MAINTENANCE AND SURVEILLANCE PROGRAM PLAN

U.S. NUCLEAR REGULATORY COMMISSION

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of the Maintenance and Surveillance Program Plan (MSPP) is to provide direction for the NRC's efforts to assure effective nuclear power plant maintenance and surveillance and to do so in a manner that is consistent with and responsive to the Commission's 1984 Policy and Planning Guidance (NUREG-0885, Issue 3).

The Program Plan describes the problems and issues to be addressed and proposes development of alternative NRC approaches to regulating nuclear utility maintenance activities consistent with the Policy and Planning Guidance. The scope of the Program Plan includes all aspects of maintenance required to carry out a systematic maintenance program. It includes, therefore, as well as conventional maintenance and repair, such things as surveillance and test activities, removal of equipment from service, postmaintenance testing, return to service of equipment following maintenance, maintenance management, administrative control, personnel selection and training, procedures, and technical documentation.

1.2 BACKGROUND

The NRC's current regulatory approach to nuclear power plant maintenance is embodied in requirements for (1) quality assurance (QA) during design, construction, and operation for structures, systems and components to an extent consistent with importance to safety (10 CFR 50, Appendix B), and (2) surveillance requirements to assure that the necessary quality of systems and components is maintained (10 CFR 50.36). Despite these requirements, the NRC's rules and regulations presently provide no clear programmatic treatment of maintenance.

In addition to the lack of comprehensive maintenance requirements for safety systems, the NRC does not stipulate maintenance requirements for systems and equipment which are not safety related. This is despite the fact that many challenges to safety systems may originate from systems and components which are not classified as safety-related. The principal contribution of maintenance to safety system performance will be addressed as part of the overall approach to maintenance improvement.

Faulty maintenance practices are a principal contributing factor to operating abnormalities. Preliminary estimates by the staff indicate that aside from design deficiencies, more than 35% of the nuclear power plant abnormal occurrences reported to Congress since 1975 may be directly attributed to maintenance factors, with the trend increasing as more plants become operational.

Reviews of operating experience by the staff show a high frequency of degraded system performance due to both the lack of maintenance (especially preventive maintenance) and improperly performed maintenance, including human error during repair and surveillance testing.

A recent AEOD study concluded that 70% of events involving wrong unit or wrong train were attributable to human error during maintenance (including surveillance and testing). The types of maintenance errors described by Licensee Event Reports (LERs) and the Nuclear Plant Reliability Data System (NPRDS) include such human maintenance errors as: failure to follow procedures; installing electrical connectors incorrectly; mounting equipment (e.g., check valves) backwards or out of alignment; using the wrong parts in equipment repair; removing from service and working on the wrong system or component; misaligning valves after maintenance; and failing to remove lockwire from critical switches after service.

An engineering evaluation of a stuck open isolation check valve on the residual heat removal system at an operating boiling water reactor (BWR) determined that human error during maintenance resulted in the safety problem. The maintenance error was not discovered during post-maintenance testing nor during routine surveillance of control room position indication for the component. The safety significance of the undetected error increased the probability of an interfacing LOCA for the plant. The probability of the LOCA was estimated to be 2×10^{-4} during this period of four months while the error was undetected as compared to a normal estimate of 10^{-7} per reactor year. This is considered to be a substantial reduction in safety margin caused by a maintenance error.

Over the last two to three years, the NRC has initiated several studies demonstrating problems in nuclear power plant maintenance activities. For the most part, studies have been conducted or sponsored by various NRC offices (e.g., Research; Analysis and Evaluation of Operational Data; Nuclear Reactor Regulation) with little or no coordination and no integrating programmatic framework for maintenance issues. To date, this has resulted in a fragmented effort that does not address all the relevant issues and may be duplicative in some respects.

This Maintenance and Surveillance Program Plan is intended to integrate and plan the staff's maintenance activities, and responds directly to 1984 Commission Policy and Planning Guidance (NUREG-0885, Issue 3) directing that the staff develop a plan that "proposes alternative NRC regulatory approaches with respect to maintenance activities" (PPG, Item II.3).

2.0 DESCRIPTION OF THE PROBLEM

2.1 NOMENCLATURE AND DEFINITIONS

The scope of the Program Plan includes the entire maintenance process. Maintenance as a process is defined herein as a function with the objective of preserving the reliability and safety of plant structures, systems and components which provide assurance that the plant can be operated without undue risk to the health and safety of the public and/or restoring that reliability when it is degraded.

For the purposes of this plan, maintenance and surveillance includes (a) diagnostic or periodic testing, calibration and inspection to determine the condition of structures, systems and components, (b) preventive or corrective actions such as repair, replacement, lubrication, adjustments, or overhaul; and (c) proper removal of equipment from service, restoration to service, and post maintenance testing. Maintenance is performed during all modes of plant operation by plant staff, vendors, or contractors.

It is not the intent of this Maintenance and Surveillance Program Plan to address the technical problem of how to maintain a particular component (e.g., a pump, valve, pipe or steam generator) but rather to consider the programmatic aspects of maintenance. The objective is to identify the factors that contribute to maintenance effectiveness (e.g., procedures, training, and management) and how they may best be integrated into a functional maintenance program.

2.2 PROBLEM AND OBJECTIVES

These problems or combination of problems exist at some plants. Other plants appear to have effective, well run maintenance programs. The maintenance safety problems and the objectives being addressed by the plan consist of the following:

1. There is indication that needed maintenance is not being accomplished or is not performed effectively. The objective is to determine the effectiveness of current nuclear power plant maintenance programs, to detect the causes and effects of equipment performance degradation, and to identify corrective action to minimize equipment failures and unavailability.

2. Many failures result from improper performance of maintenance. The objective is to reduce failures from improper maintenance by identifying the fundamental causes of human maintenance errors, by identifying practices which reduce the error rate and which increase the probability of error detection prior to system demand, and to assess the effectiveness of licensee strategies for improved maintenance performance.

3. The interface between maintenance and operations is presently inadequate. The objective is to determine the causes of poor coordination among activities, to assure proper integration of maintenance, operations and other organizational interfaces for maintenance activities.

4. The number of maintenance-related challenges to safety systems is excessive. The objective is to determine the causes of the high rate of challenges and improve the effectiveness of nuclear power plant maintenance programs in assuring operability of safety systems.

5. Major portions of occupational radiation exposure (over 75%) and many radiological hazards occur to personnel performing maintenance activities (NUREG-0713). Improved planning and control of maintenance activities may significantly reduce occupational exposure to as much as half of the present exposure. The objective is to assure that by performing preventive and corrective maintenance in a planned and optimized manner, the unnecessary and unanticipated radiological exposure of maintenance personnel will be reduced.

2.3 SCOPE OF NRC ACTIONS

Two issues will be addressed in deciding on an NRC approach to assure effective maintenance performance.

1. Whether the scope of NRC concern is only with maintenance of safety related structures, systems and components or whether other equipment is also included.

2. Which of several alternative approaches to address maintenance problems in the U. S. nuclear power industry are to be considered in implementing this Plan. These alternatives are:

   - Develop and implement Policy Statements, regulations or Regulatory Guides,
   - Plant-specific review of utility proposed maintenance programs,
   - Industry self-monitoring through INPO, or other activities (e.g., development of national standards),
   - Continue present programs,
   - Some combination of alternatives.

2.4 TECHNICAL ISSUES

Resolution of several technical issues will be accomplished by a program to provide data and methods for evaluating industry maintenance. These technical issues are:

1. Human Error in the Performance of Maintenance

   Operators and maintenance personnel (in about equal proportion) account for about 2/3 of all human error incidents resulting in LERs. Many maintenance errors have had serious safety consequences. Most of these errors result from poor human factors design of plant equipment, inadequate procedures, and/or insufficient personnel qualifications and training. Although Probabilistic Risk Assessment (PRA) studies have treated human error, it is difficult to quantify the impact of human error in maintenance on risk, and to assess the effect of proposed changes to reduce the incidence of human error in the performance of maintenance. Consequently, there are no currently acceptable criteria for determining the optimum methods for reducing human errors occurring during maintenance activities.

2. Indicators of Maintenance Effectiveness

   Measures of maintenance effectiveness may include indices of the effects of aging, the frequency of reactor scrams or safety system challenges, equipment performance data, SALP ratings, plant housekeeping, reportable human errors in maintenance, and work force man-rem exposure. However, the NRC has not, as yet, identified valid and reliable measures of maintenance effectiveness. It is believed that multiple measures may provide an accurate picture of plant maintenance effectiveness since factors such as management and organization, personnel selection and training, and procedures all affect maintenance performance. There is a need to develop methods of measuring mairtenance effectiveness of individual utilities (needed to identify plants with poor maintenance histories) and to compare maintenance performance across the nuclear utility industry as a whole (needed for feedback on effectiveness of regulatory initiatives). Even if NRC elects to rely heavily on INPO programs to upgrade maintenance performance in the industry, a measurement methodology to determine maintenance program improvement or lack of improvement is needed. In addition, means of determining acceptable levels of human error for maintenance activities are needed.

3. The Role of Preventive Maintenance in Counteracting Aging and Service Wear Effects

The degradation of operational characteristics and reliability of plant systems with age and service wear needs to be documented and expressed in quantitative terms. The appropriate resolution of the aging issue depends on answers to some basic questions: (a) what aging effects are likely to impair plant safety; (b) what methods of testing, calibration and inspection will be effective in detecting system degradation due to aging prior to the loss of the system function; and (c) what is the appropriate mechanism for implementing remedial actions identified from testing, surveillance, and inspection? It is likely that a partial resolution of the aging issue will determine the appropriate role of preventive and corrective maintenance programs in detecting and correcting aging and service wear effects in selected electrical and mechanical components.

Significant technical questions must be resolved to ensure the effectiveness of a preventive maintenance program in enhancing safety. These questions include: (a) what are the components to be maintained, (b) what type of maintenance is to be performed (e.g., replace components, overhaul, etc.), and (c) what is the appropriate schedule for each maintenance action?

4. Management and Organization Impacts On Maintenance Effectiveness

Management practice and organizational structure have an important bearing on performance of an organization. Proper management of maintenance has been cited as an essential element of an effective maintenance program (NUREG-1000). The NRC currently does not pursue extensive analysis of corrective action for management related maintenance problems. There also appears to be insufficient means to document and disseminate lessons learned and to objectively compare maintenance performance in the industry. Management committment to improved maintenance and dissemination of current maintenance practices and industry experience are needed.

5. Maintenance Program Criteria and Standards

Many effective maintenance practices have been identified from programs which have resulted in improved reliability and performance in other industries such as the FAA and the military. Also, the nuclear industry has begun to document some effective maintenance practices, e.g., EPRI's maintainability guidelines. There is a need to identify acceptable

maintenance practices for application to plants with poor maintenance histories and for guiding routine NRC inspection. Standards and criteria are needed for application to plants with poor maintenance practices as well as for generic application and development of improved inspection methods.

The national standards organizations, such as IEEE, ASME, ANS, or ANSI, presently do not have comprehensive standards on maintenance for industry use in developing effective maintenance programs. Industry self-regulation through such standards could create a common reference for maintenance practices. With such standards, NRC regulatory development activities could focus on approaches such as review guidance, revised inspection modules, or statements of good practices as general guidance documents.

6. The Maintenance and Operations Interface

Safety related systems are sometimes taken out of service or bypassed during surveillance testing and maintenance. Errors in surveillance testing and maintenance have resulted in the wrong equipment being taken out of service or in continued unavailability of equipment following maintenance or testing due to a failure to properly return equipment to service.

The proper integration of maintenance and operations is needed to verify correct performance of activities and reduce human errors. The provision of accurate information for monitoring the status and availability of systems and equipment before, during, and following maintenance may reduce operational as well as maintenance errors.

3.0 PLAN FOR PROBLEM RESOLUTION

3.1 MAINTENANCE AND SURVEILLANCE PROGRAM STRATEGY

Resolution of the technical and regulatory issues will be accomplished by a number of projects conducted in phases. In many instances, fundamental work needs to be completed which addresses portions of several issues. For example, a reliable measure of maintenance performance effectiveness is required for the resolution of issues related to management and organization impacts, maintenance criteria and standards, and the maintenance and operations interface.

The Maintenance and Surveillance Program will be conducted in phases to provide for EDO interim evaluation of results and recommendations prior to initiation of additional activities. The phased approach will also provide the industry an opportunity to take an active role in identifying and proposing solutions to maintenance problems.

The program consists of five phases, as shown in Figure 3.1.

- Phase I Survey and Evaluation
- Phase II Identification of Problems and Impacts
- Phase III Analysis of Alternatives
- Phase IV Development of the Implementation Plan
- Phase V Implementation and Follow-up

The objectives and expected products to aid the EDO evaluation at each phase of the program are as follows:

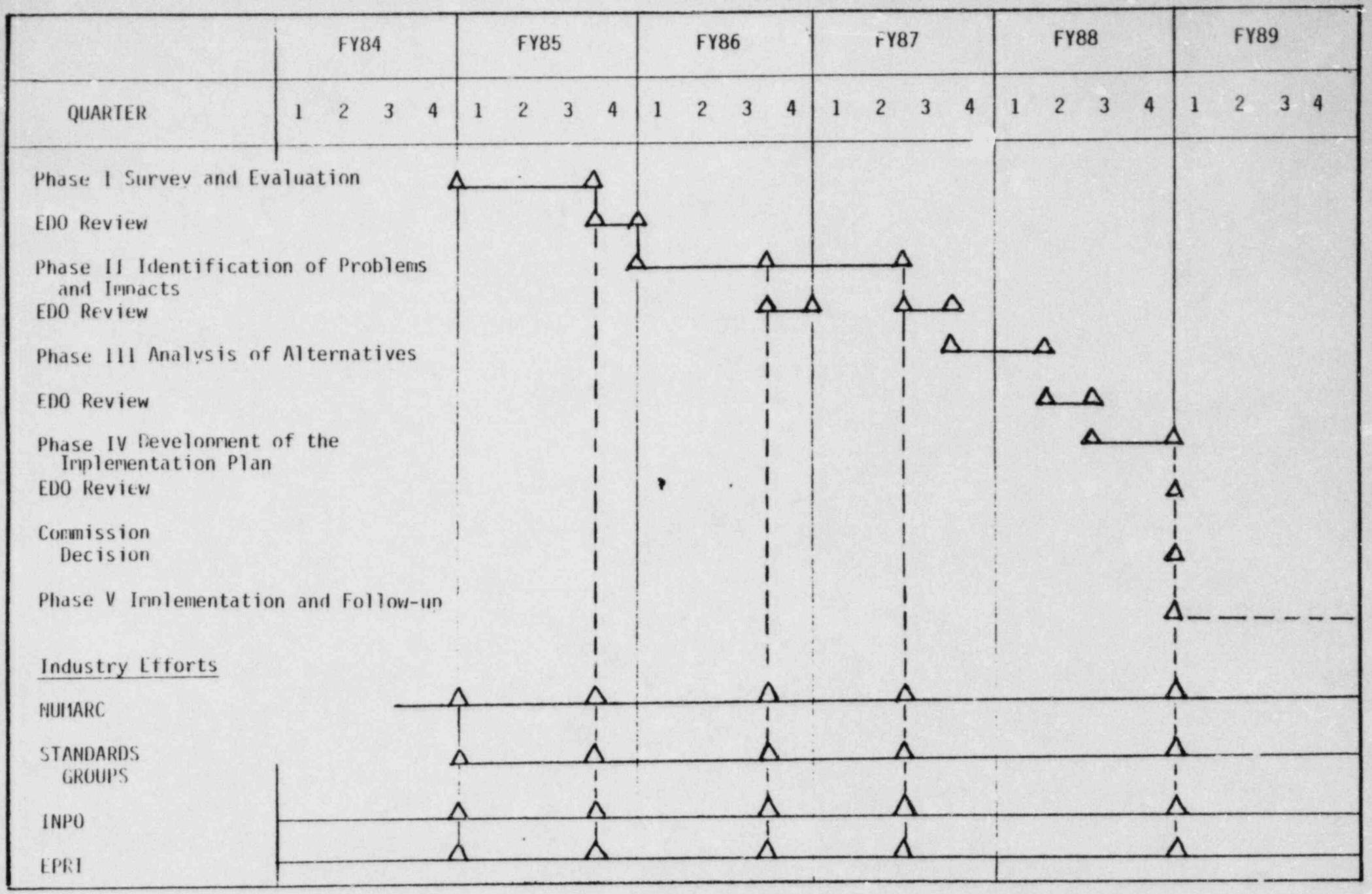
Phase I: Survey and Evaluation of Maintenance Effectiveness

Objective: to survey current maintenance practices in the nuclear industry and to evaluate their effectiveness.

Expected products:

- Description of current industry practices in maintenance and surveillance
- Preliminary objective indicators of maintenance performance effectiveness
- Methods for NRC use in assessment of plant maintenance effectiveness

FIGURE 3.1 PROGRAM PHASES



- Staff assessment of industry progress in self-improvement
- Participate in industry standards committees to initiate maintenance standards development activities
- Recommendations for subsequent maintenance program activities

Phase II: Identification of Maintenance Problems and Impact on Safety

Objective: to identify distinct maintenance problem areas and determine their impact on plant safety and worker dose.

Expected products:

- Data to support a definition of the scope of NRC concern and prioritization of individual maintenance problems
- Technical information to determine the contribution to risk and necessary corrective actions
- Validated indicators of maintenance effectiveness related to plant safety
- Assessment techniques for NRC use in determining plant maintenance effectiveness
- Survey and comparison of foreign nuclear power plant maintenance
- Survey and analysis of maintenance requirements and programs in other U.S. industries
- Recommendations for endorsement of good maintenance practices
- Contributions to draft industry standards for maintenance

Phase III: Identification and Analysis of Alternative Corrective Actions

Objective: to identify and analyze the alternative regulatory strategies to ensure maintenance effectiveness and achieve safety and health benefits.

Expected products:

- Identification of appropriate regulatory strategies
- Regulatory analysis of alternatives, including value/impact assessment

- Recommendations for appropriate NRC action
- Input to industry standards for maintenance

Phase IV: Develop an Implementation Plan

Objective: to develop an implementation plan for appropriate NRC and industry action.

Expected products

- Modified existing or appropriate new industry and/or NRC guidance or regulations concerning maintenance
- Description of the recommended method of implementation of corrective action for maintenance problems
- Regulatory decision
- Input to nationally endorsed industry maintenance standards

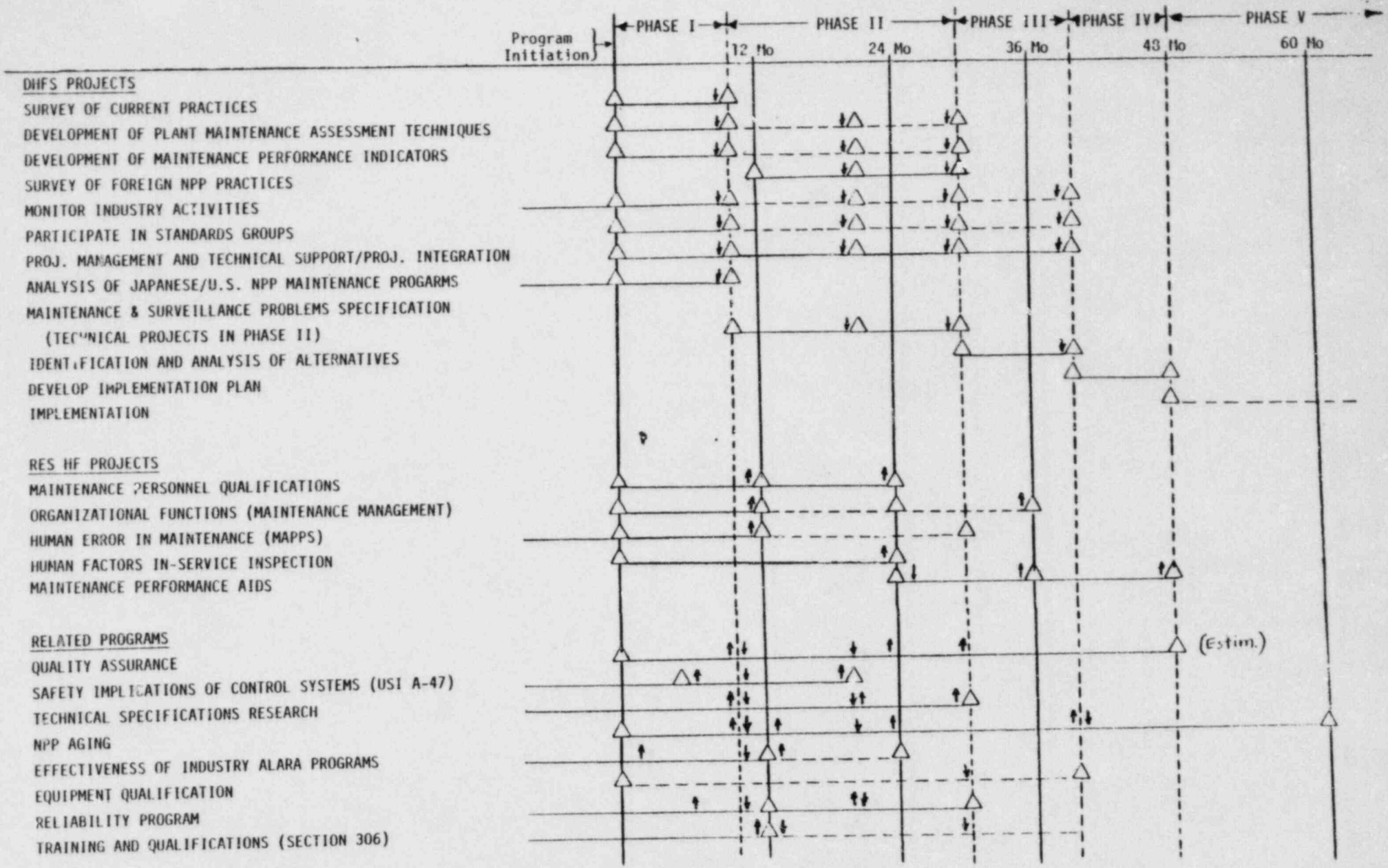
Phase V: Implementation

Objective: to implement appropriate NRC action for maintenance and to follow up and assess the safety impact of corrective action in industry.

While a phased approach to the Program is envisioned, it is anticipated that some activities will span more than one phase of the Program as preliminary results and methods are refined and validated. Use and review of interim results from planned multi-year activities will allow for the assessment of progress toward major milestones.

Coordination with other NRC offices will be necessary to utilize results of planned and ongoing activities related to maintenance and its impact on safety. Human factors research and other related projects are shown in Figure 3.2, emphasizing milestones and their anticipated integration into the maintenance and surveillance program. Vertical arrows on Figure 3.2 show where related project results will be utilized. Interim products of planned activities will provide data to evaluate the safety impact of maintenance problems and improvement strategies during early phases of the Maintenance Program.

FIGURE 3.2 - IMSP MILESTONES AND INTERACTIONS*



↑ indicates input into IMSP

↓ indicates IMSP input to related programs

*explanation of interactions in text

3.2 MAINTENANCE AND SURVEILLANCE PROJECTS (PHASE I)

The projects described below are intended to provide the technical basis for developing an NRC position on maintenance, to provide measurement techniques for use in evaluating maintenance programs of licensees and license applicants, and to provide a basis for licensing decisions relevant to assuring adequacy of maintenance. The following human factors projects will support development of the Phase I objective.

3.2.1 Survey of Current Maintenance Practices

The objective of this project is to assimilate data for assessing the present status of maintenance in the nuclear industry and to develop a method to describe the performance of the maintenance programs at nuclear power plants. This task will provide an assessment of the current maintenance programs in the nuclear industry. Several sites (e.g., one in each Region) will be selected for evaluation by a team to determine the maintenance program effectiveness. The reviews will (1) provide a baseline as reference for the assessment of future developments due to implementation of new or revised maintenance practices, standards, etc. and (2) identify plants where improvements in maintenance programs are most needed to enhance safety of operation.

This project will also include a review and analysis of inspection reports for operating reactors, development of a classification scheme for identified problems, and identification and review of additional information needs and sources (e.g., AEOD analyses, INPO evaluations, PAT inspection reports) in order to identify the characteristics of current maintenance programs and practices in the U.S. nuclear power industry.

The development, implementation, and the effectiveness of the preventive maintenance program at Salem will be evaluated as an example of a recent licensee response to a requirement for maintenance. Other industry experience with and need for preventive maintenance will be compared with the Salem program. As a result, important factors influencing the success of a preventive maintenance program will be identified.

3.2.2 Development of Plant Maintenance Assessment Techniques

In this project, a maintenance performance evaluation method will be developed for direct assessment of licensee maintenance performance using, e.g., a workbook, checklist, or other evaluation tool for NRC use. Input to development

of this method will be the experience gained from surveys of current maintenance practices. The objective is to determine criteria by which to monitor licensee performance and response to maintenance program improvements. The measurement techniques developed in this task will be validated with site visits and appropriate statistical analyses.

3.2.3 Maintenance Performance Indicators

Objective and quantifiable variables will be identified for use in determining maintenance effectiveness as it influences safety. Preliminary investigations of plant performance safety indicators have shown that multiple variables may be selected which in combination, indicate the effectiveness of a nuclear utility's maintenance practices. The development of maintenance safety indicators will build upon preliminary analyses of variables to derive a set of indicators which may be used to describe industry maintenance performance, compare plant maintenance effectiveness, and assess maintenance trends and patterns. Data and methods such as the American Nuclear Insurers plant data system will be evaluated for applicability to maintenance performance assessment.

3.2.4 Survey of Foreign Nuclear Power Plant and Related Maintenance Practices

This project will extend the analyses already initiated to compare Japanese and U.S. nuclear power plant maintenance programs. In addition, a survey and comparison of other foreign nuclear utility maintenance practices and requirements (e.g., French, German, Swedish and Canadian) will be made and contrasted with U.S. maintenance programs during Phase II of the Maintenance Program.

3.2.5 Monitor Industry Activities

Throughout all phases of the Maintenance and Surveillance Program, the NRC will monitor industry progress and experience in developing strategies for improved maintenance. Coordination with INPO will be necessary to monitor the effectiveness of the INPO plant evaluations, accreditation of training, and good practices in enhancing maintenance performance in the nuclear industry. Implementation of EPRI guidelines and the results of EPRI investigations will be monitored and their impact assessed. In addition, industry activities such as standards development and data reporting will provide input to the NRC development of performance measurement methods, guidelines, and criteria for maintenance and surveillance.

3.2.6 Participate in Standards Groups

During all phases of the maintenance program, NRC representatives are encouraging and plan to participate in development of industry national standards for maintenance by IEEE, ASME, ANS and ANSI groups. Industry standards are perceived as a means of promoting maintenance program improvements without NRC regulation. NRC endorsement of industry standards will be considered during Phase III of the maintenance program.

3.2.7 Maintenance and Surveillance Program Integration

Numerous projects sponsored or monitored by DHFS as well as by other NRC offices and industry groups are expected to produce data and information which is necessary to evaluate the safety significance of maintenance problems and potential solutions. The purpose of this project is to coordinate planning as well as to review, evaluate and integrate the results of multiple projects in order to develop appropriate conclusions and make recommendations based on available technical information.

3.2.8 Analysis of Japanese/U.S. NPP Maintenance Programs

This project involves a comparison of U.S. and Japanese nuclear power plant maintenance programs in the following areas: the differences in U.S. and Japanese NPP operating experience, the organization and management of NPP maintenance in Japan, and the comparison and contrast of Japanese and U.S. preventive maintenance requirements. The results of this project will be utilized in Phase II to provide technical inputs as an aid to determining the appropriate balance between the requirements for surveillance testing and preventive maintenance.

3.2.9 Maintenance Personnel Qualifications

The purpose of this research project is to identify from job and task analysis data, the knowledges, skills, and abilities required for the duties of electrical, mechanical, instrumentation and control, and supervisory maintenance personnel. The pertinent education and vocational training backgrounds as well as any aptitudes which provide the appropriate knowledge, skills, and abilities will be determined. The goal is to determine the appropriate maintenance personnel qualifications for use in developing standards and by which to assess current industry practice in ensuring the qualifications of maintenance personnel. The results of this two-year project will be utilized in Phases II and III of the Maintenance Program to provide

information about the present level of maintenance personnel skills and the necessary personnel qualifications, i.e., knowledges, skills, and abilities, for correct performance of maintenance tasks.

3.2.10 Organizational Functions and Roles with Emphasis on Maintenance

This research project will develop an approach for identifying organizational factors (e.g., configuration, staffing, policies and practices) which may affect maintenance performance. This analysis will focus on the maintenance element and other utility and station level organizational elements that interface with and/or influence maintenance. The research will involve analyses of organizational functions crucial to safety and roles assumed by individual managers and other members of the utility in those functions. The results of this two-year project will be utilized in Phase I and Phase II of the Maintenance Program to provide information about the nature and severity of problems in management of plant maintenance activities.

3.2.11 Human Error in Maintenance

The study of human error in nuclear plant maintenance has been pursued under a multi-year research program to develop the maintenance personnel performance simulation (MAPPS) model. A model has been developed for use in predicting errors in performance of maintenance tasks based upon a variety of task data and performance shaping factors. The model is presently being validated. Future application of the model for determining the safety importance of certain maintenance tasks and other variables affecting maintenance will be determined during Phase I of the Maintenance Program.

3.2.12 Human Factors in Inservice Inspection

The preliminary investigation of human factors issues and problems in inservice inspection activities at nuclear power plants has been initiated by the Office of Research. The need for subsequent research into the specific maintenance method of inservice inspection will be determined during Phase I of the Maintenance Program.

3.2.13 Maintenance Performance Aids

A project to study the application of job performance aids (JPAs) to maintenance tasks is envisioned for Phase II of the Maintenance Program. Such a research project would use

the results of maintenance personnel qualifications research to determine the optimum format, content, and use of JPAs as a means of improving personnel performance.

3.3 RELATED PROJECTS

Related ongoing and planned projects have been identified which may provide technical data and other products useful to of the maintenance and surveillance program. A listing of related projects in NRC offices and industry organizations is given in Table 3.1.

A description of the interfacing programs extends only to those elements that are related to the maintenance and surveillance program, it must be noted that the scope of these programs encompasses other objectives as well.

Although sufficient information has been developed to initiate Phase I projects, detailed milestones and interfaces have not been identified for all related NRC and industry programs. Specific project details are being coordinated with other offices and may result in the need for changes or modifications to project schedules to provide interim products as appropriate.

Major programmatic responsibilities for NRR include projects to measure maintenance performance, assessment of industry developments and scoping NRC activities, with DHFS having lead responsibility. These projects are related to DHFS activities concerning maintenance indicators, assessment methods, maintenance practices, and foreign experience in maintenance.

Coordination with IE is necessary for projects related to the evaluation of importance to safety issues and QA program impact on maintenance standards and criteria development. Participation of IE headquarters and Regional staff with NRR staff to evaluate licensee maintenance performance and monitor industry programs is envisioned.

Coordination with RES will provide support for program elements to determine maintenance personnel qualifications, review surveillance and Technical Specification requirements and investigate reliability methods and their applicability to maintenance programs. The projects described below have been identified as important interfaces for the Maintenance Program. DRAO will coordinate ongoing and planned activities to support these program elements. The Nuclear Plant Aging Research of RES/DET will provide information related to the role of maintenance in counteracting the effects of plant aging and make recommendations as appropriate for criteria and standards development for selected electrical and mechanical components.

AEOD will support IE and NRR review of licensee operating experience related to maintenance. LER data will be an important source of data for measurement of maintenance performance effectiveness.

TABLE 3.1 RELATED PROGRAMS [1]

	Responsible Organization
NRC	
Quality Assurance Program Plan	IE/DQASIP
Safety Implications of Control Systems (USI A-47)	NRR/DST (RES)
Technical Specifications Research	NRR/DL (RES)
Nuclear Plant Aging Research	RES/DET
Effectiveness of Industry ALARA Programs	NRR/DSI (RES)
Equipment Qualification - R.G. 1.89	NRR/DE
Reliability Research	RES/DRAO
Training Rule - Section 306 of Nuclear Waste Policy Act	NRR/DHFS
Industry	
Maintenance Activities Coordination	NUMARC
Standards	ANS, ASME, IEEE
Plant Evaluations	INPO
NPRDS, SEE-IN	INPO
Maintenance Superintendent's Workshops	INPO
Good Practices	INPO
Accreditation of Training	INPO
Maintainability Guidelines	EPRI
Technical Specifications	EPRI
Reliability Centered Maintenance	EPRI
Personnel Selection	EEI

[1] Not identified in Figure 3.3

3.3.1 Quality Assurance Program

The goal of the NRC is to assure a high level of quality in management of reactor design, construction, operations, and maintenance. The NRC policy with respect to improving the quality of nuclear plants is to (1) assure utilities provide the appropriate management framework and capability for safe operation and maintenance of nuclear plants; (2) to improve quality in utility operations and in procedures, systems, and components used in operations; and (3) to develop better guidance for the treatment of plant systems, components, and equipment that can adversely affect safe operation (Program Guidance, May 1984).

The NRC's Quality Assurance Program Plan, developed by IE, is scheduled to be completed in October, 1984. Several major initiatives of the QA Program are anticipated to have important implications for Maintenance Program activities. These include:

- development and use of QA performance indicators and trends for assessing the effectiveness of QA programs;
- the NRC inspection program (including IE team inspections and agency SALP reviews);
- QA/QC personnel issues
- revision to quality assurance standards (e.g., Regulatory Guide 1.33); and
- the important to safety issue and development of improved methodology for identifying and classifying systems, structures, and components.

Use of performance indicators for assessing effectiveness of QA programs as well as revisions to NRC inspection programs are expected to involve revisions to or development of new inspection modules or techniques for assessing licensee performance. IE is working with WPPS to develop and implement a pilot program for this project at WPN-2. Indicators of maintenance performance will be included in the program. The Maintenance and Surveillance Program, Phase I activities, will provide assessment methods and preliminary indicators of licensee maintenance performance elements which may be applied. Information from IE assessments of licensee maintenance performance from routine inspections, SALP reviews, and PAT inspections will provide information about the current status of maintenance performance in the industry. These data will be used as one source of information in order to develop techniques for

objectively assessing licensee maintenance performance during Phase I of the Maintenance Program.

The Maintenance Program project to study the qualifications of maintenance personnel may have implications for the qualifications of plant QA/QC personnel. Results from the two-year research project will be provided to IE for use in their study of personnel issues.

The need for revision of existing and development of new NRC standards and guides will be addressed in Phase III of the Maintenance Program. Revisions to the QA/QC standards (i.e., Regulatory Guide 1.33) as part of the IE QA Program will likely precede the Phase III activities. Evaluation of alternative means of ensuring maintenance effectiveness during Phase III may involve coordination with IE for Regulatory Guide modifications.

The IE plant surveys for the important to safety issue will be an important source of information for Phase I of the Maintenance Program. IE has visited several utilities to examine their overall approach to ensuring quality in nonsafety-related systems and activities.

The IE surveys will provide data regarding plant practices in maintaining equipment important to safety. The scope of the Maintenance Program concerns maintenance of systems and equipment regardless of classification. However, the scope of regulatory concern, to be determined during Phase III of the Maintenance Program, will be based on regulatory analysis of important to safety as well as other factors. The agency policy regarding systems and equipment important to safety will help to determine the scope of regulatory concern for maintenance. The nature and safety significance of maintenance problems identified during Phase II may also clarify the definition of important to safety in terms of risk. For each of the QA program projects described above, working contacts have been established between IE/QAB and NRR/DHFS.

3.3.2 Safety Implications of Control Systems (Unresolved Safety Issue A-47)

The Division of Safety Technology (DST), Generic Issues Branch (GIB), is the lead organization for this unresolved safety issue. The project identifies nonsafety grade control systems in which a failure or malfunction could have significant impacts on plant safety. The study is designed to identify the control systems that are important

to safety, to conduct computer simulations to determine the effects of failures, to evaluate licensee responses to relevant regulatory actions, and to propose criteria or guidelines to improve the reliability of nonsafety grade systems.

Areas of Interaction

- The resolution of the issue will be utilized in Phase II and Phase III of the IMSP as an element in a comprehensive maintenance program.

- The definition and criteria used to identify systems that are not safety grade, but have important impacts on safety, will be considered in maintenance programs if the Commission approves the use of such categorization.

3.3.3 Technical Specifications Research

In August 1983 the Executive Director for Operations (EDO) requested the Deputy Executive Director for Regional Operations and Generic Requirements (DEDROGR) to establish a Task Group to identify the scope and nature of problems with surveillance testing in current Technical Specifications and to develop alternative approaches to provide better assurance that surveillance testing does not adversely impact plant safety. The Task Group found (NUREG-1024) that because of the interdependence between surveillance testing, limiting conditions for operation (LCOs) and their bases, it was necessary to broaden the scope of the review. The EDO endorsed the thrust of the recommendations and the implementation methodology outlined in their report. The Division of Licensing (DL), Standardization and Special Projects Branch (SSPB), was subsequently assigned the lead responsibility to develop and implement a program that would accomplish the intent of the Task Group's recommendations.

A November 14, 1983 EDO directive also indicated that the Office of Research (RES) would provide the research and analytical support needed for the NRR program. As a result of this action, the Division of Risk Analysis and Operations (DRAO) initiated a broad-based program, Procedure for Evaluating Technical Specifications (PETS), designed to examine approaches for developing a quantative basis to support engineering judgments in evaluating Technical Specifications, and to demonstrate and fully document the methodology.

In a related activity, the Division of Safety Technology, (DST) Reliability and Risk Assessment Branch (RRAB), has the lead responsibility for the resolution of Generic Issue B-61 to optimize ECCS allowable outage periods and test/maintenance intervals to reduce system unavailability. Presently, the maintenance unavailability of a component depends not only on the average length of time that a component is out for maintenance, but also on the frequency with which the maintenance is performed. Present technical specifications do not control the frequency of such unavailability, but a cumulative outage limit may be effective in doing so.

Since analytically based criteria are needed as a basis for determining surveillance and test intervals in technical specifications for emergency core cooling systems (ECCS), NRR/DST has requested that RES incorporate into the PETS program the need to identify and evaluate possible means of implementing limits on cumulative outage times. The RES methodology for analytically deriving cumulative outage limits for ECCS will be tested by DST and a licensing position developed.

The PETS program is expected to provide support for setting limits on reliability levels for diesel generators. The Division of Systems Integration (DSI), Power Systems Branch (PSB), has the lead responsibility for the resolution of Generic Issue B-56 on diesel reliability. Issue B-56 has a high priority ranking due to its impact on plant safety concerning successful accident mitigation. The PETS program will investigate several criteria, which will be essential to the development of a methodology to relate cumulative outage time with diesel reliability level, diesel configuration, and surveillance frequency.

Phase I of the PETS program is scheduled for FY 1985 as a concerted effort to urgently resolve some generic questions surrounding the risk importance of both corrective and preventive maintenance procedures, as well as to provide timely support for B-61 and B-56.

Areas of Interaction

- In Phase I need for continuation of the PETS program will be determined. The MSPP is designed to examine the surveillance requirements in the technical specifications in view of the preventive maintenance program. The PETS methodology will be reviewed to determine how to utilize it in analyzing the hypothesis that an effective maintenance program may compensate for some of the

surveillance requirements in existing Technical Specifications. DHFS will prepare the user need for continuation of the PETS program to analyze the hypothesis.

- The PETS program will complete the technical analysis during Phase II (1) to determine the requirements for changing the surveillance requirements in relation to the preventive maintenance programs and (2) to establish surveillance requirements on the basis of system reliability.

- The ECCS outage research will provide input to Phases II and III of the Maintenance and Surveillance Program. The risk-based methodology for deriving technical specification outage limits will be evaluated as a means of determining maintenance needs and the results of trial technical specifications evaluations will be used to determine the nature and extent of maintenance problems at operating plants.

- The results of the trial applications of methods for deriving ECCS outage limits will be assessed for Phase II to determine the impact on safety.

- The need for limits governing maintenance and surveillance outages will be determined so that recommendations from Phase III of the Maintenance and Surveillance Program may be used for development of a licensing position by DST for ECCS outage limits.

3.3.4 Nuclear Plant Aging Research

The Nuclear Plant Aging Research (NPAR) program sponsored by the Office of Research, Division of Engineering Technology (DET), is intended to identify and characterize aging and service wear effects associated with electrical and mechanical components, interfaces, and systems likely to impair plant safety. The research will identify and recommend methods of inspection, surveillance and condition monitoring of electrical and mechanical components and systems which will be effective in detecting significant aging effects prior to loss of safety function so that timely maintenance and repair or replacement can be implemented. Aging research will also identify and recommend acceptable maintenance practices to mitigate the effects of aging and service wear.

Areas of Interactions

- The important products which will be input to the Maintenance and Surveillance Program Phase I Survey and Evaluation will be a survey of current maintenance practices for selected components including motor operated valves.

- Anticipated results from the NPAR which will be useful for Phase II Identification of Problems and Impacts will be an evaluation of the relative benefits of preventive and corrective maintenance and identification of potential mechanisms causing equipment degradation through improper maintenance for selected components.

- Recommendations for preferred maintenance practices for selected components provided from the NPAR will be used in Phase III of the maintenance program for analysis of Alternatives for ensuring effective maintenance.

- The NPAR will provide an evaluation of the role of maintenance in counteraction aging effects.

- Phase I and II of the Maintenance Program will provide information regarding plant maintenance indicators and current industry practices to the NPAR.

- Recommendations for regulatory alternatives for ensuring effective maintenance performance, including means of mitigating the effects of aging and service wear as appropriate, will be provided for DET/RES review from Phase III of the Maintenance Program.

3.3.5 Effectiveness of Industry ALARA Programs

The Division of Systems Integration (DSI), Radiological Assessment Branch, is concerned with the high proportion of occupational radiation exposure which is attributed to maintenance activities. RAB is funding a project intended to identify the issues and perform cost-benefit analysis on new dose-reduction techniques and industry-developed equipment. A related research project is a comparative review of occupational dose experience at U.S. and foreign nuclear power plants. The scope of this research includes an identification and evaluation of high-dose maintenance tasks as well as new industry incentives for dose reduction. One aspect of the RAB program is to evaluate the effectiveness of industry (e.g., INPO) programs to reduce occupational exposure and determine the need for further regulatory guidance.

Areas of Interaction

- The results of the research and assessment of industry programs will be used in developing measures of maintenance practices and problems during Phase I of the Maintenance and Surveillance Program. Occupational exposure data will be reviewed as a possible indicator variable for assessing licensee maintenance effectiveness.

- High-dose maintenance tasks that are identified from the RAB programs will be used in evaluating the safety impact of maintenance problems during Phase II of the Maintenance and Surveillance Program.

- Dose-reduction techniques identified will be evaluated for their impact on maintenance effectiveness.

- The survey of industry maintenance practices and problems from Phase I of the Maintenance Program will provide information on maintenance practices that impact ALARA programs.

- The above information, as well as information about the relationship between occupational exposure data and maintenance effectiveness as safety indicators, will be provided from Phase I and Phase II of the Maintenance Program to RAB/DSI for input to their determination about the need for regulatory guidance.

3.3.6 Equipment Qualification

The Division of Engineering (DE), Equipment Qualification Branch (EQB), pursues quality control of nuclear power plant equipment to ensure performance in accordance with design specifications. The equipment qualifications program requires information regarding age-related performance degradation of equipment and components and maintenance and surveillance activities which affect equipment integrity. Results of the Nuclear Plant Aging Research will provide implications for the environmental integrity of electrical and mechanical components and equipment qualifications. Information and methods by which licensees may identify and perform necessary maintenance effectively is needed to evaluate equipment qualification impacts. While initial IE inspections of EQ programs will focus on the technical adequacy of the initial qualification process, maintenance activities necessary to maintain qualification will need to be built into the inspection program.

Area of Interaction

- The need for regulatory guidance to ensure equipment qualification will be identified as the safety impact and nature of maintenance problems are investigated during Phase II of the Maintenance Program and provided to DE/EQB.

3.3.7 Reliability Program

The Division of Risk Analysis and Operations (DRAO) of the Office of Research sponsors the reliability research program with objectives to design and build reliability into systems that are important to safety and prevent degradation of this reliability during operation. The tasks to be performed under the reliability research program include a screening evaluation to survey available reliability techniques applicable to LWRs. Elements that appear most promising for applicability to nuclear plant reliability will be developed for trial application.

Areas of Interaction

- The reliability research program is expected to produce methods and recommendations for determining priorities for maintenance (e.g., frequency, preventive or corrective type) and would help to prioritize equipment for maintenance action.

- The results of the trial applications will be important for evaluation of the safety impact of maintenance problems during Phase II of the Maintenance Program.

- Recommendations for reliability-centered maintenance strategies from the reliability program will be considered during the analysis of alternatives in Phase III of the Maintenance Program.

- Information from Phase I surveys of current maintenance practices will be provided to DRAO/RES to identify current reliability practices and implementation constraints at operating plants.

Related projects being sponsored by EPRI are being monitored for use in the Maintenance Program through the RES Reliability Program. These EPRI projects include efforts to evaluate Technical Specifications requirements affecting safety system reliability as well as a trial application of reliability centered maintenance methods at a sample of plants.

3.3.8 Training and Qualifications of Personnel (Section 306 of the Nuclear Waste Policy Act

The NRC response to Public Law 97-425, The Nuclear Waste Policy Act, Section 306 has been to propose requirements for all licensees and applicants to provide a systems approach to training (SAT) as the basis for ensuring that personnel are trained for performance of their job tasks and duties.

Maintenance as well as operations personnel training would be required by the rule to be based on Systems Approach to Training (SAT).

The Division of Human Factors Safety proposes to publish the rule if approved by the Commission and evaluate industry implementation of the SAT. The NRC will continue to inspect and evaluate licensee training programs, including maintenance training, using criteria based on the SAT.

Areas of Interaction

- The need for further regulation of maintenance personnel qualifications and training will be evaluated based on the NRC review of industry implementation of SAT-based training.
- The results of NRC maintenance training reviews will be utilized during Phase II of the Maintenance Program to assess the effectiveness of industry maintenance personnel training programs.
- The evaluation of the safety impact of maintenance personnel qualifications and training, as determined from Phase II activities of the Maintenance Program will be provided to DHFS personnel for assessing the effectiveness of industry maintenance personnel training.

3.4 INTERACTIONS WITH OUTSIDE ORGANIZATIONS

Interactions with outside organizations will be conducted in order to assess the acceptability of industry initiatives and activities to achieve the objectives of the maintenance program. A number of outside organizations have expressed interest in nuclear power plant maintenance and are concerned in various aspects of maintenance operations. The Program Plan is designed to assess the significance of the contribution of these organizations and to utilize their activities to complement the NRC efforts. The primary coordination point is currently with NUMARC. Through NUMARC and direct NRC contacts, the following organizations are expected to play major roles in a national program for improving maintenance in the nuclear industry.

1. Nuclear Utility Management and Human Resources Committee (NUMARC)

The NUMARC has identified four initiatives in response to the NRC Maintenance and Surveillance Program development. The four initiatives represent the near-term industry effort to study and improve maintenance performance.

The initiatives are:

- development of objective, quantifiable indicators for assessing industry maintenance;
- reviewing of INPO criteria used for evaluating plant maintenance;
- a reviewing of SEE-IN data for maintenance-related events; and
- an inventory of current industry maintenance programs.

These initiatives are tentatively scheduled to be completed by March 1985, with results available to the NRC.

2. Standards Organizations

The ASME Committee on Operations and Maintenance, the ANS Operations Committee and the IEEE Nuclear Power Engineering Committee have been conducting a dialogue within the last few years on the need for a national standard on maintenance for nuclear power plants. A working relationship will be conducted with these organizations by NRC representatives on the committees and by periodic presentations on NRC activities to the committee meetings. If a national standard on maintenance becomes available within a reasonable period of time, it will be considered for inclusion in the regulatory alternatives.

3. Institute of Nuclear Power Operations

The Institute of Nuclear Power Operations (INPO) is involved in a number of activities that are closely related to the subject of the Maintenance Program Plan. The following INPO programs are considered: (a) INPO's periodic plant evaluations address issues in maintenance. The Program Plan will assess the effectiveness of the plant evaluations and will consider it as one of the regulatory alternatives concerning industry self-monitoring; (b) INPO has developed qualification guidelines for mechanics, electricians and instrumentation/control technicians. The implementation of these guidelines

will be followed; (c) INPO has conducted a number of workshops for maintenance superintendents. NRC participation and observation of the workshops will be continued; (d) INPO is in the process of documenting and disseminating information on good industry practices. INPO good practice activities on maintenance will be followed in the Implementation Plan; (e) INPO's Accreditation Program for Training includes maintenance personnel. Training accreditation is being evaluated by NRR; the results will be monitored as part of the planned maintenance activities.

4. Department of Energy

The Department of Energy (DOE) has developed a method to assess the performance of maintenance for nuclear reactors within the Management Oversight and Risk Tree (MORT) program. The method has been used for DOE reactors, and is in the process of being validated with a number of Scandinavian nuclear power plants. The applicability of the DOE assessment method for NRC use will be evaluated within this program.

5. Electric Power Research Institute

The Electric Power Research Institute (EPRI) has been conducting a large number of research studies related to maintenance. Some of the EPRI programs, such as the development of a preventive maintenance guide (EPRI Report NP-3416) or the maintainability guidelines (EPRI Report NP-2360) are directly related to some elements of the Program Plan. The results of the EPRI research studies will be utilized in the program and NRC personnel will participate in and contribute to EPRI maintenance workshops.

6. American Nuclear Insurers, Inc.

The American Nuclear Insurers, Inc. (ANI) considers plant maintenance as one factor for developing an overall plant assessment. The ANI method and past experience will be reviewed and utilized in the development of performance measurement techniques in Phase I and II of the Maintenance Program.

7. Vendor Maintenance Programs

The maintenance guidelines, maintenance program recommendations, and maintenance services available from the vendors of nuclear power plants will be evaluated and utilized in the program.

8. Maintenance Activities Outside the Nuclear Industry

The U.S. military, the NASA and the Federal Aviation Administration (FAA) have well-established and successful maintenance programs. The technical, organizational and regulatory aspects of these maintenance activities will be included in the program by direct exchange of information, documentation, and data between the above organizations and the NRC staff.

9. Foreign Countries Maintenance Programs

The staff plans to continue its exchange of maintenance program information with the Japanese and to initiate information exchange with the French, German, Swedish, United Kingdom and Canadian Governments.

10. Edison Electric Institute (EEI)

Edison Electric Institute has been developing examinations for selection of nuclear power plant personnel. Ability and aptitute screening as selection practices for maintenance personnel should be pursued for possible incorporation in standards and guidance for personnel qualifications. The staff will exchange information with EEI regarding personnel selection and screening practices in the industry.