

# ANO-1 Experiences Using the B&WOG Structural Tools to Prepare Aging Management Reviews for License Renewal

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## ABSTRACT

ANO-1 submitted an application to the NRC to extend its operating license for an additional 20 years on January 31, 2000. NRC regulations governing the license renewal process require the preparation of an Integrated Plant Assessment (IPA) to demonstrate that the effects of aging on systems, structures and components (SSCs) at ANO-1 are adequately managed. ANO participated in the B&W (now Framatome) Owners Group (BWOG) Generic License Renewal Program (GLRP) in developing the B&WOG "Aging Effects for Structures and Structural Components", commonly referred to as the "Structural Tools". The Structural Tools document is a generic evaluation based on material (concrete, steel, etc.) and environments (protected from weather, exposed to weather, exposed to fluids, etc.) that assist the user in performing an evaluation of aging effects (cracking, change in material properties, loss of material, etc.). The purpose of the tools is to provide consistent criteria for identifying aging effects and to allow personnel other than material experts to perform aging management reviews. Using the structural tools, considerable time was saved in preparing Aging Management Review (AMR) reports since the reviewer did not have to independently research potential causes of aging effects for the materials and environments being reviewed. This paper summarizes the ANO-1 experiences gained in preparing AMR reports utilizing the Structural Tools.

## INTRODUCTION

Arkansas Nuclear One, Unit 1 (ANO-1), located in Russellville, Arkansas, is operated by Entergy Operations, Inc., and has a Babcock and Wilcox (B&W) nuclear steam supply system. It received an operating license on May 21, 1974, which will expire at midnight, May 20, 2014 (License No. DPR-51). Under NRC regulations in 10 CFR Part 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants," ANO-1 has the option to request the issuance of a renewed operating license that would allow an additional 20 years of operation. This would extend the operation of ANO-1 until the year 2034.

Entergy Operations, Inc., has had a long-standing interest in renewing the ANO-1 operating license. This interest has led to extensive participation as a member of the Babcock and Wilcox Owners Group (B&WOG) efforts associated with license renewal, which began in 1985. In 1992, the B&WOG evaluated options for license renewal and developed a plan for a "generic" license renewal program. This program, called the Generic License Renewal Program (GLRP), has the goal of providing a viable and economical method for the participating utilities to renew their operating licenses. Following the 1995 revision to 10 CFR Part 54, Entergy Operations, Inc., established a dedicated ANO-1 site license renewal team to prepare the initial license renewal engineering reports, which included preparing reports on the Aging Management Review results.

### What is an Aging Management Review (AMR)?

10 CFR Part 54 contains the regulatory requirements that must be satisfied in order to obtain a renewed operating license. NEI 95-10, "Industry Guidance for Implementing the Requirements of 10 CFR Part 54 - The License Renewal Rule," provides additional guidance on how to comply with 10 CFR Part 54. The License Renewal Rule contains several requirements that a licensee must complete and document prior to submittal of a renewal application. One of these requirements is to perform an Integrated Plant Assessment (IPA). The IPA must document:

1. the systems, structures and components (SSCs) within the scope of 10 CFR Part 54 (i.e., long-lived passive structures and components);
2. the methods used to identify the SSCs; and

3. for each structure and component identified, demonstrate that the effects of aging will be adequately managed so that the intended function(s) will be maintained consistent with the current licensing basis (CLB) for the period of extended operation.

In order to complete the IPA, an Aging Management Review (AMR) must be completed for each set of structures and components within the scope of 10 CFR Part 54. The AMR is performed to identify the applicable aging effects that must then be managed during the period of extended operation. For ANO-1, the AMRs serve as a portion of the auditable and retrievable on-site records documenting compliance with 10 CFR Part 54 and their contents will be summarized in the license renewal application.

The AMR demonstration that the effects of aging will be adequately managed is accomplished by:

1. understanding how the structure or component performs its intended function (e.g., provide structural or functional support to safety-related equipment),
2. identifying the aging effects (e.g., cracking) that could impair the intended function of the structure or component, and
3. identifying the applicable plant program (e.g., Maintenance Rule Program) that adequately detects and mitigates the aging effect.

Although generic AMRs were produced for Class 1 mechanical systems, in-scope structures (e.g., reactor building, auxiliary building) did not have the benefit of a generic AMR. Therefore, site specific AMRs were prepared for the in-scope structures and their structural components. These site-specific AMRs presented the biggest challenge to the ANO-1 license renewal team since there was no generic AMR to cite as the basis for the ANO report. All review work had to be done by the ANO team.

#### Why were the B&WOG Structural Tools Developed?

The B&WOG recognized that the absence of generic AMRs for structures and structural components could create a significant duplication of effort among the member utilities, particularly in the area of aging effects determination. Aging effects may be determined based on consideration of the materials of construction and operating environment. Therefore, aging effects guidelines could be developed that were applicable at all sites. Other potential benefits from developing generic aging effects guidelines would be:

- 1 consistent identification of aging effects among the B&W utilities for similar materials and environments, and
- 2 allowance for personnel other than materials experts to perform the aging reviews by utilizing generic criteria that is easy to interpret and apply (i.e., criteria based on a user-friendly format that defines aging effects thresholds in specific and measurable terms that can be interpreted by personnel who are not necessarily experts in materials, corrosion, fatigue, or other applicable specialty areas).

Based on the potential benefits identified, the B&WOG initiated the development of BAW-2279P, "Aging Effects for Structures and Structural Components", commonly referred to as the Structural Tools. This document includes a description of generic material and environment based age-related degradation guidelines and their application to the materials and environments within the scope of license renewal, an overview of industry incidents of aging effects, and guidance on demonstration of aging management. Utilizing these tools, site-specific evaluations of structural components subject to an aging management review can be prepared.

Originally, the Structural Tools were developed for the GLRP members only. However, in 1997 they were offered and sold to the Westinghouse Owners Group (WOG) and to the Boiling Water Reactor Owners Group (BWROG). Therefore, the Structural Tools are now available for use by members of the B&WOG, the WOG, and the BWROG, which represents most of the nuclear power plants in the United States.

What are the Structural Tools?

In general, the Structural Tools are a set of material and environment based guidelines that assist the evaluator in the identification of applicable aging effects for structural components, which is a key element of the AMRs. The Structural Tools provide the generic bases for the evaluation of potential aging effects for the materials and environments and confirm the existence and validity of the aging effect through review of industry experience. The materials and environments are derived from known age-related degradation mechanisms and verified by a review of the industry operating experience such as NPRDS and NRC generic communications.

The evaluation of aging effects in the Structural Tools allows for structures and structural components to be divided into material groups based on materials of construction and operating environment.

The identified aging effects considered for the following material groups include:

Material Group	Aging Effect
1. Structural steel and steel components	Loss of material Cracking Mechanical distortion Change in material properties
2. Structural steel and steel components in fluid environments	Loss of material Cracking Mechanical distortion Change in material properties
3. Threaded fasteners	Loss of preload Cracking of bolting materials Loss of material
4. Concrete structures and components	Loss of material Cracking Change in material properties Aging effects for masonry blockwalls
5. Fire barriers	Loss of material Cracking/delamination Change in material properties Separation
6. Earthen structures	Loss of material Loss of form Change in material properties
7. Elastomers	Cracking Change in material properties
8. Teflon	Change in material properties

Chapters of the Structural Tools address the scope of materials, environments, aging effects, industry experience, aging management programs, and references for the above eight material groups. The Structural Tools assist the evaluator in the identification of the aging effects that may be a concern for the period of extended operation.

### How did ANO-1 Use the Structural Tools?

ANO-1 used the Structural Tools to help develop the list of applicable aging effects as part of the AMRs for structural components determined to be within the scope of license renewal and subject to aging management review. BAW-2279P was the primary reference document for identifying aging effects. This approach saved considerable time by minimizing the effort required to identify and reference relevant technical, historical, operating experience, and other documents. The Structural Tools have these relevant documents referenced and validated. The ANO-1 AMRs in conjunction with the Structural Tools provide the complete evaluation of potential aging effects.

ANO-1 used the Structural Tools to prepare seven Aging Management Review (AMR) reports for in-scope structures and their structural components. Structures were selected during the screening portion of the Integrated Plant Assessment, where it was decided which were in the scope of license renewal. The seven structural AMR reports are as follows:

1. Reactor Building
2. Reactor Building Internals
3. Auxiliary Building
4. Intake Structure
5. Emergency Cooling Pond and Intake/Discharge Canals
6. Aboveground/Underground Yard Structures and Associated Piping Trenches
7. Bulk Commodities

Typically the structural AMR reports contain the following sections:

- 1.0 Introduction
- 2.0 Scope of Components Under this AMR
- 3.0 Effects of Aging on the Components
- 4.0 Demonstration that Effects of Aging are Managed
- 5.0 Summary and Conclusions
- 6.0 References

The individual AMR reports identify the structure and structural component intended function(s). The functions of structures and structural components subject to aging management review are indicated in the Structural Tools and are generally in accordance with ANO-1 design basis documents (a.k.a., Upper Level Documents).

The seven ANO-1 AMRs utilized multiple chapters of the Structural Tools to perform the evaluation of the applicable aging effects. For example, the Intake Structure AMR utilized the following:

- The chapters for steel and steel in fluid environments were used in the evaluation of the Intake Structure's steel components subject to aging management review,
- The chapter for threaded fasteners was used for the evaluation of bolts, studs, screws, etc.,
- The chapter for concrete components was used for the evaluation of the structure's foundation, floor slabs and walls, and,
- The chapter for elastomers was used for the evaluation of gaskets, structural sealants, etc.

Some chapters of the Structural Tools were used for most of the seven AMR reports (e.g. steel and concrete chapters) while others were used for only one or a few of the reports (e.g. earthen structures, teflon).

Each time the Structural Tools were used, considerable time was saved since the reviewer did not have to independently research the potential causes of aging effects for the materials and environment being reviewed. The Structural Tools gave clear and validated criteria for determining the aging effects. In general, the tools allowed the structural reviews to be performed in an average of a month each and documented in reports that contained an average of less than 60 pages each. Without the tools, it is estimated that the review would have taken twice as long and would have required twice the volume in report documentation.

For example, a summary of applicable aging effects and associated aging mechanisms is presented at the end of each chapter. Aging effects determined to be applicable in the Structural Tools were then further assessed for their applicability to ANO-1. Generally, this could be determined by answering “Yes” or “No” to additional criteria in the Structural Tools such as:

- Are chloride solutions >500 ppm? (Yes or No)
- Is material yield strength >150 ksi? (Yes or No)
- Is temperature greater than 400°F? (Yes or No)

The person performing the review did not have to be a materials expert to answer the questions. Plant chemistry guidelines, operating data, and design data could be used to readily determine if a “Yes” or “No” answer was applicable.

Following identification of the applicable aging effects, the reviewer would then determine if an aging management program was in place to address the aging effect (e.g., Maintenance Rule Program). The Structural Tools gave some general guidance on demonstration of aging management, and additional guidance was provided in NEI 95-10. Some of the existing ANO programs were found to be adequate without modification to address the applicable aging effect, while other existing programs required modification to fully address certain applicable aging effects. Once the aging management program was established, the AMR was complete since it included the following information:

- a listing of components that are subject to aging management review and the intended function they must perform during the period of extended operation
- a determination of the applicable aging effects that must be managed for the material and environment associated with the components
- a review of existing or new aging management program(s) that manages the applicable aging effects to ensure they provide reasonable assurance that the component intended function will be maintained for the period of extended operation.

#### ANO-1 Site Specific Changes to Structural Tools

During the process of reviewing and applying the B&WOG Structural Tools at ANO-1, some changes, additions, or deviations from the tools were implemented to address site-specific needs and lessons learned from the review process. Since the development of the tools was generic, such changes and supplements were expected, and the tools were easily modified without detracting from the overall time saving value of the tools. Some of these changes, additions, or deviations were:

Steel Material Grouping: In lieu of grouping steel components into two separate material groups as in the Structural Tools (i.e., structural steel and steel components and structural steel and steel components in fluid environments), ANO-1 grouped steel components into one grouping and considered both atmospheric and fluid environments in the evaluation of aging effects for the overall steel component grouping.

Concrete – Aging Effects due to Elevated Temperature: The Structural Tools identified a threshold in excess of 300 °F for long term exposure to elevated temperature which may lead to a loss of material and cracking. The Structural Tools identified a general area elevated temperature threshold of 150 °F and a localized elevated temperature threshold of 200 °F which may lead to a change in material properties for concrete. ANO-1 opted to utilize the lower temperature thresholds in evaluating the applicability of loss of material and cracking as aging effects for concrete components due to elevated temperature.

Threaded Fasteners Aging Effects: In addition to the aging effects identified by the Structural Tools for threaded fasteners, ANO-1 also considered that the aging effects applicable to steel were also applicable to threaded fasteners since the two material groups are made of similar materials of construction and exposed to similar environments.

Sub-materials: ANO-1 considered various sub-materials associated with the different material groupings (e.g., welds for steel, grout/reinforcement for concrete) in its aging management review of structural components. Aging effects determined to be applicable to a material group were also deemed to be applicable to a material group’s sub-materials.

The above changes, additions, and deviations from the B&WOG Structural Tools are examples of some of the ANO-1 site-specific changes. As discussed earlier, such changes were expected and the Structural Tools were flexible enough to allow for changes/supplements without detracting from the time saving value of the tools.

## **CONCLUSION**

The B&WOG Structural Tools were an integral part of the ANO-1 AMR reports for in-scope structures and structural components. The Structural Tools provided a user-friendly format to define thresholds for aging effects that were easy to interpret and apply to ANO components. This allowed site personnel to efficiently perform aging reviews to determine applicable aging effects, even though the site personnel were not necessarily materials experts. The site-specific ANO-1 AMRs in conjunction with the Structural Tools provided the complete evaluation of applicable aging effects for ANO-1's structures and structural components.

Results of the aging management reviews for ANO-1 structures and structural components were summarized and tabulated in the ANO-1 License Renewal Application that was submitted to the NRC in January 2000.