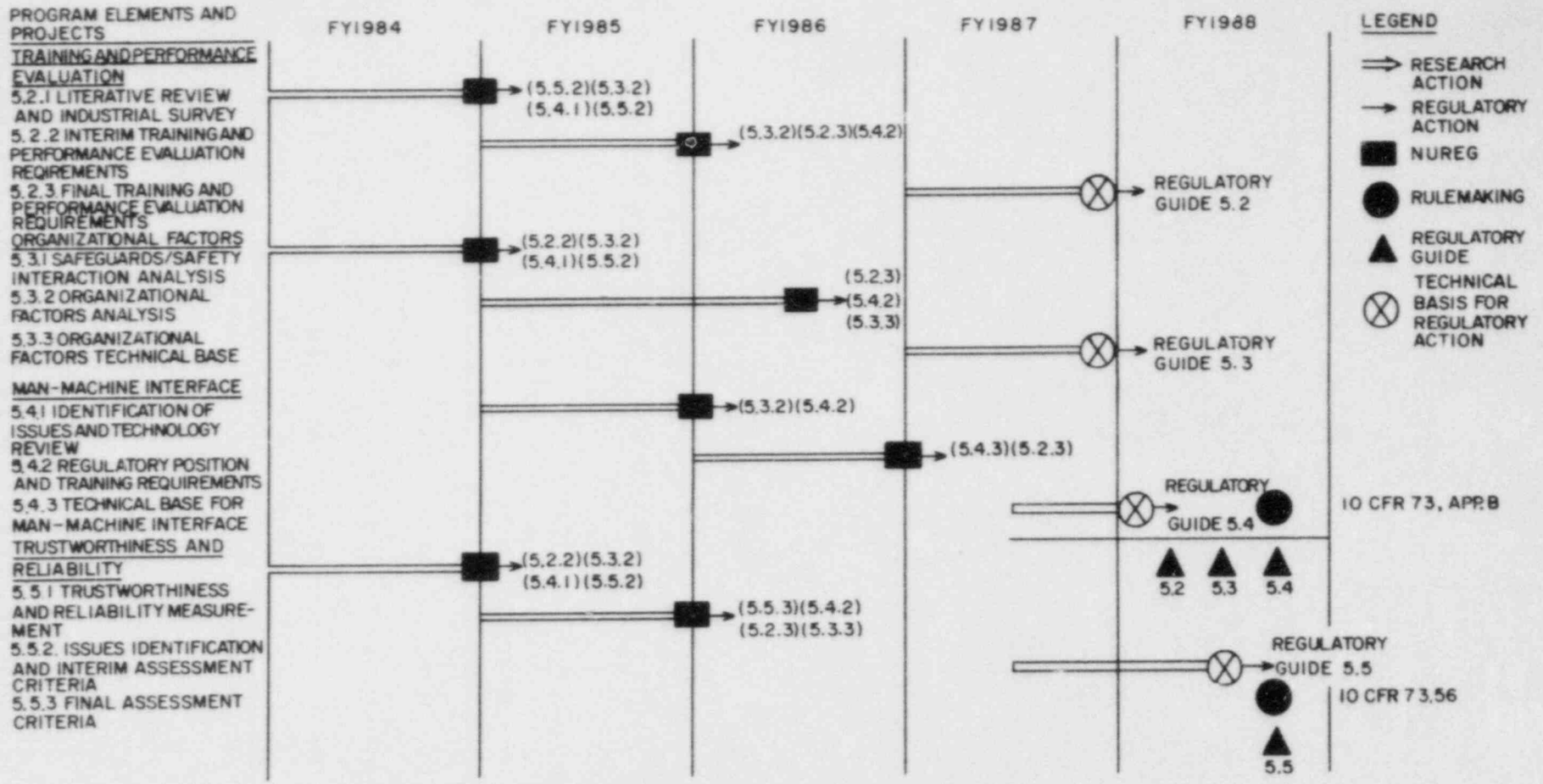

Figure 4.2 Resource Requirements.

Program Elements	FY 1984		FY 1985		FY 1986		FY 1987		FY 1988	
	PY	Funding	PY	Funding	PY	Funding	PY	Funding	PY	Funding
(5.2) Training & Performance Evaluation	.3	130K	.3	130K	--	--	.3	100K	--	--
(5.3) Organizational Factors	.3	100K	.3	90K	.2	60K	.2	80K	--	--
(5.4) Man-Machine Interface	--	--	.3	100K	.3	100K	.2	50K	--	--
(5.5) Trust-worthiness and Reliability	.3	100K	.3	100K	--	--	.3	80K	.3	120K
TOTALS	.9	330K	1.2	420K	.5	160K	1.0	310K	.3	120K

aspects of training that vary most significantly among licensees. This should be done so as to allow the identification of training practices which can be related to the quality of performance as it is evaluated by the licensee and NRC.

Performance evaluation methods and practices are also to be investigated during this project by reviewing government, industry, and open literature to identify the best methods of measuring and improving the quality of personnel performance. This is necessary to measure progress and identify problems which both provide feedback to training program design. This investigation will include the methods presently in use and under development by DOD and DOE for fixed site security as well as those used by public and private sector high performance organizations found during this study. The results of this part of the project will be used to establish means of measuring performance which can potentially be related to variations in safeguards training programs.

This project includes consideration of how licensees evaluate their personnel. It has been shown in this study that organizationally based performance evaluation programs can strongly affect the performance of personnel in organizations (see Section 2.14 of Chapter 3, Volume II). In addition, performance evaluation can be directly used for feedback to design training programs. These types of evaluations are generally used for raises and

promotions within the organization. Because of the strong and well-established association between training and subsequent performance evaluation these human factors issues have been combined in this program element and are studied together during this first project.

The second project, "Interim Training and Performance Evaluation Requirements Project" (Section 5.2.2), involves the selection of specific training and performance evaluation techniques and methods which can be applied to nuclear power plant safeguards. This project will also discuss and describe the means for making these techniques available through regulation or alternative actions.

Interim evaluative criteria for reviewing licensee training and qualification programs will be developed if needed.

The final project in this program element, "Final Training and Performance Evaluation Requirements Project" (Section 5.2.3), commences in September 1986 (a year after the conclusion of the second project) in order to take advantage of results from the Trustworthiness and Reliability, Organizational Factors, and Man-Machine Interface Program Elements. This project is aimed at developing a final integrated regulatory position in order to take advantage of the results from other program elements.

Products of this program element will include two reports (September 1984 and September 1985) which will provide interim evaluative criteria (FY 1986). The last project will be completed in September 1987 and report detailing a final integrated training and performance evaluation regulatory position will be supplied along with a technical basis for regulatory action including procedures, review criteria, and regulatory guidance (FY 1988).

4.3 Organizational Factors Program Element

The goal of this program element is to assist NRC in assuring that organizational factors affecting safeguards at nuclear power plants are adequate to protect against radiological sabotage. In order to accomplish this goal, an examination of the interaction of safeguards with operational activities important to safety are examined along with an investigation of other relevant organizational factors.

The various organizational units which have been established to operate a nuclear power plant have been developed and defined according to normal operational plant conditions. When an emergency situation exists personnel functions may cut across normal lines of authority. In addition, the objectives of different organizational units may come into conflict as when access controls impede operator access to manually operated valves during an emergency. The first project in this program element "Safety/Safeguards Interaction Analysis Project" (Section 5.3.1) is aimed at identifying and evaluating the impacts of these interrelated emergency response responsibilities. This program element also contains an analysis of the NRC safety/safeguards study

(NUREG-0992). Recommendations for mitigation strategies will be developed along with recommendations for design of training programs. This project will be detailed in a NUREG document in September 1984.

Other organizational factors have been strongly argued to affect the performance of safeguards at nuclear power plants. Shiftwork, consideration of the use of force, and attitude, among others, have been alleged to have marked effects on safeguards quality according to information and opinions developed during conduct of this study (see Sections 2.8, 2.9, 2.12, in Chapter 3, Volume II). However, there is no clear, replicable evidence that these factors significantly affect nuclear power plant safeguards. The second project in this program element, "The Organizational Factors Analysis Project" (Section 5.3.2) involves firmly establishing what the effects of organizational factors are, to what extent they affect performance, and development of potential mitigating strategies to counter any deleterious effects identified. A final NUREG document is to be produced in March 1986.

The third project in this program element, "Organizational Factors Technical Base Project" (Section 5.3.3), involves compilation of all factors relevant to NRC activities aimed at assuring that licensee organizations are capable of optimal safeguards responses. This technical base will include information developed in other program elements relevant to regulatory action on organizational factors.

Products of this program element will include two reports and a detailed technical base. The first report (September 1984) will detail recommendations for mitigating the adverse effects of staff interactions on plant safety. The second (March 1986) will recommend strategies for mitigating the deleterious effects of organizational factors found to affect the performance of safeguards personnel. These results will also be used to support the development of a final training and performance evaluation regulatory position and provide a technical basis for regulatory action if needed (September 1987).

4.4 Man-Machine Interface Program Element

The goal of this program element is to assist NRC in developing regulatory requirements and guidance concerning the interface of safeguards personnel with automated systems and safeguards equipment at use in nuclear power plants. In order to accomplish this goal, a survey of research already done to support regulation of man-machine aspects of operational safety and automated security systems will be undertaken. Then an overall regulatory position on the man-machine interface in safeguards will be developed along with a technical basis for regulatory action.

It has been shown to be both cost and performance effective to use automated security systems to minimize the need for human actions in maintaining fixed site security. Recent advances in intrusion alarm systems have further enhanced the desireability of automated security functions. However, it has been shown in the study of human factors affecting operational safety that, virtually regardless of the level of automation, human actions will play a

significant role in responding to an incident successfully. This is especially true in the event that compensatory measures must be taken when automated systems are unavailable for any reason. Even when automated systems are working properly human errors in using them have been shown to be critical.

In addition to automated systems such as intrusion alarm systems, and doorway personnel monitors, there are many types of equipment associated with safeguards activities. Firearms, portable radios, bulletproof attire, and chemical "mace-type" devices are typical types of equipment that safeguards personnel may need to use competently and with a high degree of confidence with very little warning.

The nature of the man-machine interface in nuclear power plant safeguards has not been comprehensively examined. Issues to be addressed in an examination are optimal alarm system design, use of safeguards equipment (including access controls, communication equipment, etc.), optimal format and wording of contingency plans, and equipment maintenance practices and procedures.

As can be seen in Table 4.1, this program element is scheduled to start in FY 1985. This is to take advantage of initial data and information developed in the Training and Performance Evaluation and the Organizational Factors program elements. By doing this, more can be understood about the actual needs, practices and activities of power plant security forces during a response. For example, a review of current training practices for security equipment and automated systems will be available at the start of the first man-machine interface project.

The first project "Identification of Issues and Technology Review Project" (Section 5.4.1) in this program element involves an overall investigation of relevant information. Related programs from DOD and DOE will be fully analyzed including studies of signal processing theory, use of artificial intelligence, cognitive decision making information, and others deemed relevant. Information developed in the operational safety field, including that developed for power plant control rooms and safety equipment, will be investigated. A NUREG document will detail the results of this study in September 1985.

The second project in this program element, "Regulatory Position and Training Requirements Project" (Section 5.4.2), will entail development of methods, including possible regulatory actions, for implementing man-machine interface technologies found applicable in the first project. In addition, appropriate recommendations on training associated with the man-machine interface will be made and used in the final training and performance evaluation project (Section 5.4.3).

The third project in this program element, "Technical Base for Man-Machine Interface Project" (Section 5.4.3), involves development of a technical basis for regulatory action. It commences in April 1987 in order to take into account relevant information developed in other program elements.

Products from this program element will include a report identifying man-machine issues in safeguards and a review of current technology (September 1985) and a report which recommends a regulatory position and appropriate training requirements (September 1986). A technical basis for regulatory action will be completed (November 1987).

4.5 Trustworthiness and Reliability Program Element

The goal of this program element is to support NRC regulatory actions which bear on the issues posed by insider malevolence and human reliability breakdowns. In order to accomplish this goal, this program element includes projects aimed at developing measurement techniques for determining the adequacy of trustworthiness activities undertaken by licensees and means used to assure the continuous reliability of personnel.

Trustworthiness and reliability have always been among the primary concerns in designing safeguards for nuclear power plants. Insider sabotage and fitness-for-duty have recently become important issues because of the increase in reported acts of vandalism and drug use at reactor sites. The Insider Rule Package arose out of these hightened concerns.

No means for measuring the actual effectiveness of regulatory requirements and licensee programs aimed at assuring trustworthiness and reliability have been developed. Trustworthiness and reliability activities and requirements are generally based on the successes of other institutions such as the military and security agencies of the federal government.

The first project in this program element, "Trustworthiness and Reliability Measurement Project" (Section 5.5.1), is aimed at developing means of measuring the effectiveness of trustworthiness and reliability programs used at nuclear power plants. Once measurement techniques have been developed, a NUREG report detailing these methods will be produced (September 1984).

The second project, "Issues Identification and Interim Assessment Criteria Project" (Section 5.5.2) is aimed at identifying critical issues associated with trustworthiness and reliability programs at nuclear power plants including those associated with employee civil liberties, rights, and attitudes. Interim assessment criteria for licensee programs will be developed if needed and a NUREG report prepared (September 1985).

The third project, "Final Assessment Criteria Project" (Section 5.5.3) will include collection and analysis of data useful for making measurements developed in the first project and revision of interim evaluation criteria developed in the second project. A technical basis for regulatory action will be developed if needed for proposed actions (April 1988).

5. PROJECT DESCRIPTIVE STATEMENTS

5.1 Organization of this Section

The projects which have been described in Section 4 are summarized in this section. Each project is described in one page to facilitate discussions concerning projects. The section numbers are the same as the project designation numbers in Figure 4.1

5.2 Training and Performance Evaluation Program Element Projects (see Section 4.2)

5.2.1 Literature Review and Industrial Survey Project

Purpose: A one-year (October 1983 - September 1984) project to examine the state of training for nuclear power plant safeguards personnel and assess the relationship between training and performance evaluation techniques. This project is aimed at resolving issues of uniformity and quality in training programs and performance evaluations as they affect the performance of safeguards personnel.

Research Requirements: Overall NRC emphasis on improved training for all operational personnel at power plants in "Long Range Research Plan" NUREG-0961 and the need for a technical basis for regulatory action is proposed.

Description of Work: Project work includes (1) a literature search and analysis of training and performance evaluation methods used in public and private sector organizations and (2) an analysis of safeguards training and performance evaluation programs currently used by licensees.

Anticipated Results: Results will include a technical data base which details successful training and performance evaluation methods developed and tested by existing high performance organizations and those methods currently in use in the nuclear industry including major variations. These methods will be detailed in a NUREG document in September 1984.

Potential User Groups: NMSS for review of safeguards training and qualification programs. NRR for reviewing performance appraisal methods filed during licensing. I&E for assisting in inspections and audits.

Other Related Research: Trustworthiness and Reliability Measures Project (Section 5.5.1), Safety/Safeguards Interaction Analysis Project (Section 5.3.1).

Resources:	FY 1984
Funding	130 K
RES Staff	.3 SY

References: NUREG-0219, NUREG-0464, NUREG-0576, NUREG-0764, NUREG/CR-1327, NUREG-0768, SECY-83-179, NUREG/CR-3215, NUREG/CR-3520.

5.2.2 Interim Training and Performance Evaluation Requirements Project

Purpose: A one-year (October 1984 - September 1985) project to assess the state of training for nuclear power plant safeguards personnel and assess the relationship between training and performance evaluation techniques. This project is aimed at resolving issues of uniformity and quality in training programs and performance evaluations as they affect the performance of safeguards personnel and to establish a technical basis for regulatory policy and actions.

Research Requirements: Overall NRC emphasis on improved training for all operational personnel at power plants in "Long Range Research Plan" NUREG-0961 and the need for a technical basis for regulatory action.

Description of Work: Project work involves: (1) examination of successful performance and organizationally based training and evaluation techniques for specific application to nuclear power plant security organizations and systems, (2) development of means to make available to licensees those techniques found to be suitable either through regulatory action or alternative guidance, and (3) development of interim evaluative criteria.

Anticipated Results: Results of this project will include a NUREG document detailing the findings of this project (September 1985).

Potential User Groups: NMSS for review of safeguards training and qualification programs. NRR for reviewing performance appraisal methods used by licensees. I&E for assisting in inspections and audits.

Other Related Research: Organizational Factors Analysis Project (Section 5.3.2), Man-Machine Issues and Technology Review Project (Section 5.4.1), Trusworthiness and Reliability Issues and Assessment Criteria Project (Section 5.5.2).

Resources:	FY 1985
Funding	130 K
RES Staff	.3 SY

References: NUREG-0219, NUREG-0464, NUREG-0576, NUREG-0764, NUREG/CR-1327, NUREG-0768, SECY-83-179, NUREG/CR-3215, NUREG/CR-3520.

5.2.3 Final Training and Performance Evaluation Requirements Project

Purpose: A one-year (October 1986 - September 1987) project to assess the state of training for nuclear power plant safeguards personnel and assess the relationship between training and performance evaluation techniques. This project is aimed at resolving issues of uniformity and quality in training programs and performance evaluations as they affect the performance of safeguards personnel and development of a final technical basis for regulatory action.

Research Requirements: Overall NRC emphasis on improved training for all operational personnel at power plants in "Long Range Research Plan" NUREG-0961 and the need for a technical basis for regulatory action.

Description of Work: Project work includes (1) integration of training needs developed in the Man-Machine Interface Trustworthiness and Reliability, and Organizational Factors Program Elements into evaluation criteria for training and performance evaluating programs and (2) interim assessment and documentation of improvements in licensee programs.

Anticipated Results: Results of the project include development of a final technical basis for regulatory action including relevant information developed in other program elements.

Potential User Groups: NMSS for review of safeguards training and qualification programs and support for proposed rules rulemaking. NRR for reviewing performance appraisal methods used by licensees. I&E for assisting in inspections and audits.

Other Related Research: Organizational Factors Technical Base Project (Section 5.3.3), Technical Base for Man-Machine Interface Project (Section 5.4.3), Final Assessment Criteria Project (Section 5.5.3).

Resources:	FY 1987
Funding	100 K
RES Staff	.3 SY

References: NUREG-0219, NUREG-0464, NUREG-0576, NUREG-0764, NUREG/CR-1327, SECY-83-179, NUREG/CR-3520.

5.3 Organizational Factors Program Element Projects (see Section 4.3)

5.3.1 Safety/Safeguards Interaction Analysis Project

Purpose: A one-year (August 1983 - September 1984) project to identify organizational conflicts and coordination problems which may affect nuclear power plant safety. Particular emphasis will be put on the safeguards, health/physics, and operational organizations as they affect plant safety during both normal and off-normal events. This project will be aimed at identification of problems and potential mitigation strategies.

Research Requirement: Established by the "Report of the Committee to Review Safeguards Requirements at Power Plants," NUREG-0992.

Description of Work: Project work includes: (1) Analysis of Safety/Safeguards Committee report focusing on potential human interaction problems and (2) formulation of specific proposals for improvement.

Anticipated Results: Results will include a NUREG report detailing (September 1984) potentially troublesome situations and conditions involving safety/safeguards interactions and proposals for mitigating deleterious effects. Information developed in the project will be used in the Man-Machine Interface and Training and Performance Evaluation Program Elements.

Potential User Groups: NMSS for reviewing contingency plans and access controls, NRR for reviewing operational procedures and radiation protection standards, I&E for assistance in inspections and audits.

Other Related Research: Literature Review and Industrial Survey Project (Section 5.2.1), Trusworthiness and Reliability Measures Project (Section 5.5.1).

Resources:	FY 1984
Funding	100 K
RES Staff	.3 SY

References: NUREG-0992, NUREG/CR-3196, NUREG/CR-3215, SECY-83-179, NUREG/CR-3520.

5.3.2 Organizational Factors Analysis Project

Purpose: A one and a half year (October 1984 - March 1985) project to determine the effects of organizational factors on safeguards personnel performance. These factors will include, but not be limited to, shiftwork, consideration of the use of force, attitude, and issues identified in FY 1984. The goal of this project is to systematically verify which organizational factors do affect safeguards personnel performance and if found to have an effect how they may be addressed in regulatory action or policy.

Research Requirement: Established by the "Report of the Committee to Review Safeguards Requirements at Power Plants," NUREG-0992.

Description of Work: Project work includes: (1) identification of organizational factors not fully addressed in FY 1984, (2) identification and development of measurement techniques to assess the impact of identified factors, (3) collection of data necessary to determine impacts of identified in Task 2, and (4) recommendation of activities to mitigate the deleterious effects found in Task 3.

Anticipated Results: Results will include a NUREG report (March 1986) which will detail the effects of organizational factors affecting nuclear power plant safeguards. Results of this project will be used in the Man-Machine Interface and Trustworthiness and Reliability Program Elements.

Potential User Groups: NMSS to assess the adequacy of licensees' security organization. I&E to assist in site inspections and audits.

Other Related Research: Interim Training and Performance Evaluation Requirements Project (Section 5.2.2), Identification of Issues and Technology Review Project (Section 5.4.1), Issue Identification and Interim Assessment Criteria Project (Section 5.5.2).

Resources:	FY 1985	FY 1986
Funding	90 K	60 K
RES Staff	.3 PY	.2 PY

References: NUREG-0992, NUREG-0768, NUREG/CR-3196, NUREG/CR-3215, SECY-83-179, NUREG/CR-3520.

5.3.3 Organizational Factors Technical Base Project

Purpose: A one-year (October 1986 - September 1987) project to develop a complete technical base for regulatory action concerning organizational factors affecting nuclear power plant safety and safeguards.

Research Requirement: Established by NUREG-0768 and NUREG-0992.

Description of Work: Project work includes (1) collection of all data relevent to regulatory actions concerning organizational factors in nuclear power plant safeguards. Relevant information from other program elements will be integrated into this technical base, (2) recommendation of regulatory position and development of draft regulatory guides.

Anticipated Results: A technical basis for regulatory action on organizational factors (September 1987).

Potential User Groups: NMSS to assess licensee's policies concerning organizational factors. I&E to assist on-site inspections and audits.

Other Related Research: Final Training and Performance Evaluation Project (Section 5.2.3), Technical Base for Man-Machine Interface Project (Section 5.4.3), Final Assessment Criteria Project (Section 5.5.3).

Resources:	FY 1987
Funding	80 K
RES Staff	.3 SY

References: NUREG-0992, NUREG-0768, SECY-82-179, NUREG/CR-3196, NUREG/CR-3215, NUREG/CR-3520.

5.4 Man-Machine Interface Program Element Projects (see Section 4.4)

5.4.1 Identification of Issues and Technology Review Project

Purpose: A one-year (October 1984 - September 1985) project to assess CAS/SAS design, safeguards equipment, training requirements, and the optimal format and wording of contingency plans. The purpose of this project is to optimize the design of intrusion alarm systems, safeguards equipment training programs and optimal modes of using contingency plans. The focus of this analysis will be the integration of human factors developed for operational safety with safeguards technology.

Research Requirement: Established by post-TMI research on operational safety.

Description of Work: Project work includes: (1) identification of critical man-machine interface factors affecting safeguards personnel responses and (2) examination of man-machine interface technical development in plant operating systems which is applicable to factors identified in Task 1.

Anticipated Results: Results will include a NUREG report (September 1985) detailing critical man-machine interface considerations for CAS/SAS design and safeguards equipment and potentially useful technologies developed for operations personnel in safety research.

Potential User Groups: NMSS for evaluating design of alarm stations and safeguards equipment as well as contingency plans and security procedures. I&E assistance in inspections and audits.

Other Related Research: Organizational Factors Analysis Project (Section 5.3.2), Issues Identification and Interim Assessment Criteria Project (Section 5.5.2), Interim Training and Performance Evaluation Requirements Project (Section 5.2.2).

Resources:	FY 1985
Funding	100 K
RES Staff	.3 SY

References: NUREG-0178, NUREG-0320, NUREG-0508, NUREG/CR-0509, NUREG/CR-1051, NUREG/CR-0510, NUREG/CR-0543, NUREG/CR-1468, SECY-82-179, NUREG/CR-3520.

5.4.2 Regulatory Position and Training Requirements Project

Purpose: A one-year (October 1985 - September 1986) project to assess CAS/SAS design, safeguards equipment, training requirements, and the optimal format and wording of contingency plans. The purpose of this project is to optimize the design of intrusion alarm systems, safeguards equipment training programs and optimal modes of using contingency plans. The focus of this analysis will be the integration of human factors developed for operational safety with safeguards technology.

Research Requirement: Established by post-TMI research on operational safety.

Description of Work: Project work involves (1) development of methods for integrating man-machine technologies identified as useful in FY 1985 into power plant safeguards systems, and (2) development of training requirements necessary for optimal use of technologies being applied to safeguards equipment.

Anticipated Results: Results will include a report detailing potential improvements in man-machine interfaces in safeguards including optimal format for presentation of contingency plans for safeguards personnel. Evaluation criteria for assessing licensee programs will be produced. Training requirements developed in this project will feed into the Final Training and Performance Evaluation Project (Section 5.2.3).

Potential User Groups: NMSS for evaluating design of alarm stations and safeguards equipment as well as contingency plans and security procedures. I&E assistance in inspections and audits.

Other Related Research: Organizational Factors Analysis Project (Section 5.3.2).

Resources:	FY 1986
Funding	100 K
RES Staff	.3 SY

References: NUREG-0178, NUREG-0320, NUREG-0508, NUREG/CR-0509, NUREG/CR-1051, NUREG/CR-0510, NUREG/CR-0543, NUREG/CR-1468, SECY-82-179, NUREG/CR-3520.

5.4.3 Technical Base for Man-Machine Interface Project

Purpose: A six-month (April 1987 - September 1987) project to develop a complete technical basis for regulatory action concerning the man-machine interface in safeguards systems and equipment for nuclear power plants.

Research Requirement: Established by post-TMI research on operational safety.

Description of Work: Project work involves (1) compilation of data relevant to the man-machine interface in security systems at nuclear power plants and (2) development of a draft regulatory guide and proposed regulatory position.

Anticipated Results: Results will include a comprehensive technical basis for regulatory action.

Potential User Groups: NMSS for evaluating design of alarm status and safeguards equipment as well as contingency plans and security procedures. I&E for assistance in inspections and audits.

Other Related Research: Final Training and Performance Evaluation Project (Section 5.2.3), Organizational Factors Technical Base Project (Section 5.3.3), Final Assessment Criteria Project (Section 5.5.3).

Resources:	FY 1987
Funding	50 K
RES Staff	.2 SY

References: NUREG-CR-0178, NUREG-0320, NUREG-0508, NUREG/CR-0509, NUREG/CR-1051, NUREG/CR-0510, NUREG/CR-0543, NUREG/CR-1468, SECY-82-179, NUREG/CR-3520.

5.5 Trustworthiness and Reliability Program Element Projects (see Section 4.5)

5.5.1 Trustworthiness and Reliability Measurement Project

Purpose: A one-year (October 1983 - September 1984) project to assess the feasibility of developing measures of personnel trustworthiness and reliability with particular emphasis on site security against radiological sabotage. This project is aimed at systematically assessing the impact of safeguards activities undertaken to assure personnel trustworthiness and reliability.

Research Requirement: Requirements for this research comes from the potential implementation of the Insider Rule Package and recent increases in vandalism at power plants. In addition, potential relaxation of access controls as a result of improved assurances of trustworthiness have been recently considered.

Description of Work: Project work includes: (1) Formulation of method for identification of measures related to trustworthiness and reliability in nuclear power plants (i.e., direct and surrogate measures demonstrated to be reasonable indicators for regulatory use), (2) development of a means for acquiring data relevant to measures identified, and (3) preliminary analysis of existing data sources for their practicality, usefulness, and acceptability.

Anticipated Results: Results will include a NUREG report (September 1984) discussing in detail the use of measurement and analysis techniques potentially applicable to assessing trustworthiness and reliability in licensee plants.

Potential User Groups: NMSS to develop acceptance criteria to systematically evaluate licensee programs (e.g. screening programs, access controls) submitted during license reviews and as conditions of present licenses. I&E to support inspection of licensee programs during audits.

Other Related Research: Literature and Industrial Survey Project (Section 5.2.1), Safeguards/Safety Interaction Analysis Project (Section 5.2.1).

Resources:	FY 1984
Funding	100 K
RES Staff	.3 SY

References: NUREG-0768, NUREG-0703, NUREG/CR-2075, NUREG/CR-2076, NUREG/CR-2643, NUREG/CR-1254, NUREG/CR-1031, NUREG/CR-1032, NUREG/CR-3196, NUREG/CR-3520.

5.5.2 Issues Identification and Interim Assessment Criteria Project

Purpose: A one-year (October 1984 - September 1985) project to develop measures of personnel trustworthiness and reliability with particular emphasis on site security against radiological sabotage. This project is aimed at assessing the impact of safeguards activities undertaken to assure personnel trustworthiness and reliability and to provide evaluative criteria for NRC regulatory activities.

Research Requirement: Requirements for this resarch comes from the potential implementation of the Insider Rule Package and recent increases in vandalism at power plants. In addition, potential relaxation of access controls as a result of improved assurances of trustworthiness have been recently considered.

Description of Work: Project work includes: (1) Formulation of method for identification of measures related to trustworthiness and reliability in nuclear power plants (i.e., direct and surrogate measures demonstrated to be reasonable indicators for regulatory use) and (2) development of recommendations to mitigate problems associated with issues identified for use by the NRC staff.

Anticipated Results: Results will include a user's manual (September 1985) for evaluating licensee programs on an interim basis and detailing issues which are of importance from a regulatory standpoint. Results from this project will also be used in the Training and Performance Evaluation Program element.

Potential User Groups: NMSS to develop acceptance criteria to systematically evaluate licensee programs (e.g., screening programs, access controls) submitted during license reviews and as conditions of present licenses. I&E to support inspection of licensee programs during audits.

Other Related Research: Interim Training and Performance Evaluation Requirements Project (Section 5.2.2), Organizational Factors Analysis Project (Section 5.3.2), Identification of Issues and Training Requirements Project (Section 5.4.1).

Resources:	FY 1985
Funding	100 K
RES Staff	.3 SY

References: NUREG-0768, NUREG-0703, NUREG/CR-2075, NUREG/CR-2076, NUREG/CR-2643, NUREG/CR-1254, NUREG/CR-1031, NUREG/CR-1032, NUREG/CR-3196, NUREG/CR-3520.

5.5.3 Final Assessment Criteria Project

Purpose: A one-year (April 1987 - March 1988) project to develop measures of personnel trustworthiness and reliability with particular emphasis on site security against radiological sabotage. This project is aimed at assessing the impact of safeguards activities undertaken to assure personnel trustworthiness and reliability and providing final acceptance criteria for licensee programs.

Research Requirement: Requirements for this research comes from the implementation of the Insider Rule Package and increases in vandalism at power plants. In addition, potential relaxation of access controls as a result of improved assurances of trustworthiness are being considered. Evaluation of programs which have been functioning for more than 24 months can be undertaken.

Description of Work: Project work includes (1) formulation of a method for collecting data identified the first project of this program element, (2) collection and analysis of relevant data, (3) systematic evaluation of activities undertaken by licensees for assuring trustworthiness and reliability and (4) development of final acceptance criteria for licensee programs.

Anticipated Results: The results of this project include final acceptance criteria for licensee programs aimed at assuring trustworthiness and reliability and a technical basis for regulatory action if necessary to amend insider rule package.

Potential User Groups: NMSS to develop acceptance criteria to systematically evaluate licensee programs (e.g., screening programs, access controls) submitted during license reviews and as conditions of present licenses. I&E to support inspection of licensee programs during audits.

Other Related Research:

Resources:	FY 1987	FY 1988
Funding	80 K	120 K
RES Staff	.3 SY	.3 SY

References: NUREG-0768, NUREG-0703, NUREG/CR-2075, NUREG/CR-2076, NUREG/CR-2643, NUREG/CR-1254, NUREG/CR-1031, NUREG/CR-1032, NUREG/CR-3196, NUREG/CR-3520.

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14 ABSTRACT (200 words or less)

The first task was to identify and rank human factors affecting the quality of nuclear power plant safeguards in terms of their importance. The opinions of over 85 experts were solicited and 28 responses were received. These responses were rigorously analyzed to ascertain what human factors could be considered important to power plant safeguards. In addition, the Safeguards Summary List (NUREG-0525) was systematically analyzed for human factors influences. Also, relevant government and industry literature was reviewed. These data sources were then aggregated and an overall importance ranking of human factors issues was developed. This part of the research effort is fully documented and described in Chapter 2 of Volume II.

The second part of this effort involved determining the feasibility of conducting research in the areas found to be important to power plant safeguards. A determination of research feasibility was based on the practicality, usefulness, and acceptability of conducting research and using the results in a regulatory context. This part of the effort is fully documented in Chapter 3 of Volume II.

Research efforts addressing human factors in safeguards were then developed and prioritized according to the importance of human factors areas derived in the first part of the study and the feasibility of research determined in the second part. Research was also grouped to take advantage of common research approaches and data sources where appropriate. Chapter 4 of Volume II details the development of methodological groupings for optimizing resource use.

15a KEY WORDS AND DOCUMENT ANALYSIS

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Training Evaluation, Organization,
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