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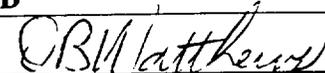
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AGING MANAGEMENT REVIEW FOR REACTOR LICENSE RENEWAL

by

Sam Lee and P.T. Kuo
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission

ABSTRACT

The Nuclear Regulatory Commission (NRC) issues licenses for commercial power reactors to operate for up to 40 years and allows these licenses to be renewed for additional periods of 20 years. In 1995 the Commission issued Part 54 of Title 10 of the Code of Federal Regulations (10 CFR Part 54) specifying the regulatory requirements for license renewal. The license renewal rule focuses on managing the adverse effects of aging of plant structures and components. The NRC staff has developed license renewal rule implementation guidance documents. The NRC staff uses a systematic approach in evaluating the adequacies of aging management programs. The NRC has approved several license renewal applications to date and will likely be asked to approve dozens more over the next 10 to 15 years.

INTRODUCTION

The Nuclear Regulatory Commission (NRC) issues licenses for commercial power reactors to operate for up to 40 years and allows these licenses to be renewed for additional periods of 20 years. The original 40-year license term was selected on the basis of economic and antitrust considerations, not because of technical limitations. In 1995 the Commission issued a rule (10 CFR Part 54) specifying the regulatory requirements for license renewal (Ref. 1). The license renewal rule focuses on managing the adverse effects of aging of plant structures and components. The NRC has approved several license renewal applications to date and will likely be asked to approve dozens more over the next 10 to 15 years.

The license renewal review process proceeds along two tracks — one for safety issues and the other for environmental issues. An applicant must provide NRC with an evaluation that addresses the technical aspects of plant aging and describes how the effects of aging will be managed. The applicant must also prepare an evaluation of the potential environmental impact of plant operation for another 20 years. Public participation is an important part of the license renewal process. The NRC holds a number of public meetings during each license renewal application review. NRC evaluations, findings, and decisions are published when completed. In addition, members of the public have an opportunity to request a formal adjudicatory hearing if they would be adversely affected by the renewal.

This paper discusses the technical reviews of plant aging management programs. The reader may wish to visit the license renewal page at the NRC Web site for additional information (<http://www.nrc.gov>). The documents referenced in this paper are available at this Web site. The U.S. Government Printing Office (GPO) has also published these documents on a single

compact disk (CD). The reader may order the CD by calling the GPO bookstore at 202-512-1800 and referring to Stock Number 052-020-00868-0.

LICENSE RENEWAL GUIDANCE DOCUMENTS

The NRC staff and the industry have developed license renewal rule implementation guidance documents. These guidance documents incorporate lessons learned from the NRC staff's review of the first few license renewal applications.

During the initial license renewal reviews, the NRC and the industry recognized that most of the existing programs at the plants could adequately manage aging effects for license renewal without being changed. The NRC staff therefore undertook a generic review of existing programs to determine which programs could adequately manage aging effects without change and which should be augmented. This generic review is documented in the Generic Aging Lessons Learned (GALL) report (Ref. 2). The GALL report is the technical basis for the Standard Review Plan for License Renewal (SRP-LR), which is the NRC staff guidance on how to review a license renewal application (Ref. 3). The SRP-LR focuses the review on areas where existing programs should be augmented or further evaluated for license renewal. Focusing the review makes the license renewal process more efficient and effective, and also reduces unnecessary regulatory burden.

The industry, through the Nuclear Energy Institute (NEI), developed industry guidance in NEI 95-10 on how to do a license renewal assessment for a plant and on what information to submit in a license renewal application (Ref. 4). In a Regulatory Guide for License Renewal (RG-LR) (Ref. 5) the NRC staff endorsed Revision 3 of NEI 95-10 as describing an acceptable format and content for a license renewal application.

The license renewal rule, the GALL report, the SRP-LR, and the RG-LR together provide regulatory requirements and a complete and efficient regulatory framework for ensuring continued plant safety for license renewal. The guidance documents are living documents. The NRC staff will update them periodically to capture additional lessons learned from future renewal application reviews.

AGING MANAGEMENT REVIEW

The license renewal rule requires applicants to manage aging of long-lived, passive structures and components. The applicable aging effects are those that have occurred and those that could potentially cause structure and component degradation. The materials, environment, stresses, service conditions, operating experience, and other relevant information are considered in identifying applicable aging effects.

Aging management programs are generally of four types: prevention, mitigation, condition monitoring, and performance monitoring. Prevention programs prevent the effects of aging. For example, coating programs prevent external corrosion of a tank. Mitigation programs attempt to slow the effects of aging. For example, water chemistry programs mitigate internal corrosion of piping. Condition-monitoring programs inspect for the presence and extent of aging effects. Examples are the visual examination of concrete structures for cracking and the ultrasonic examination of pipe walls for erosion-corrosion-induced wall thinning. Performance-

monitoring programs test the ability of a structure or component to perform its intended functions. For example, a heat balance tests the heat transfer capability of heat exchanger tubes.

More than one type of aging management program may need to be implemented to ensure that aging effects are managed. For example, in managing internal corrosion of piping, a mitigation program (water chemistry) may be used to minimize susceptibility to corrosion. However, condition monitoring (ultrasonic inspection) may also be necessary to verify that corrosion is indeed insignificant.

The NRC staff considers that an acceptable aging management program should consist of the following 10 elements, as appropriate:

1. Scope of Program

The program should cover the specific structures and components being evaluated for license renewal.

2. Preventive Actions

Preventive actions should mitigate or prevent the applicable aging effects.

3. Parameters Monitored or Inspected

The parameters to be monitored or inspected should be identified and linked to the effects of aging on the intended functions of the particular structure and component. For a condition-monitoring program, the parameter monitored or inspected should detect the presence and extent of aging effects. Examples are measurements of wall thickness and detection and sizing of cracks. For prevention and mitigation programs, the parameters monitored should be the specific parameters being controlled to achieve prevention or mitigation of aging effects. An example is the coolant oxygen controlled in a water chemistry program to mitigate pipe cracking.

A performance-monitoring program may not be able to ensure that structure and component can perform its intended functions unless the degradation of passive intended functions is linked to the performance being monitored. For example, a periodic diesel generator test alone does not provide assurance that the diesel will start and run properly under all applicable design conditions. The test verifies that the diesel will perform if all the support systems function, but provides little information related to the material condition of the support system components and their ability to withstand design basis event loads. Thus, a design basis seismic event could cause the diesel embedment plate anchors or the fuel oil tank to fail if the effects of aging on these components are not managed during the period of extended operation.

4. Detection of Aging Effects

Detection of aging effects should occur before there is a loss of the structure and component intended functions under all design conditions of the current licensing basis.

The inspection method (e.g., visual, volumetric, and surface examination), sample size, data collection, and timing of inspections should ensure timely detection of aging effects. When sampling is used to inspect a group of structures and components, the inspection population should be based on a similarity of materials of construction, fabrication, procurement, design, installation, operating environment, and aging effects. The sample should be biased toward locations most susceptible to the aging effect of concern. There should be provisions to expand the sample size when degradation is detected in the initial sample.

5. Monitoring and Trending

Monitoring and trending should predict the extent of degradation and thus allow timely corrective or mitigative actions. Data collected over time should be evaluated to estimate a degradation rate and confirm that the next scheduled inspection will occur before a potential loss of structure and component intended function.

6. Acceptance Criteria

The acceptance criteria, against which the need for corrective actions will be evaluated, should ensure that the structure and component intended functions are maintained under all current licensing basis design conditions during the period of extended operation. For example, erosion-corrosion may cause carbon steel pipe wall thinning under certain conditions. An aging management program for erosion-corrosion may consist of periodically measuring the pipe wall thickness and comparing it to a specific minimum wall acceptance criterion. Corrective action, such as piping replacement, is taken before this minimum is reached. The piping may be designed for thermal, pressure, deadweight, seismic, and other loads, the acceptance criterion must ensure that the thinned piping would be able to carry these current licensing basis design loads.

7. Corrective Actions

Root cause determinations and corrective actions to prevent recurrence should be timely.

8. Confirmation Process

The confirmation process should ensure that corrective actions are adequate, appropriate, have been completed, and are effective.

9. Administrative Controls

Administrative controls should provide a formal review and approval process.

10. Operating Experience

Operating experience under existing aging management programs, including past corrective actions to enhance or add programs, should be considered. A past failure does not invalidate an aging management program if the failure resulted in appropriate

program enhancements or new programs. Operating experience can show where an existing program has succeeded in managing aging degradation in a timely manner and where it has failed. This information provides objective evidence to support the conclusion that the effects of aging will be managed adequately so that the structure and component intended functions will be maintained during the period of extended operation.

The NRC staff systematically evaluates license renewal aging management programs against these 10 elements. On the basis of this evaluation, the NRC staff may ask the applicant to augment specific areas of a program. The GALL report documents the NRC staff's evaluation of 45 generic aging management programs for plant structures and components (Ref. 2). The GALL report also documents areas where programs should be augmented in the NRC staff's plant-specific review. This plant-specific review is described in the SRP-LR (Ref. 3).

The current licensing basis of a plant also includes time-limited aging analyses (TLAAs), as defined in 10 CFR Part 54. These are existing aging analyses that assume a 40-year operating term. An example is metal fatigue analysis based on the number of anticipated cyclic loads for 40 years. The license renewal rule requires the applicant to extend these TLAAs to show that the aging analysis conclusions are valid for 60 years. Alternatively, the applicant can demonstrate that the aging effects associated with these TLAAs will be adequately managed for license renewal by aging management programs. The TLAA evaluations are discussed further in Refs. 2 and 3.

SUMMARY

The NRC issues licenses for commercial power reactors to operate for up to 40 years and allows these licenses to be renewed for additional periods of 20 years. The NRC focuses license renewal reviews on the adequacy of the applicant's programs to manage aging effects on plant structures and components during the period of extended operation. The NRC staff, with stakeholder participation, has developed license renewal guidance documents to implement an efficient and effective licensing process to maintain safe plant operation for another 20 years. The process is stable and predictable and reduces unnecessary regulatory burden. The NRC has approved several license renewal applications to date and will likely be asked to approve dozens more over the next 10 to 15 years.

REFERENCES

1. Title 10 of the Code of Federal Regulations, Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," U.S. Government Printing Office, Washington, DC, 1995 (included as Appendix A to Ref. 4 below)
2. NUREG-1801, Volumes 1 and 2, "Generic Aging Lessons Learned (GALL) Report," U.S. Nuclear Regulatory Commission, Washington, DC, July 2001.
3. NUREG-1800, "Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants," U.S. Nuclear Regulatory Commission, Washington, DC, July 2001.

4. NEI 95-10, Revision 3, "Industry Guideline for Implementing the Requirements of 10 CFR Part 54 — The License Renewal Rule," Nuclear Energy Institute, Washington, DC, March 2001.
5. Regulatory Guide 1.188, "Standard Format and Content for Applications To Renew Nuclear Power Plant Operating Licenses," U.S. Nuclear Regulatory Commission, Washington, DC, July 2001.

From: Samson Lee
To: Natalie Bath
Date: 7/22/02 7:11AM
Subject: Re: Ageing Management Publication

Ms. Bath:

Attached is P.T. Kuo's NRC paper as requested. I have included the original WordPerfect file and a converted PDF file.

Thanks,
Sam

CC: Pao-Tsin Kuo

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