Process Simulation of Seamless Remote Cutting System for Reactor Pressure Vessel

Dongjun Hyun [a*], Sung-Uk Lee [a], Yong-Chil Seo [a], Geun-Ho Kim [a], Jonghwan Lee [a], Kwan-Seong Jeong [a], Byung-Seon Choi [a], Jeikwon Moon [a]
[a] *Korea Atomic Energy Research Institute,*
989-111 Daedeok-daero, Yuseong-gu, Daejeon, Republic of Korea, 305-353
[*] *Corresponding author: dongjunn@kaeri.re.kr*

1. Introduction

Main components of a superannuated nuclear power plant (NPP) are highly activated and heavy structures, and thus no hands-on operation by workers is permitted for the purpose of the dismantling operations. Therefore, remote handling equipment has to be applied to dismantlement of the main components [1]. Although existing remote handling equipment has contributed to considerable reduction of radiation exposures to workers, radiation exposures by replacing operations, which is to take installed equipment out and to put equipment for the next process in, are still remained. The replacing operation increases cost of the whole dismantling process and causes a lot of risks such as radiation exposures, worker accidents and outages of equipment.

This paper proposes a seamless remote cutting system to enhance productivity and safety of the whole dismantling process by eliminating the replacing operations and demonstrates the feasibility of the proposed system with 3D graphical process simulations.

2. Methods and Results

In this section technical characteristics of the seamless remote cutting system and results of the dismantling process simulation over the reactor pressure vessel are described.

2.1 Seamless Remote Cutting System

A seamless remote dismantling system is proposed for the key solution to dismantle highly radioactive and heavy components during NPP decommissioning. The seamless remote dismantling system discloses its originality as a capability dealing with all the dismantling processes related with the major components of the NPP without any intervention. Previous dismantling equipment was designed for a specific component or a single process, and thus an equipment replacement process, which is a time consuming and risky operation, was necessarily required between respective processes. In this paper, the seamless remote dismantling system is designed and verified through process simulations over all the dismantling processes for major components of a Korean NPP, and a number of difficulties such as confined workshop, complex moving lines, and interferences are overcome.

The seamless remote dismantling system consists of a polar crane, a pool crane, a manipulator equipped with a vertical rail, a circular saw, a turn table equipped with a translational rail, a band saw and a radioactive waste container, and is settled in the reactor pool of the containment building (see Fig. 1).

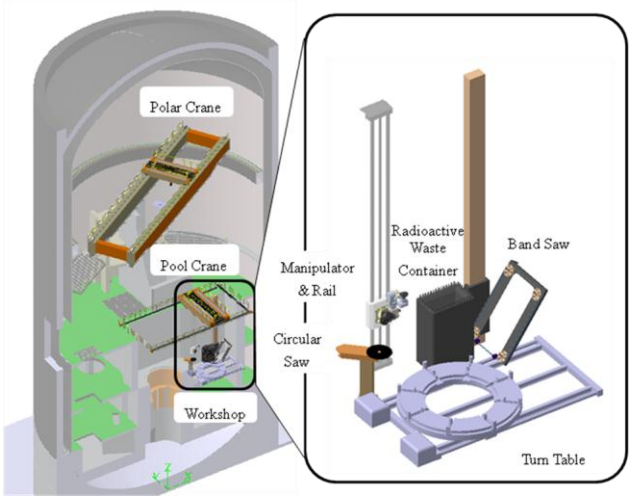

Fig. 1. Seamless Remote Cutting System.

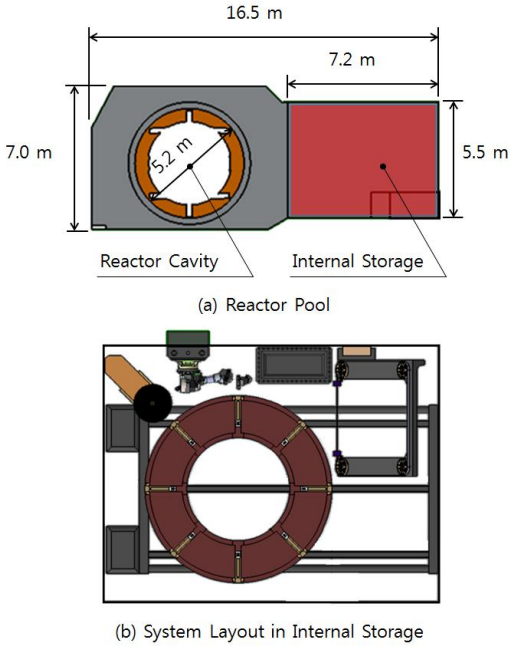

Fig. 2. Seamless Remote Cutting System.

Fig. 2 shows the layout of the seamless remote cutting system of which the order is the circular saw, the manipulator, the radioactive waste container and the band saw from the side of the reactor cavity.

2.2 Process Simulation Results

The whole dismantling process over the reactor pressure vessel can be categorized as followings

1) Slicing and segmenting of large cylindrical components (see Fig. 3)

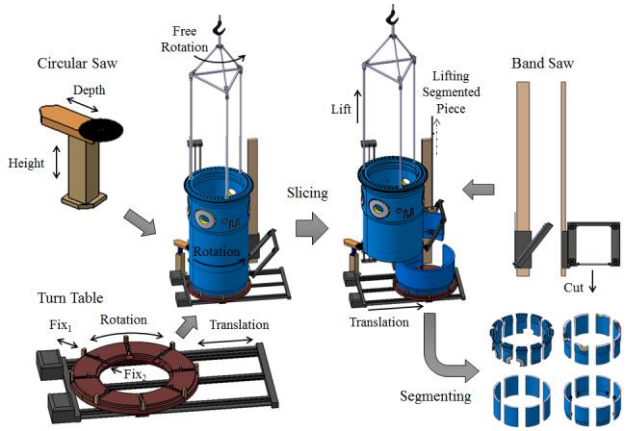

Fig. 3. Slicing and segmenting for reactor vessel.

2) Segmenting of thick plates (see Fig. 4)

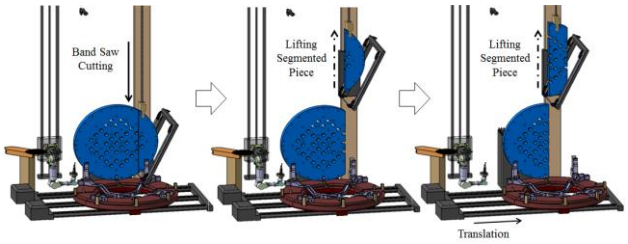

Fig. 4. Segmenting for upper support plate of upper internal assembly.

3) Tube cutting with the hydraulic cutter (see Fig. 5)

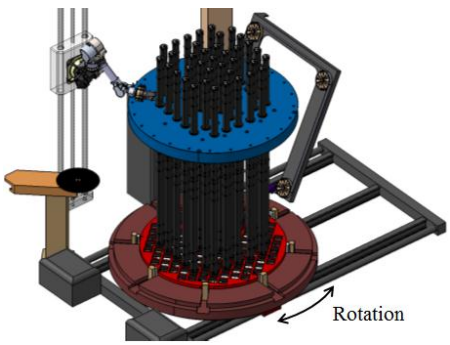

Fig. 5. Tube cutting for control rod guide tube of upper internal assembly.

4) Dexterous cutting with the high pressure abrasive water jet (see Fig. 6)

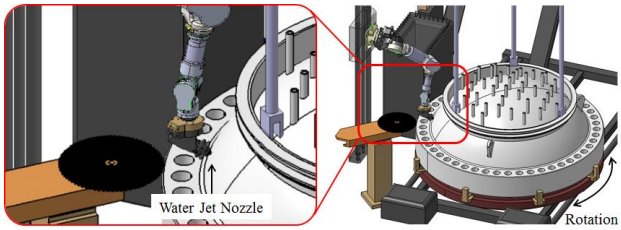

Fig. 6. Water jet cutting for the hemispheric surface of the reactor pressure vessel head.

5) Eliminating the head of the bolt and miscellaneous cutting

3. Conclusions

The simulation result of dismantling processes over major components of the NPP demonstrates that proposed cutting system can deal with all the components without any intervention such as a removal of initially installed equipment, additional installation of equipment in the course of the whole dismantling process and unnecessary drainage of the reactor pool. The proposed system is expected to reduce considerable time and cost and to improve safety during the whole dismantling process.

Acknowledgements

The research was supported by the Nuclear R&D Program through the Ministry of Science, ICT & Future Planning.

REFERENCES

[1] RADIOACTIVE WASTE MANAGEMENT COMMITTEE, Remote Handling Techniques in Decommissioning, NEA/RWM/R(2011)2, Nuclear Energy Agency, 2011.