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An evaluation on the scenarios of work trajectory during installation of dismantling equipment for decommissioning of nuclear facilities

KwanSeong Jeong [a,*], ByungSeon Choi [a], JeiKwon Moon [a], Dongjun Hyun [a], Jonghwan Lee [a], IkJune Kim [a], GeunHo Kim [a], ShinYoung Kang [a], JongWon Choi [a], SeongYoung Jeong [b], SangMyeon Ahn [b], JungJun Lee [b]

[a] Korea Atomic Energy Research Institute, Daedeok-daero 989-111, Yuseong-gu, Daejeon 305-353, Republic of Korea
[b] Korea Institute of Nuclear Safety, Gwahak-ro 34, Yuseong-gu, Daejeon 305-383, Republic of Korea

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ABSTRACT

This study is intended to suggest an ergonomic evaluation on the working postural comfort. This study issued for the first time a methodology in view of combination between visual field and comfort. Especially, the ergonomic evaluation using the virtual decommissioning environments is user-friendly because setup of physical mock-up environments is difficult. This study verified the front and standing postures are best working postures during movement under radiation environments of nuclear facilities. It is expected that this methodology will make it possible to establish the ergonomic plan for decommissioning of nuclear facilities and safety of decommissioning will be improved and also decommissioning costs also can be reduced.

1. Introduction

Decommissioning of nuclear facilities has to be accomplished by assuring the safety of workers because decommissioning activities of nuclear facilities are under high radioactivity and work difficulty. Musculoskeletal disorder (MSD) is a serious occupational health problem facing manual material handling workers which affects a significant proportion of the workforce.

This study is intended to suggest an ergonomic evaluation on the working postural comfort. On the basis of literature reviews, a site-specific ergonomic evaluation method for decommissioning of nuclear facilities was designed. Verification and validation of the suggested methodology were proven by experiments carried out under virtual decommissioning environments instead of physical mock-up.

2. Installation activities of dismantling equipments

2.1. A dismantling procedure of the major components in a nuclear power plant

For decommissioning of nuclear power plants, it is essential to dismantle major components such as reactor pressure vessel, steam generator, pressurizer, and reactor coolant pump as shown in Fig. 1 (Jeong et al., 2014).

The necessary equipments to dismantle the major components in a nuclear power plant are band saw, circular saw, gantry manipulator, turntable, and waste container as presented in Fig. 2.

A series of dismantling procedure for the major components in a nuclear power plant consist of 'lifting and putting the major components on the turntables' and 'segmenting the major components using circular saw and band saw' as presented in Fig. 3.

2.2. A worker intervention in the middle of the dismantling procedure

In the middle of the dismantling procedure, a worker comes to enter into the containment. According to the dismantling procedure of the major components, a worker moves from the upper floor to the down floor on the major components in the containment for the purpose of checking the installation activities of dismantling equipments using a remote crane. At this time, a worker should choose one of several alternatives which one is the best way of moving from the upper floor to the down floor on the major components in the containment. The several alternatives are 'moving with ladder' and 'moving with elevation apparatus' as shown in Fig. 4. And when a worker moves from the upper floor to the down floor on the major components in the containment, it is essential to evaluate the ergonomics pos-

* Corresponding author. Tel.: +82 42 868 8652; fax: +82 42 868 2975.
E-mail address: ksjeong1@kaeri.re.kr (K. Jeong).

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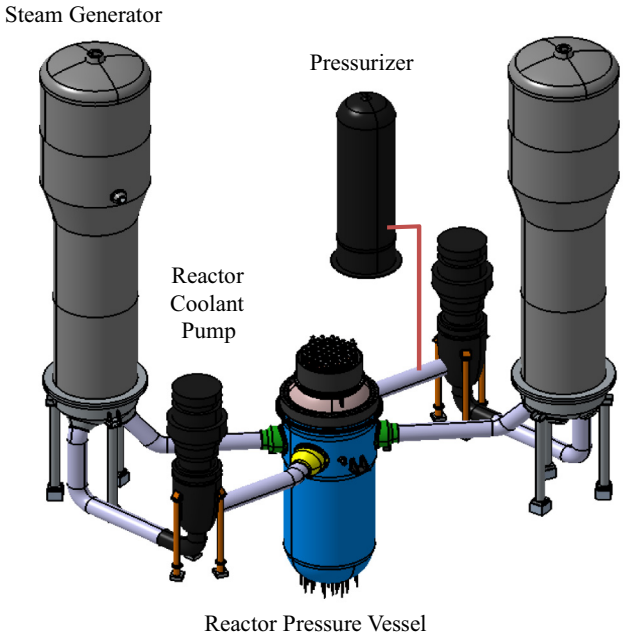

Fig. 1. The major components in a nuclear power plant.

ture comfort in view of visual field because decommissioning itself is carried out under unexperienced workplace with radiation environment.

3. Literature review of the working posture evaluation methodology

3.1. Review of the working posture evaluation methods

Musculoskeletal disorder (MSD) is believed to be closely related to posture, physical overexertion, duration and frequency of physical effort, discomfort, and physical fatigue (Pheasant, 1999). In order to reduce MSD risks, many methods have been developed to investigate ergonomic design problems. These methods can be mainly classified into subjective and objective evaluation methods (Li and Buckle, 1999). Borg's scale, which is also called the Rated Perceived Exertion method, is a subjective tool that has been used to evaluate the effort of subjects in a variety of research; it has been validated as consistent with several physiological variables (Garcin et al., 1998; Kim et al., 2004). Another well-known subjective method, Body Part Discomfort, was developed to evaluate the intensity of discomfort felt by subjects (Corlett and Bishop, 1976; Lowe, 2004; Yuan and Kuo, 2006; Lin et al., 2010).

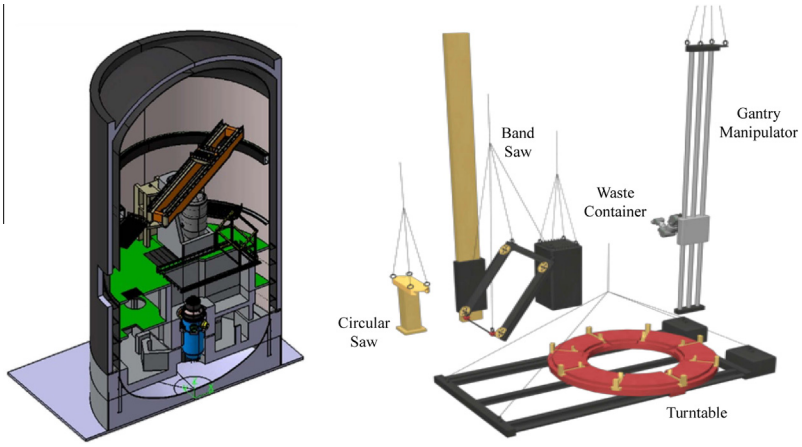

Fig. 2. Dismantling equipments of the major components in a nuclear power plant.

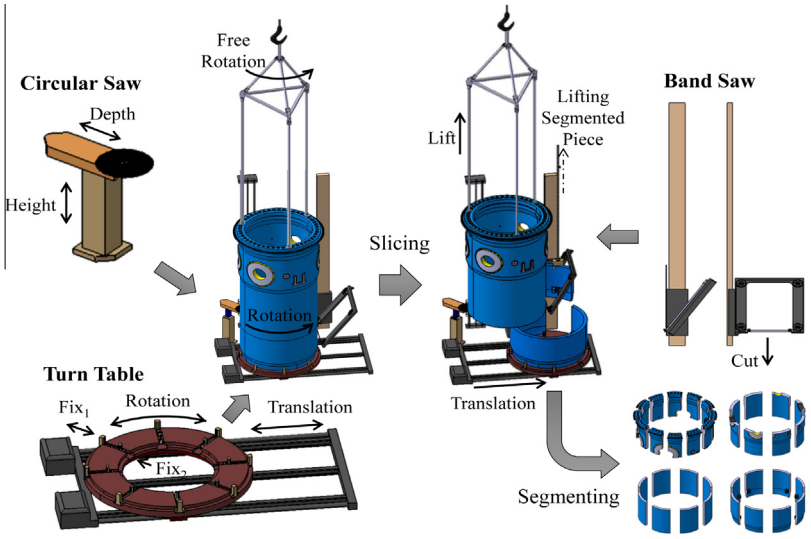

Fig. 3. A dismantling procedure of the major components.