Introduction of Applying Technology for Decommissioning and Decontamination in PWR Npp's

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1. Introduction

Twenty four nuclear power reactors including Shin-Wolsong unit 2 are operating in Korea. Considering general durability of nuclear power plant which is around 30 to 40 years, Kori unit 1, which has been operating since 1977, and Wolsong unit 1, which has been operating since 1882, are expected to be decommissioned and decontaminated; as the durability of other nuclear power plants are expected to terminate in near future, each local autonomous entity has been putting efforts to pre-acquire domestic nuclear power plant decommissioning service.

The technologies utilized in nuclear power plant decommissioning are classified into four categories such as decontamination, transaction, restoration and delivery division and the safety and economic feasibility of nuclear power plant decommissioning can be hugely affected depending on the selected technology.

Therefore, this article aims to introduce new technologies that can be applied in the domestic nuclear power plant decommissioning service facility based on the dismantling and decontaminating technique used in Japan's WDF (Waste Dismantling Facility)

2. The Management of Nuclear Power Plant Dismantlement

The nuclear power plant dismantling facility located in ibaraki O-arai – a pretreatment facility in charge of dismantlement and treatment of facilities exposed to radiation in case of dismantling nuclear power plant – is working on inventing dismantling technique. This facility consists of a basement and three-floor and the gross floor area of 5,400m^2. The wastes are classified into three categories such as high level α waste, low level α waste and β·γ wastes. This facility has developed various techniques that can be utilized in the actual nuclear power plant dismantlement including decontamination, dismantlement and disconnection of massive solid wastes (high-radioactive contaminants) that can hardly be handled in other general facilities. In this facility, several technologies such as the chemical decontamination, plasma arc decontamination, ice blast decontamination, electro-polishing decontamination and disconnection by plasma cutter and hacksaw were developed. This facility consists of α sell, β sell, remote control station, radiation office, fitting room, control room and truck load room.

3. Treatment Process of Solid Radioactive Wastes

The wastes carried in this facility are classified into three categories such as β γ wastes, high level α wastes and low level α wastes. The process of carry-in and carry-out of β γ wastes is following:

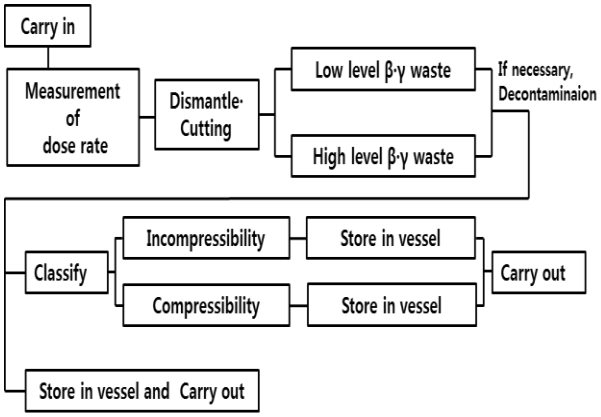

Fig. 1. The System Flow Chart of Radioactive Wastes Treatment

The β γ wastes are compacted, decontaminated and classified into incompressibility or compressibility waste and then it is sent to the nuclear waste disposal site.

4. Ice Blast decontamination

Ice blast decontamination is a surface decontamination process using ice and dry-ice particles made by pelletizer. The particles are blasted to an object to be decontaminated through a carrier medium such as compressed air. Using the blast impact energy and can be remove the nuclides at low temperature are the distinct features of ice blast process. Fig. 2 shows a conceptual illustration of ice blast system. The system consists of a pelletizer and blaster. Only a maintenance free flexible pressure hose and a blasting nozzle are installed in the cell.

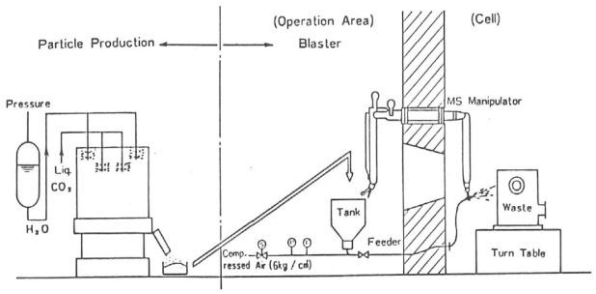

Fig. 2. Ice Blasting Decontamination System.

The pelletizer is capable of producing blast particle at a rate of about 200kg/h. The particles are made of converting liquefied carbon dioxide into fine powders through adiabatic expansion and compacted into column shaped particles of 4mm diameter and 5 mm length. The water supply system in the pelletizer can mix the water or ice into blast particles up to approximately 20%. By mixing with water, the hardness of blast particles can be increased and the contaminated nuclides can be carried into the liquid waste during decontamination process.
The evaluation of test result so far obtained has verified the validity of this decontamination process, as compared with pressurized water process, holds down the secondary waste generation to the order of one tenth and achieves higher decontamination capability.

5. Electro-polishing Decontamination

This is an application of electro-polishing, a common industrial technique for surface processing of metals, to nuclear decontamination. WDF selected a 5% sulfuric acid solution as its electrolyte in consideration of electrolytic properties such as polishing efficiency and uniform dissolubility as well as after treatment of spent electrolyte. Decontamination will take place with the application of positive charge to waste composed of metals in a conductive electrolyte because the charge will displace the metal surface into the electrolyte as cation. In order to regenerate such a spent electrolyte for reuse and extended service life, electro-deposition technique based on the principle of electro-deposition which is reverse to electrolysis is used to recover metal ions from the spent electrolyte. The basic concept of electro-polishing system is illustrated in Fig. 3.

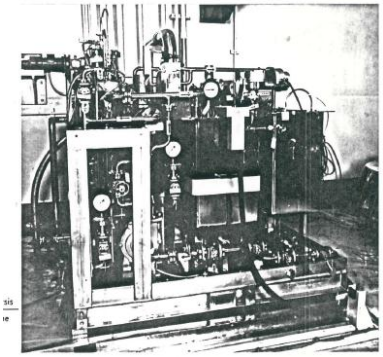

Fig. 3. Electropolishing Decontamination System

6. Plasma Cutting Robot

In order to dismantle large-size equipment and machines of complex configuration installed in high-radiation and high-contamination areas, it is essential to use remote control technique for automatic, efficient and safe dismantling and removal operations. Plasma cutting robot was installed in WDF, as a modified version of industrial robots, as a link in the development of remote control technology to verify its usefulness in the dismantling of wastes from operating plants. This robots was based on a teaching playback method, in which a cutting path on an object is preliminary taught to the robot and cutting is made to the given cutting path. If the object to be cut has a complex configuration, its teaching procedure takes much time. To solve this problem, the robot is now given some notable improvements, i. e. the addition of a voltage arc sensor which will feedback voltage fluctuation during cutting to the robot for automatic cutting operation in addition to a non-contact type laser distance sensor, a joy stick and master arm.

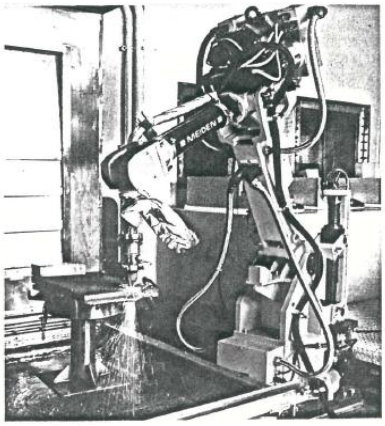

Fig. 4. Plasma Cutting Robot

7. Radiation Image Display(RID)

To improve measurement and evaluation efficiency for decommissioning, to decrease radiation exposure during the work and also to improve the reliability of measurement data, WDF has been developing a radiation image display capable of remote and automatic measurement and image display of the distribution of radioactive substances. Its operating principle is to run a collimated γ ray detector and distance meter to scan across a contaminated object to be measured and obtain radiation information and distance information, from which a computer will create a picture of the distribution of radioactive substances (evaluation picture) composed of 1,500 to 9,000 plots divided into ten color levels and then will display the picture on a TV monitor as a synthetic image. The measurement principle is illustrated in Fig. 5.

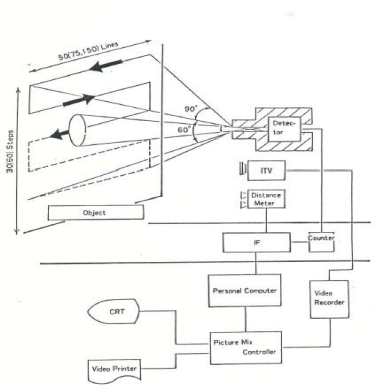

Fig. 5.Radiation Image Display System

The evaluation picture shows a counting value at each plot in ten color levels (red-yellow-green-blue-non color) with the largest counting value of the plots in the picture placed as the upper limit. RID provide, the synthetic image on radioactive substances information depositing on the inner surface of contaminated tank. The applicability of this equipment was evaluated in a test made on wastes and as liquid waste tank. The results obtained from the test are shown Fig. 6.

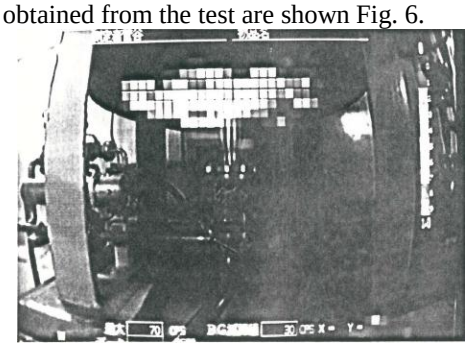

Fig. 6 Example of Liquid Waste Tank Measurement

8. Conclusion

As nuclear power plants are getting older, interests on a dismantling technique are increasingly attracting more attention. Decommissioning and decontamination business will be opened a new prospect in the field of nuclear industry in near future. Although this article briefly points out operation process and dismantling techniques of Japan's Wastes Dismantlement Service, in order to dismantle the actual nuclear power plant, more nationally supported research and development such as evaluation of source term, and desquamation technique and contamination evaluation technique of concrete structures should be obtained first.

REFERENCES

[1] Satoshi Ikeda, Masao Shiotsuki and Hidehiko Miyao, Development of Decommissioning Technologies For Nuclear Fuel Cycle Facility In Waste Dismantling Facility