Transactions of the Korean Nuclear Society Spring Meeting
Gwangju Korea, May. 30~31, 2013

Selection criteria on factors affecting dismantling process for Reactor Vessel of NPPs

Byungseon Choi*, Dongjun Hyun , Kwanseong Jeong, Geonho Kim, Jonghwan Lee and Jeikwon Moon
Korea Atomic Energy Research Institute (KAERI), P.O.Box 150, Yuseong, Daejeon, 305-600, Republic of Korea

*Corresponding author: bschoi@kaeri.re.kr

1. Introduction

With a view to safely accomplish decommissioning of the reactor pressure vessel (RPV) component in nuclear power plants (NPPs), decommissioning scenario assessment was evaluated. Evaluation methods for decommissioning scenario of the reactor pressure vessel are two methods. One is an evaluation of dismantling technique and another is an evaluation of dismantling procedure. Method of the dismantling technique is to evaluate factors such as radiological and environmental impacts, site-specific impacts and characteristics, performance and physical characteristics, and schedule. Method of the dismantling procedure is to evaluate factors such as radiological and environmental impacts and logistics impacts. This paper suggests the way to evaluate the decommissioning process for the RPV in terms of safety and economy.

2. Evaluation of dismantling process

The RPV in NPPs is the one of the most difficult component to dismantle because it is highly radioactive and is made with very thick materials or complex structures. Generally, the RPV is composed of the reactor vessel (RV) that has comparably simple structure but very large thickness and the reactor vessel internals (RVI) that has very complex structure but comparably small thickness. In this study the RPV means the RV for simplification because discussing area becomes too large in case that both the RV and the RVI are covered in this article. The RVI could be discussed in other article.

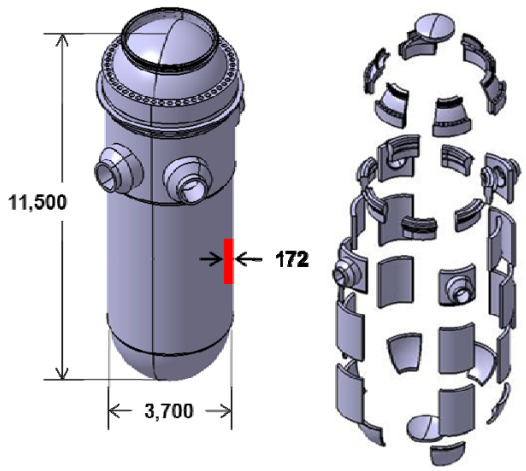

Fig. 1: RPV of NPP and segmentation plan

Thickness of the RPV, that is the RV, is greater than Thickness of the RPV, that is the RV, is greater than 150 mm mostly and greater than 300 mm in some area. Tools can cut steel plates, of which thickness is greater than 200 mm, are not many. Candidates to evaluate cutting tools are only contact arc metal cutting (CAMC) tool, high pressure abrasive water jet (HPAWJ), mechanical saw and diamond wire saw. Candidates to evaluate positioning equipment are the manipulator that is mainly composed of rotational joints and the carrier system that is mainly composed of simple linear motions and has stiff structure. In this paper, evaluating factors for cutting tools and positioning equipment have been defined and estimated the optimal combination of those for the decommissioning process

Evaluating factors of cutting

Evaluating factors of the cutting tool can be divided into three categories largely, which are original characteristics of the cutting tool, requirements for the positioning equipment in remote operations and reliability that is commonly needed in the decommissioning project.

1) Original characteristics of the cutting tool
- Cutting capability
- Cutting speed
- Versatility
- Production of secondary waste

2) Requirements for the positioning equipment
- Suspending stiffness
- Payload
- Positioning accuracy
- Force-control capability

3) Reliability
- Maintenance
- Durability
- Resistance to the environment

Evaluating factors of remote positioning tools

Evaluating factors of the remote positioning tool can also be divided into three categories, which are characteristics of the remote positioning tool, factors responding to requirements from the cutting tool and common reliability.

1) Characteristics of the remote positioning tool
- Range of motion

- Dexterity
- Occupied volume

2) Factors responding to cutting tool
- Suspending stiffness
- Payload
- Positioning accuracy
- Force-control capability

3) Reliability
- Maintenance`
- Durability
- Resistance to the environment

Evaluation of Remote Handling Technologies for RPV

Evaluation results by the method from the above factors on remote handling technologies are shown in Fig. 2 to Fig.4. We performed case studies for two NPPs. Rancho Seco and Würgassen are chosen as recent decommissioning projects in which RPVs are segmented by remote handling technologies. Rancho Seco have completed segmentation of the RPV using the HPAWJ and the diamond wire saw from 2006 to 2007. Würgassen have completed segmentation of the RPV using the HPAWJ and the band saw from 2008 to 2010. All those decommissioning projects could be good references representing recent trend of remote handling technologies for RPV.

Fig. 2: Evaluation of cutting tools - performance parameters

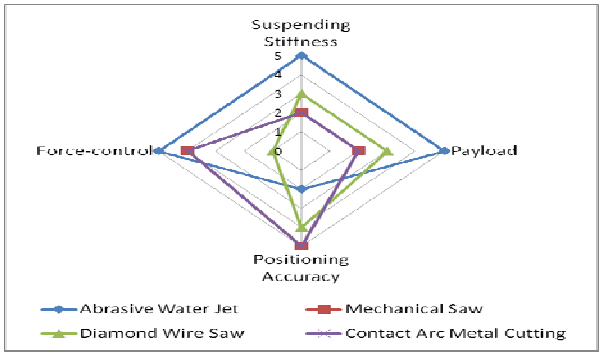

Fig. 3: Evaluation of cutting tools - requirement for positioning equipment

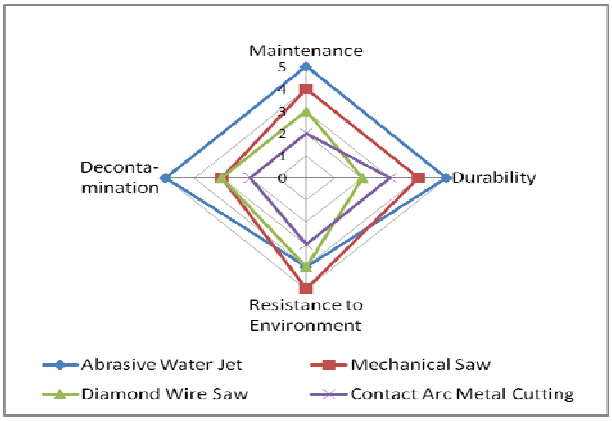

Fig. 4: Evaluation of cutting tools - reliability

3. Conclusion

Evaluation results conclude that the dismantling operation of Würgassen is much more efficient than that of Rancho Seco. Würgassen has 8 preferable factors relatively although Rancho Seco has merely 4 preferable factors. To consider total time to complete the cut, Rancho Seco took 2 years to segment the RV into 21 pieces and Würgassen took 3 years to segment the RV into 252 pieces, which is 12 times more than Rancho Seco.

This paper proposes the way to evaluate the decommissioning process for the RPV and shows reasonability of the proposed methodology from above case studies. Evaluating factors defined in this article could be helpful to decide the preferable remote handling technology out of numerous alternatives.

REFERENCES

[1] Radioactive Waste Management Committee, “Remote Handling Techniques in Decommissioning”, 2011
[2] Electric Power Research Institute, “Rancho Seco RV Segmentation Experience Report”, 2008
[3] Annette Bender, nee Schmitz, “Dismantling of RPV Internals Experience within AREVA NP”, 2010
[4] Robert W. Henderson, Ludger Eickelpasch, “Cutting Reactor Pressure Vessels and their Internals – Trends on Selected Technologies – 10247”, 2010
[5] L.E. Boing, D. R. Henley, W. J. Manion and J. W. Gordon, “An Evaluation of Alternative RV Cutting Technologies for the Experimental Boiling Water Reactor at Argonne National Laboratory”, 1989.