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AN AGING MANAGEMENT PROGRAM FOCUSED ON THE FULL UTILIZATION OF EXISTING LICENSES

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ABSTRACT

An Aging Management Enhancement Program has been developed to identify and mitigate the risk and uncertainties that unusual, accelerated, or previously unanticipated aging of Systems, Structures, and Components pose to the continued long term safe, economic, and reliable operation of nuclear facilities. This paper defines a process intended to enhance the understanding and control of the aging of systems, structures, and components (SSCs). The program is selective and proactive. It largely employs the experience and knowledge of personnel that have hands-on responsibility for engineering, maintaining, and operating the facility. The identification of SSCs and associated age related degradation mechanisms (ARDMs) that present future vulnerabilities to a plant allow focused actions to be implemented to remedy or abate the risk prior to the aging degradation adversely impacting plant operation. Selection of structures and components susceptible to accelerated aging degradation and appropriate remedial corrective and/or preventive actions are based on a recognized need to achieve a balance between plant safety, plant economics, and plant reliability.

INTRODUCTION

Nuclear facilities can benefit from programs that identify aging related degradation that may occur during the licensed forty year life of the plant and beyond. Current License Renewal activities predominantly focus on the period of time that would extend the operating life of nuclear plants from forty to sixty years. These License Renewal activities are occurring at a time when plants have not clearly demonstrated an ability to run economically for their original licensed period of forty years. Programs and investments that promote the full utilization of the existing license are required. Such programs will focus on the period of time between the current age of the facility and forty years. Programs that attempt to understand and anticipate the unusual or accelerated aging degradation of the plant during this period will promote the Full Utilization of the Existing License. Such programs will also lead to a clearer understanding of the areas of the plant that require more thorough investigation when License Renewal activities are desired. Focusing on the period of forty to sixty years without aggressively pursuing a strong process that ensures ongoing aging mitigation and competitive reliable plant performance is inherently risky and short-sighted.

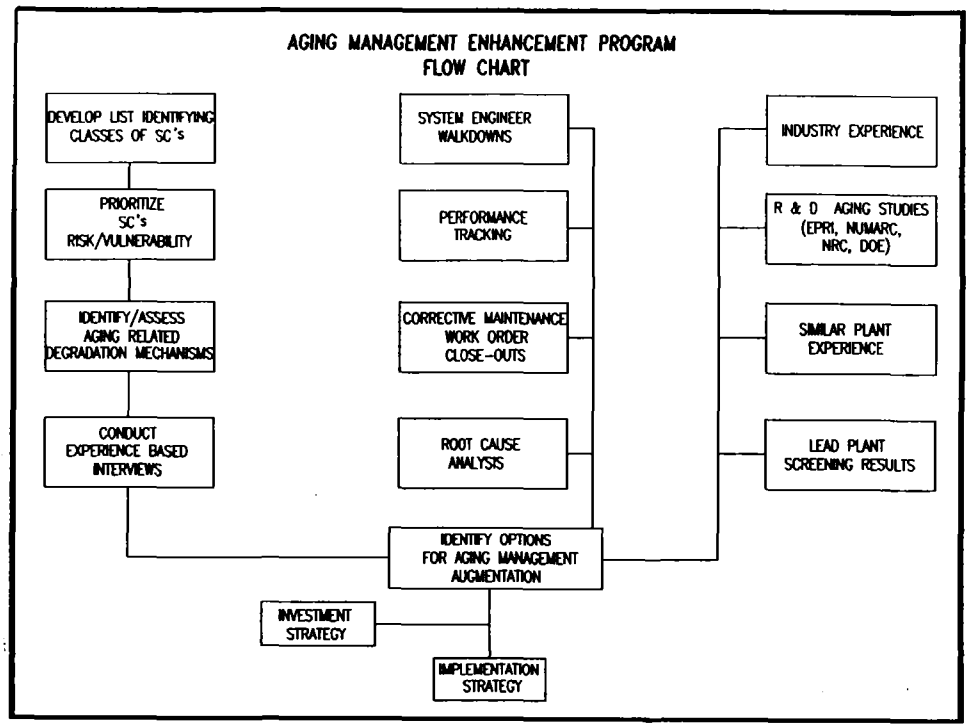
Existing maintenance programs are appropriately focused on active equipment that operates or must be available during normal or off-normal modes of operation. Valves, pumps, motors, compressors, gasketed joints, and similar equipment are covered by corrective maintenance, preventive maintenance and, increasingly, reliability centered maintenance programs. Other more focused programs that are effective in monitoring and mitigating aging include programs such as reactor vessel embrittlement programs, steam generator programs, fatigue monitoring programs, erosion/corrosion programs, and many others. Existing programs should be reevaluated to assure adequacy in managing the known aging processes. Identification of degradation mechanisms that are not being captured by existing maintenance and surveillance programs form the basis for special aging related programs.

AGING MANAGEMENT PROGRAM

The identification and implementation of programs to control aging related degradation is performed by the process illustrated in the flow chart in Figure 1. Three parallel paths are shown.

The first path relies on the knowledge of the engineering, operations, and maintenance staff supporting the power plant. Classes of components or structures to be reviewed in detail are selected, and intensive knowledge and experience based interviews of personnel selected to have

Figure 1



specific knowledge of the specific class of component or structure are performed. There are three primary activities in the first path. These are Performance Based Screening, Experience Based Interviews, and Program Augmentation. The following sections will describe these activities in detail.

The second and third paths utilize other activities and experience both from inside and from outside the specific utility in order to gain broader insight into the possible stressors or expected performance of the plant structures or components being studied. These activities will also be described.

PERFORMANCE BASED SCREENING

Structures and components (SCs) that are vulnerable to unacceptable aging degradation will be identified by utilizing Performance Based Screening. Performance Based Screening uses the actual performance of structures and components at the plant being studied and at other similar plants and the knowledge of selected engineers to enable aging trends to be recognized. Performance tracking and trending programs will be utilized to monitor the actual performance of SCs at the plant and to provide insight into the selection process. Screening and trending programs will allow early detection of aging related degradation.

A review of structures and components in the plant is performed to identify "classes of structures" and "classes of components" (e.g., concrete structures, medium voltage cables, stainless steel motor operated valves, and NSSS components are classes of structures and components). The classes of structures and components are identified by reviewing all types of structures and components at the plant and by grouping components together that have common aging mechanisms. A classification of all the parts of the power plant resulted in twenty eight classes of structures and components. These are tabulated in Table 1. For each class, subclasses allowed further definition and categorization.

The classes of structures and components are reviewed to identify those classes whose aging is believed to present the greatest risk to the safe, economic, and reliable operation of the plant. This review and risk assessment is performed by a management team specially selected to have overall insight into the performance of the plant. Their task is to review the classes of structures and components in order to develop a prioritized list of classes of structures and components. The prioritization is in order of susceptibility to unusual or unanticipated aging. Those classes of components felt to present the greatest potential vulnerability resulting from the presence of aging related degradation mechanisms are identified to be evaluated first. Experienced based interviews, to be defined in the next section, are utilized in the evaluation.

Table 1: Aging Management Enhancement Program Commodity List

1.	Batteries	15.	Motors
2.	Battery Chargers	16.	Penetration Assemblies, Electrical
3.	Cables/Wires	17.	Piping
4.	Coatings/Paint	18.	Pipe Supports/ Restraints
5.	Conduits/Cable Trays	19.	Piping Components
6.	Ducts (HVAC)	20.	Instruments
7.	Electrical Terminations	21.	Pumps
8.	Emergency Diesel Generators	22.	Security System
9.	Fans	23.	Structures
10.	Fasteners	24.	Tanks
11.	Heat Exchangers	25.	Transformers, Power
12.	Insulation/ Fireproofing	26.	Tubing
13.	Inverters	27.	Valves
14.	Miscellaneous Electric Components	28.	Special Items

The team that performs the prioritization utilize their experience from the specific power plant, but also the integrated knowledge that they have from other sites, including emerging issues, industry-wide interaction, and fossil units.

EXPERIENCE BASED INTERVIEWS

The highly ranked classes of structures and/or components that are selected for further evaluation are reviewed in detail in Experience Based Interviews. This process is based on the tenet that the people that know the most about the specific structure or component are those that maintain, operate, and engineer that structure or component. The elicitation and integration of the collective information from such a group of experienced personnel coupled with relevant industry experience and focused research results is the most effective way to define, anticipate, and take action with respect to unanticipated or accelerated age related degradation.

The basis for the expert elicitation techniques is a NUREG entitled "Eliciting and Analyzing Expert Judgement: A Practical Guide" and prepared by Los Alamos Labs [1]. The process defined in Reference 1 has been adapted to the needs of this special application. The process utilized in the interviews will be defined below.

Interview Process

The interview process has three steps. These are pre-interview preparation, actual interview sessions, and report preparation. Each of these will be described.

Pre-Interview Preparation

Prior to the interviews, the interviewers and interviewees are selected. The interviewers must be carefully selected. The interviewers should have technical familiarity with the issues but need not be experts. These individuals should have an open mind, be good listeners, have an ability to create a comfortable non-threatening environment, and have an interest in performing the interviews.

The interviewees - those to be interviewed - are selected by consultation with other knowledgeable personnel. It is effective to develop a list of potential interviewees and then contact maintenance supervisors, systems engineers, and others to obtain endorsements for those on the list as well as to obtain recommendations for others that would be good candidates. Although the number of interviewees is not important, eight to ten interviews might be expected. Some interviews with specific personnel with focused experience can be short. The interview list should include a wide range of personnel from those that have hands-on experience to those that are solely in decision-making roles. Personnel with previous responsibilities and historical knowledge can also provide valuable information on structure or component performance and operating experience over time.

The interviewees should include a carefully selected expert in the mechanisms of degradation. This expert would depend on the specific component or structure, but could possibly include a corrosion expert, a polymer expert, a concrete degradation expert, or an expert in another field related to the component or structure being evaluated.

The vendor of the equipment should also be contacted to provide an experienced person to be interviewed. This person should have knowledge of the history of the structure or component and should be aware of experience at other facilities. Competing vendors can also be included to provide a different perspective.

A comprehensive package of information should be assembled for the interviewers. This package should include design information, vendor manuals, component history, tabulation of maintenance performed at the plant, tabulation of Nuclear Plant Reliability Data System (NPRDS) surveys, industry aging degradation reports (NUREGs, Electric Power Research Institute reports, NRC reports, etc.),

Design Basis Documents, Tech Specs, Test Procedures, Maintenance Procedures, and other information that could be useful. The interviewers should review this information in detail prior to the interviews.

Training in the techniques of effective interviewing should be provided. NUREG CR-5424 [1] should be provided and reviewed. An individual experienced in these methods should provide training on the most appropriate and effective methods of interviewing. The Interview Team should review and discuss the methods that they will use to conduct the interviews. Although the interview process must seem informal and relaxed to the interviewee, it must be well planned, understood, and executed by the Interview Team.

As they continue to work together, the Interview Team should develop a listing of questions and a flow of topics prior to the interview meeting to serve as a guide for the team during the interviews.

Interviews

The interview should begin with an introduction of the interviewers and a description of the process together with intended objectives. The process should proceed somewhat casually. Interviewers need to respect the flow of the elicitation process and allow a line of questions to be completed before proceeding to the next subject.

Questions should include a characterization of the environmental conditions that the structure or component will experience in service. The environmental characterization should include the extremes during normal and off-normal operation. Questions should also include personal recollections of inspections and conditions of the structure or component. Inquiries about condition monitoring and specific modes of degradation, corrosion, for example, are useful. Specific repair procedures that the interviewee has personally performed and resulting observations can provide valuable insight into the aging process. Through all these questions, the interest is in their experience base and how they have made decisions, what they have seen, what was the condition, and what did they see in addition to what they went to look for. An overall question on perceived reliability and the interviewees level of confidence is beneficial since it can help provide a subjective validation of risk and provides an open-ended opportunity to explore the thoughts that have developed over time. Recommendations that they would have can be useful when integrated with other interview results.

While the interviewers are not trying to become experts during this process, they should gain a very broad understanding of many aspects of the structure or component. The job of the interviewers is to integrate the information and to decide how the various parts of the information gained fit together.

Copious notes should be taken by the interviewers. These notes should be reviewed at the conclusion of the interview for the purposes of drawing intermediate conclusions.

Report Preparation

Immediately following the completion of the interviews, the interviewers should meet to identify the primary conclusions drawn from the interviews. Phone interviews with other utilities or fossil stations may be useful to assure that there are not other mechanisms or experiences that other utilities have experienced. This information should be integrated into the reports. The report should provide summaries of the information gained and specific recommendations for augmenting the engineering, operations, maintenance, and/or testing activities that are being performed on the structure or component.

PROGRAM AUGMENTATION

Conclusions of the Experienced Based Interviews should either support the existing programs or indicate that the existing programs should be augmented. The potential "augmentation" should not only include the possibility that maintenance and/or inspection activities should be enhanced, but should also explore the possibility that excessive maintenance and/or inspections are being performed and can be reduced. Any recommendations that are selected for implementation should be integrated and tracked as part of the ongoing maintenance activities. The basis for the recommendations should be included.

ACTIVITIES AND EXPERIENCE FROM BOTH INSIDE AND FROM OUTSIDE THE SPECIFIC UTILITY

Existing utility programs should be augmented to assure that potential aging related degradation is noted. Programs, for instance, that require periodic walkdowns should be utilized to identify emerging aging related degradation. The walkdowns, augmented by aging degradation considerations, could provide a direct indication of many discernable aging related degradation mechanisms, such as corrosion, vibration, cavitation, seal or packing degradation, or others. An aging related degradation section can be added to the walkdown reports.

Maintenance task closeout activities can be augmented to provide greater information on the condition of the component and the cause of the maintenance. These closeouts could document "As-Found Condition", "What was repaired?" and "What was the cause of the failure?" information that could be utilized for identification of aging mechanisms and to identify signs of aging related degradation.

Tracking, trending, and reporting of any structure or component performance could be utilized to identify aging related issues. Any increase in the failure rate of particular structures or components or classes of structures or components can be a key indicator of aging related problems. Trending of test results, component failures, corrective maintenance actions, or other system or component unreliability is important to the identification of aging related degradation.

Root cause analyses may be performed on significant failures which adversely impact of plant safety, economics, or reliability. These root cause analyses could be reviewed to identify signs of aging related degradation.

These are examples of activities that could be implemented to build on existing programs. All these augmented programs can provide insight into aging that would be difficult to pick up otherwise.

ACTIVITIES AND EXPERIENCE FROM INDUSTRY RESEARCH AND OTHER PLANTS EXPERIENCE

Industry, regulatory, and vendor notices and bulletins that describe failures of structures or components should be reviewed, evaluated and disseminated to provide an early warning or corroboration of aging related degradation mechanisms. The results of research that provides insight into plant operation, maintenance, surveillance, or engineering activities should be identified, reviewed, and disseminated. This research may come from the Nuclear Regulatory Commission, Department of Energy, Electric Power Research Institute, Nuclear Utility Management and Resources Committee (NUMARC), and others.

Plants that are as old or older than the plant being investigated should be particularly monitored. Periodic visits to such plants should be scheduled to capture failure and degradation experience in structures or components with longer operating history. Visits to fossil units may also provide relevant aging information for equipment that is similar in both nuclear and fossil units. It is valuable to select sites that experience similar environmental conditions if possible, such as a coastal environment.

The Lead Plants for License Renewal are performing screening and identifying those structures and components felt to require evaluation for purposes of license renewal. The results of the Lead Plant screening and programs should be reviewed for possible insight into the aging at a selected plant.

FUNCTION VERSUS DEGRADATION MECHANISM

An Aging Management Enhancement Program can effectively supplement implementation activities on the Maintenance Rule, described in 10CFR65 [2], and the License Renewal Rule, described in 10CFR54 [3]. The Maintenance Rule largely focuses on assuring that the functional performance of a system is satisfactory. This is done through a condition or performance monitoring program that bases the quality of maintenance programs on the ability to prevent failures. License Renewal Rule activities are also evolving toward a functional performance based approach.

The utilization of functional performance as a means to measure success of the programs is an appropriate and effective approach to achieve plant safety. Clearly, functional performance is important to and a goal of aging management. Focusing on plant performance, though, requires recognizable performance degradation prior to "failure". The programs must be in place to recognize significant performance degradation. The approach utilized in the Aging Management Program described herein, provides a proactive methodology to identify degradation prior to it being recognized in plant performance monitoring.

The Aging Management Program focuses on degradation mechanisms in addition to functional performance. This slightly different approach increases the likelihood that degradation that may not have yet manifested itself in degraded performance is detected. The clear definition of degradation mechanisms, combined with a knowledge of environmental stressors, can be an effective method to detect less evident risks and vulnerabilities that could significantly impact long term, economically competitive, reliable operation and nuclear production resource strategy.

SUMMARY

The effective implementation of an Aging Management Enhancement Program has the potential to identify and mitigate the risk and uncertainties that unusual or accelerated aging of Systems, Structures, and Components pose to the continued long term safe, economic, and reliable operation of nuclear facilities. The utilization of knowledge that has been developed by hands-on experience over many years is the most effective way to accomplish such a program. Proactive implementation in selected areas of the plant allows unusual and unanticipated aging to be identified and mitigated.

REFERENCES

1. "Eliciting and Analyzing Expert Judgement: A Practical Guide", NUREG/CR-5424, Los Alamos National Lab., January, 1990.

2. Title 10 of the United States Code of Federal Regulations, §50.65, "The Maintenance Rule", June, 1993.

3. Title 10 of the United States Code of Federal Regulations, §50.54, "The License Renewal Rule", December, 1991.

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The Nuclear Power Plant

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