

Development of Aging Monitor for Westinghouse 3-loop Type Reactor

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1. Introduction

Based on lots of aging database obtained from the operating plants and research results on the aging effects, Aging Monitor (AM) was developed to monitor, manage and evaluate the aging phenomena systematically and effectively in NPPs.

AM can visualize aging status of major components of NPPs and component-wise aging degradation levels is displayed on the Web.

In this paper, the basic concept of AM and developed AM for Westinghouse 3-loop type reactor are introduced.

2. Basic Concept of Aging Monitor

The AM is basically composed of 6 modules as shown in Fig. 1 : (1) Aging Alarm/Coloring Monitor (M1), (2) Aging Database (M2), (3) Aging Document (M3), (4) Real-time Integrity Monitor (M4), (5) Surveillance and Inspection Management System (M5), and (6) Continued Operation(CO) and Periodic Safety Review (PSR) Safety Evaluation (M6) [1-2].



Fig. 1. Aging Monitor modules

Key module of the AM is Aging Alarm/Coloring Monitor (M1) which provides the information on current status of aging for major components of an NPP.

When aging levels go over the pre-set criteria, the aging monitor gives an alert with coloring. M2 through M5 are supporting modules for Aging Alarm/Coloring Monitor (M1) as shown in Fig. 2.

M6 is application module for aging evaluation of aging factor, one of safety factors of PSR, and both evaluation of Time-Limited Aging Analysis (TLAA) and establishment of Aging Management Program (AMP) for life extension.



Fig. 2. Flow chart for Aging Alarm/Coloring Monitor

3. WH 3-loop type reactor Aging Monitor

Fig. 3 shows the initial screen of the programmed AM based on web including all 6 modules mentioned previous chapter.



Fig. 3. Initial screen of WH 3-loop type reactor AM

3.1 Aging Alarm/Coloring Monitor

The Aging Alarm/Coloring Monitor is composed of three sub-modules: Aging Status, Aging Value, and Aging Trend.

The Aging Status, the main sub-module of Aging Alarm/Coloring Monitor, shows that aging degradation is in progress quantitatively for various aging mechanisms of major components.

According to aging levels decided by AF, the Aging Status shows them with different colors: blue(integrity, AF of 0-0.2), green(monitoring, AF of 0.2-0.5), yellow(warning, AF of 0.5-0.75) and red(alarm, AF of 0.75 or more). Therefore, operators can confirm the

aging state for each component easily and also control the aging management in advance.

The Aging Value is a sub-module of the Aging Alarm/Coloring Monitor giving the detailed information on AFs of sub-compartments for a component. Since the Aging Value is linked with the Aging Status, clicking a button on the Aging Status, then detailed AF's information of sub-compartments for that button are displayed.

The Aging Trend is an another sub-module of Aging Alarm/Coloring Monitor showing the trend of a certain aging mechanism for a component with the passage of time from the beginning of operation up to 60 years beyond plant's lifetime. Because this sub-module is also linked with the Aging Status, it performs in the same way as the Aging Value.

Using this sub-module, operators can make preparation for maintenance activities such as repair or replacement.

3.2 Aging Database module

The Aging Database module was constructed based on the domestic and foreign aging-related damage/operating experience database, and it can be utilized for determining the aging units and aging mechanisms.

The Aging Database is composed of NPPs' piping failure DB, secondary system piping DB, regulatory aging DB and Piping property DB, etc.

3.3 Aging Document module

As a database related to aging, the Aging Document is used for determining aging units, aging mechanisms and aging values.

This module is composed of various documents: US NRC and domestic regulatory documents, licensee's documents for submitting to regulatory body and business, and research documents. Furthermore, the Aging Document will be used for aging evaluation of continued operation and PSR.

3.4 Real-time Integrity Monitor

Real-time Integrity Monitor is a module used for performing stress, fatigue and crack analyses.

Two major parameters, pressure and temperature, required for the analysis are obtained from Computerized technical Advisory system for a Radiological Emergency (CARE) in KINS that is a database containing around 40 operating parameters transferred from NPPs. Since the Aging Monitor actually needs two parameters, a database on these two parameters obtained from 11 points including RCS, a pressurizer and steam generators was made as a web database. As shown in the AM initial screen, these parameters are shown as a graph on Real-time Operating Parameter.

3.5 Surveillance and Inspection Management System

Surveillance and Inspection Management System module is to manage the operating NPP's surveillance and O/H inspection results, and those are applied to determine the AFs. This module provides the AF value to Aging Alarm/Coloring Monitor through the calculation and evaluation with periodic input of surveillance and inspection results.

Surveillance and Inspection Management System is displayed on the AM as S/I Management System which includes two windows such as Surveillance Data and Inspection Data.

3.6 Continued Operation and Periodic Safety Review Safety Evaluation module

The Continued Operation and PSR Safety Evaluation module, an application module. This module will be used for evaluation of aging factor, one of safety factors, for PSR and both evaluation of TLAA and establishment of AMP for life extension.

4. Conclusions

Aging monitor was developed to support activities of regulators and operators. Plant operator can use aging monitor as a useful tool to monitor and manage the plant aging systematically and effectively. Nuclear regulatory body can also use the aging monitor as a supplementary tool in review of licensing documents submitted.

The Aging Monitor can be used for aging-related activities: aging-related licensing, solving aging problem occurred in the site, aging evaluation for continued operation and PSR.

It can be used for even public to wipe off their vague anxiety against nuclear safety matters.

REFERENCES

- [1] IAEA, Periodic Safety Review of Nuclear Power Plants, IAEA Safety Series NS-G-2.10, IAEA, 2003.
- [2] 10 CFR 54, "Requirements for Renewal of Operating Licenses for Nuclear Power Plants", U.S. NRC.