Control Room Habitability Analysis and Testing for Wolsong Unit 1

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1. Introduction

KINS has raised some concerns related to the Control Room Habitability (CRH) through RAIs for the Periodic Safety Review for Continued Operation (CO) of Wolsong Unit 1 and recommended to assess its habitability. In response to this recommendation, KHNP has established CRH program and performed tracer gas inleakage tests. These activities are described herein including the emergency ventilation system analysis, acceptance criteria calculation for the test and Control Room Envelope (CRE) discrimination, and the results of the tracer gas tests are presented.

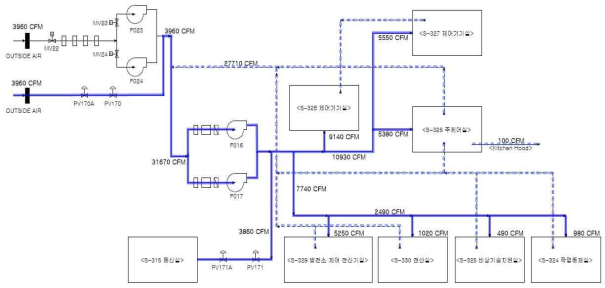
2. CRH Analysis and Tracer Gas Test

In this section CRH analysis and activities for maintenance enforcement are described.

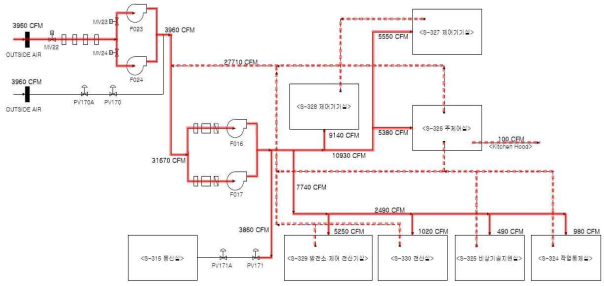
2.1 Emergency Ventilation System Analysis

Wolsong Unit 1, constructed in 1982, is the first heavy water nuclear power plant in Korea. The plant was equipped with emergency ventilation system to ensure the habitability of the operators following the recommendation of OSART in 1989. In 2006, HVAC system was improved as part of the reinforcement for the aged equipments [1].

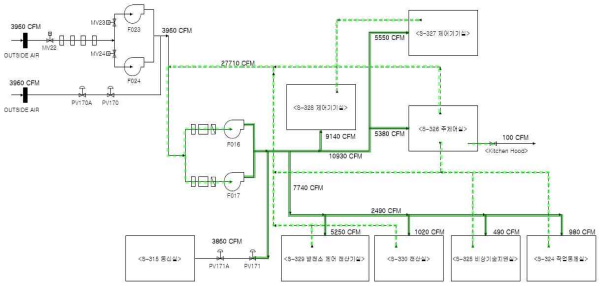
The operational modes of the emergency ventilation system of Wolsong Unit 1 are normal operation and emergency pressurization operation [1]. Though it doesn't have isolation operation mode, the emergency ventilation system can be operated in isolation mode with the blocking of incoming and outgoing air flows, as shown in Fig. 1.



(a) Normal Mode



(b) Emergency Pressurization Mode

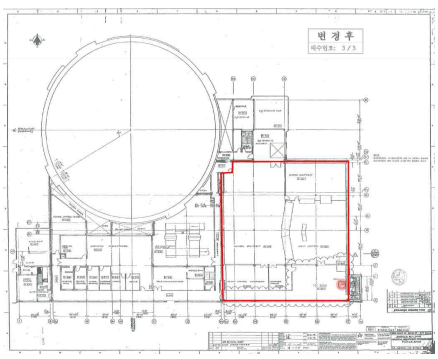


(c) Isolation Mode

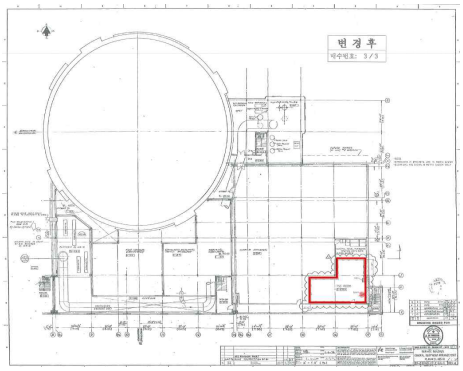
Fig.1. Diagrams of air flow of the emergency ventilation system in which solid line represents supply path and dotted line represents return path.

2.2 Discrimination of CRE

In Wolsong Unit 1, CRE had not been defined before. In order to undertake tracer gas inleakage test, discrimination of CRE was performed and presented in Fig. 2. CRE can be isolated from possibly contaminated areas when an accident occurs. It consists of Main Control Room (MCR) and Technical Support Center.



(a) CRE – Elevation Level of 109.22 m



(b) CRE – Elevation Level of 105.41 m

Fig. 2. Discrimination of the CRE including TSC which is shown in (b).

2.3 Acceptance Criteria for the Tests

There are two kinds of acceptance criteria for the inleakage tests. One is for emergency pressurization mode and the other is for isolation mode.

When an accident occurs the emergency ventilation system operates in emergency pressurization mode. Acceptance criterion for this mode is based on the dose analysis of the CRE and is presented in FSAR as 520 cfm [1]. On the other hand, acceptance criterion for the isolation mode is calculated based on the toxic gas analysis. For Wolsong Unit 1, the criterion is calculated as 3,960 cfm, which corresponds to 100% of the makeup flow rate.

2.4 Unfiltered Inleakage Tests Using Tracer Gas

Air inleakage tests using SF6 as a tracer gas were performed on the CRE by a team of test engineers from Korea Filter Testing Laboratory (KFTL). The tests were performed using written procedures based on ASTM Standard E741 [2]. Unfiltered inleakage rates into the CRE were measured separately for the operation modes of two emergency pressurization modes and two isolation modes. The test results are given in Table 1. The inleakage rates are within the acceptance criteria.

Table 1. Unfiltered Inleakage Test Results [3]

Operation Mode	Makeup Flow Rate* (SCFM**)	Inleakage Rate (SCFM**)	Acceptance Criteria (SCFM**)
A Train Pressurization	4060 +/- 294	0***	520
B Train Pressurization	3961 +/- 227	405	
A Train Isolation	-	1739	3960
B Train Isolation	-	1502	

* Averaged value of five measurements
** Referred to 70 F and 14.7 psia
*** Statistically indistinguishable from a zero value

3. Conclusions

CRH analysis including unfiltered inleakage tests according to the methodology in ASTM E741 [2] was performed for Wolsong Unit 1. The results show that the integrity of the control room of Wolsong Unit 1 is in good condition to maintain the reactor in a safe condition under accident conditions, which complies with the USNRC regulatory guides 1.78, 1.196 and 1.197 [4-6].

REFERENCES

[1] KHNP, Final Safety Analysis Report
[2] ASTM Standard E741-00, "Standard Test Method for Determining Air Change Rate in a Single Zone by means of a Tracer Dilution", ASTM, Philadelphia, PA, 2000.
[3] P. L. Lagus and S. H. Kang, "Preliminary Tracer Gas Test Data", T&IP 12-102-01, KFTL, 2013.
[4] USNRC, "Evaluating the Habitability of a Nuclear Power Plant Control Room During a Postulated Hazardous Chemical Release", Regulatory Guide 1.78, Revision 1, December 2001
[5] USNRC, "Control Room Habitability at Light-Water Nuclear Power Reactors," Regulatory Guide 1.196, June 2003.
[6] USNRC, "Demonstrating Control Room Envelope Integrity at Nuclear Power Reactors", Regulatory Guide 1.197, May 2003.