# Development of Regulatory Audit Programs for Wolsong Unit 1 Continued Operation

Hong Key Kim [a*], Seung Hwan Nho [a] and Myung Ho Song [a]
[a]*Mechanical & Materials Evaluation Dept., Korea Institute of Nuclear Safety, 62 Gwahak-ro, Yuseong-gu, Daejeon, Republic of Korea, 305-338*
[*]*Corresponding author: hkkim@kins.re.kr*

## 1. Introduction

Wolsong Unit 1 (PHWR type) design life expires on November 20, 2010. In relation to it, KHNP submitted its application to get approval of the MEST on December 30, 2009 and KINS is under review to confirm the appropriateness of continued operation.

For the comprehensive review of Wolsong Unit 1 continued operation, KINS has developed the review guidelines for PHWR type reactor including a total of 39 aging management program (AMP) items and 7 time limited aging analysis (TLAA) items [1]. Evaluations or calculations to verify the integrity of nuclear components are required for plant specific AMP and TLAA items as well as the ones specified in the guidelines.

In this paper, audit calculation programs developed for KINS staff use in reviewing applicant's submitted evaluation results are presented.

## 2. Audit Calculation Programs

The programs for audit calculation were considered for AMP and TLAA items which could be used for solving the problems to be occurred during continued operation period as well as reviewing the applicant's documents for continued operation. The developed programs are working under concurrent environment using internet to use easily in any place.

### *2.1 Pressure Tube Flaw Evaluation Program*

Evaluation program on flaws occurred in the pressure tubes was developed according to the process described in the CSA N285.8-05 revised recently [2]. Both planar/laminar and volumetric flaws can be evaluated by using the program. Fig. 1 shows the initial screen of the program.


Fig. 1. Pressure Tube Flaw Evaluation Program

### *2.2 Steam Generator Tube Integrity Evaluation Program*

This regulatory program was developed to evaluate circumferential and axial cracks on the S/G tube and composed of 4 different modules as shown Fig. 2. The required input data are shape of crack, tube dimension, material property, loading conditions, etc. and results screen is shown in Fig. 3 [3-4].

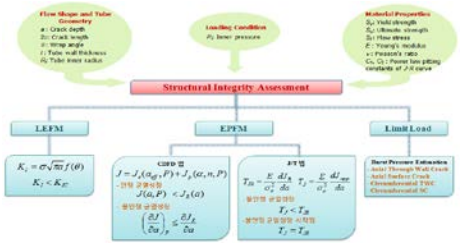


Fig. 2. S/G Tube Integrity Program Modules

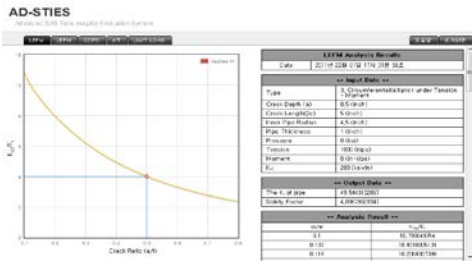


Fig. 3. Result Screen of S/G Tube Integrity Program

### *2.3 Differential Settlement Evaluation Program*

As the differential settlement is processed, piping systems penetrating containment building are subjected to additional stresses in addition to original design stresses. Whenever differential settlements are measured, evaluations of this additional stresses are complex and time consuming job.

The differential settlement analysis program shown in Fig. 4 was developed for KINS to calculate the stresses easily occurred due to static and dynamic differential settlement for containment penetrating piping systems: main steam line, main feed water line and reheater drain & venting line.


Fig. 4. Differential Settlement Analysis Program

*2.4 Crack Growth Analysis Program*

Critical sized cracks over the code acceptance criteria found during In-service inspection are repaired or evaluated with method proposed by ASME code or other alternative ones. By using the proposed method of ASME B&PV Code Sec. XI, crack growth analysis audit program running on the Web was developed as shown in Fig. 5 [5].


Fig. 5. Crack Growth Analysis Program

*2.5 High-Energy Line Failure Analysis Program*

This program was developed for protection against postulated piping failures in fluid systems. This program can calculate the thrust force, blowdown force, impact force and assess whether the pipe whip is occurred or not. Fig.6 shows the result window on thrust force [6].

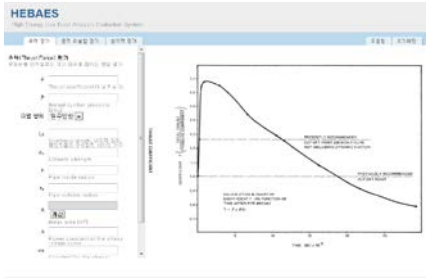


Fig. 6. Crack Growth Analysis Program

*2.6 Reactor Coolant Environment Metal Fatigue Evaluation Program*

As increasing the design life of NPPS from 40 to 60 years, environmental fatigue is considered as one of the important factors to the component design. U.S. NRC recommends that environmental effects should be considered for metal fatigue and specifies to perform the fatigue analysis according to NUREG/CR-5704, 6583 and NUREG/CR-6909 depending on metal type. This program can evaluate environmental fatigue for carbon steel, stainless steel and Alloy 600. Fig. 7 is the initial screen of the program [7].


Fig. 7. Environmental Fatigue Evaluation Program

## 3. Conclusions

Regulatory audit programs development on the various aging degradations for Wolsong unit 1 continued operation is able to use practically in following areas:

1) to evaluate AMP TLAA for Wolsong unit 1 continued operation

2) to review the PSR of CANDU type nuclear power plants performed every 10 year

3) to use in regulatory management as licenses of operating nuclear power plants and evaluate aging issues occurred in fields

## ACKNOWLEDGMENTS

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## REFERENCES

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