Designing a Remote Surface Decontamination System for Use in an ACP hot-cell

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ACP (Advanced spent fuel Conditioning Process) technology, which is a process for the reduction of uranium oxide by lithium metal in a high temperature molten salt bath for spent fuel, is being developed at the Korea Atomic Energy Research Institute (KAERI). ACP mainly consists of four sub-processes - slitting, voloxidation, electrolytic reduction, and smelting. Various types of the ACP equipment were specially designed and developed to allow their operation and maintenance to be effective by using remote means. All the ACP sub-processes are remotely conducted in a completely shielded ACP hot-cell of the Irradiated Material Examination Facility (IMEF) at KAERI because of the nature of the high radioactivity level of the spent fuel.

Undesirable products such as spent fuel debris and contaminated wastes are inevitably created during the ACP development processes. They are deposited on the ACP equipment and the inside floor and walls of the ACP hot-cell, thereby contaminating the interior of the hot-cell. Such radioactive waste is required to be cleaned and disposed of to prevent a contamination from spreading inside the hot-cell. Therefore, emphasis from a remote system viewpoint is placed on a remote surface decontamination of the contaminated in-cell floor and wall and the ACP equipment without a human worker being exposed to its radioactive environment.

This paper describes the design developments of a remote surface decontamination system for use in the highly radioactive zone of the ACP hot-cell. The surface decontamination system is required to remotely clean up the contaminated in-cell floor and walls and an equipment's surface where, as the hot-cell is active, a direct human access, even with protection, to the in-cell is not possible due to the high radioactivity level. The design developments of the surface decontamination system, therefore, should take into account the ACP hot-cell, the ACP equipment and its arrangement as well as the in-cell installation and remote operation and maintenance of the contamination cleaning system to be developed. First two design elements of the ACP hot-cell and the ACP equipment as well as its arrangement shown in Fig. 1 are the most important factors in determining the size, mobile means, and cleaning tools of the surface decontamination system. More details are needed for the environmental and spatial confinements of the ACP in-cell structure, the geometrical constraints of the ACP equipment, and the availability and location of the electricity necessary for an operation. As for the in-cell installation and remote operation and maintenance, the design should consider the remote installation and manipulation strategies, the remote repair procedures, and the capabilities and constraints of the remote handling devices that are available at the ACP hot-cell. In the design process, a compromise needs to be made between these design elements. Moreover, the design should include considerations for an interface with a human operator, a power transmission for a control, and the radiation effects of the materials to be used. The design concept, therefore, must include all the mechanical, electrical, and system integrations required to produce a fully functional remote surface decontamination system for the ACP hot-cell application.

The remote surface decontamination system, employing a vacuum cleaning method, designed in this work consists of four replaceable units - a mobile unit, a collection unit, a blower unit, and a suction unit. Each of these units is designed as modules to facilitate in a maintenance by a remote manipulation in situ. They can be separated and assembled easily in a remote manner by using the master-slave manipulators installed in the ACP hot-cell. Fig. 2 shows a graphical representation for each unit of the surface decontamination system, and their relevant assembly. The surface decontamination system is designed to have an ability to collect contaminated particles of up to 0. 3 microns by employing a four stage filtration structure, as shown in Fig.2-a. The surface decontamination system has a configuration of 243x619 (DxH) mm when assembled. Each unit, however, is designed to fit into a Padirac Cask basket which has an inside configuration of 260x436 (DxH) mm. The Padirac Cask basket is a unique means to transfer each unit from outside the hot-cell to its inside when the ACP hot-cell is active. Fig. 3 shows the graphical representations of the Padirac Cask basket containing each unit of the surface decontamination system for an in-cell transfer.

Detailed design of the remote surface decontamination system has been completed, and its construction is underway.

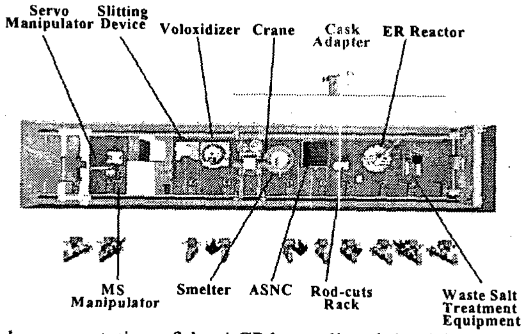

Fig. 1. The graphical representation of the ACP hot-cell and the ACP equipment arrangement

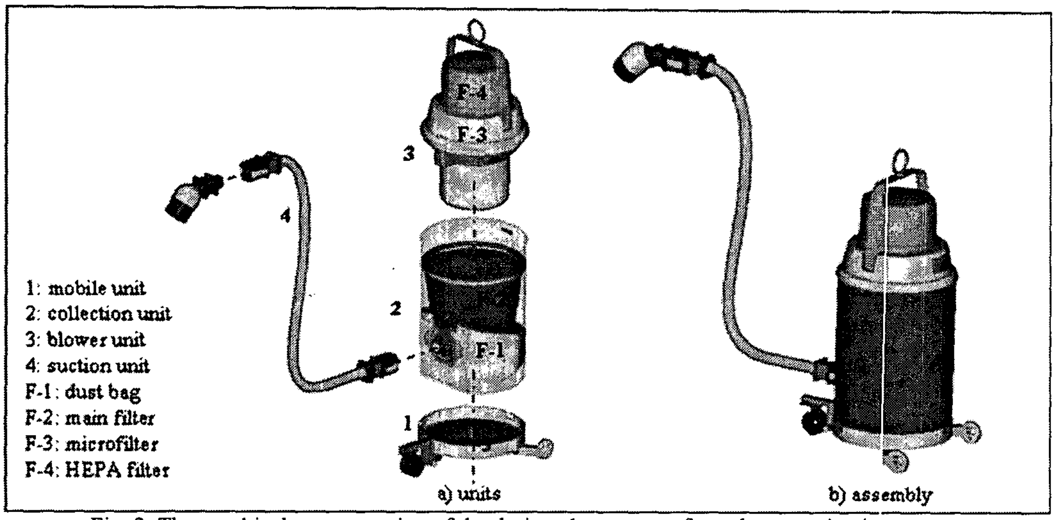

Fig. 2. The graphical representation of the designed remote surface decontamination system

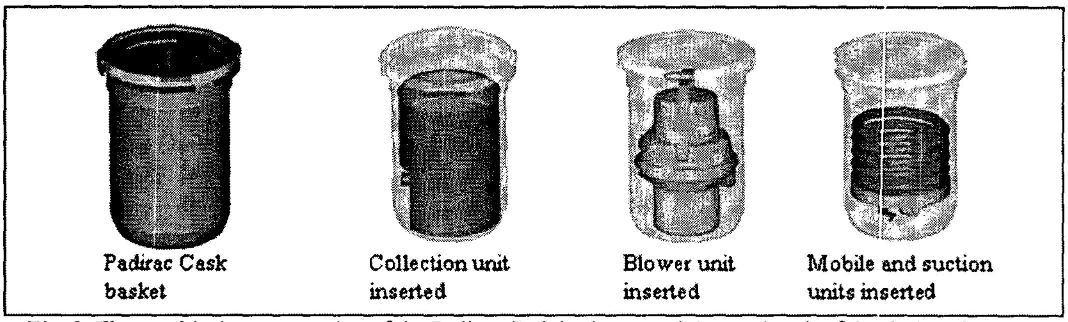

Fig. 3. The graphical representation of the Padirac Cask basket containing each unit of the designed remote surface decontamination system