# RADIATION MONITORING SYSTEM FOR ADVANCED SPENT FUEL CONDITIONING PROCESS FACITLITY

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## ABSTRACT

The ACP [1] is under development for effective management of spent fuel by converting $UO_2$ into U-metal. For demonstration of this process, $\alpha$-$\gamma$ type new hotcell was built in the IMEF[2] basement . To secure against radiation hazard, this facility needs radiation monitoring system which will observe the entire operating area before the hotcell and service area at back of it.

This system consists of 7 parts; Area Monitor for $\gamma$-ray, Room Air Monitor for particulate and iodine in both area, Hotcell Monitor for hotcell inside high radiation and rear door interlock, Duct Monitor for particulate of outlet ventilation, Iodine Monitor for iodine of outlet duct, CCTV for watching workers and material movement, Server for management of whole monitoring system.

After installation and test of this, radiation monitoring system will be expected to assist the successful ACP demonstration.

## 1. Introduction

Advanced spent fuel Conditioning Process Project is under development for safe and efficient management of PWR spent fuel. The main process of this project is to recover oxide from $UO_2$ pellet in the LiCl molten salt (Fig. 1). This process reduce heat

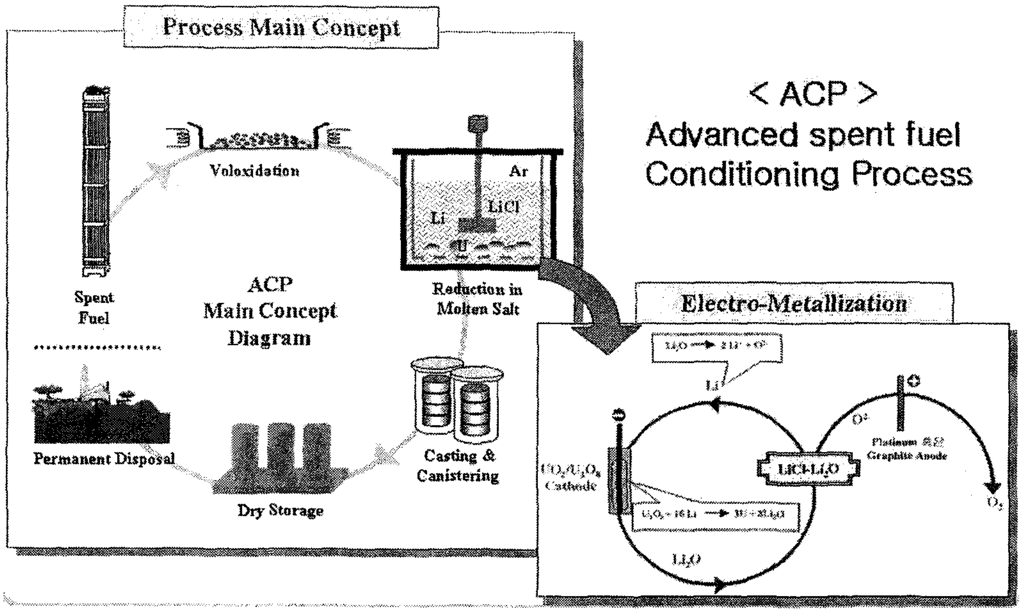
[1] ACP: Advanced spent fuel Conditioning Process
[2] IMEF: Irradiated Material Examination Facility

generation and radiation intensity of spent fuel and, therefore minimize the required area of disposal.

The whole process shoud be performed in the hotcell which could control highly radioactive materials safely. For this purpose, ACP project built a new hotcell(ACPF[3]) in IMEF basement which already has a reserved hotcell area. Fig. 2 shows bird's-eye-view of ACPF before real construction.

The operation of ACPF needs a safety guideline against radiation from hotcells in both operation area and service area where workers could reach, and consequently RMS[4] is essential for ACPF.

FIGURE 1. Main Process Concept




## 2. Radiation Source Determination

Because ACP is a dry process, there is no liquid source. To determine how much nuclear materials and radioactivities are treated during the process, this study set up the source specifications as Table 1 [1];

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[3] ACPF: Advanced spent fuel Conditioning Process Facility
[4] RMS: Radiation Monitoring System

TABLE 1. ACP Source Condition

| | |
|---|---|
| Spent fuel quantity in a year | 100kg-HM(20kg/batch, 5 batches/y) |
| Initial enrichment | 3.5 wt% |
| Assembly average burnup | 43,000 MWD/MTU |
| Cooling time | 10 years |

FIGURE 2. Hot cell bird's-eye-view


ORIGEN-2 program calculated the mass and radioactivity for each nuclide by considering the source specifications above, for all the proceeding steps and the process operating concept. As a result, Table 2 shows the total radioactivity treated during a normal operation in a year as 37,430 Ci.

TABLE 2. The Maximum Amount of Radioactivity in Hot Cell

| Radioactive Source Terms | Radioactivity (Ci) |
|---|---|
| Spent Fuel (1 Batch in process) | 9,930 |
| Metal Uranium (4 Batch after process) | 14,737 |
| Volatile Fission Products (H, Kr) (4 Batch after process) | 543 |
| Molten Salts (2 Batch after bead type) | 12,220 |
| Total | 37,430 |

## 3. System Units & Configuration

ACPF consists of two hotcell which are process cell(M8a) and maintenance cell(M8b), with 2 m width × 11 m length × 4 m height [2].

RMS consists of 7 category units which are Room air monitor, Area monitor, Hotcell monitor, Duct monitor, Iodine monitor, CCTV, and Management Server. The system units are listed in Table 3 and brief specifics for each units are described below.

TABLE 3. RMS units list

| Item | Count | Position |
|---|---|---|
| Room Air | 2 | Op., Ser. |
| Area | 3 | Op., Ser., Int. |
| Hotcell | 2 | Op., Iso. |
| Duct | 1 | Ser. |
| Iodine | 1 | Ser. |
| CCTV | 3 | Op., Ser., Int. |
| Server | 1 | Hea. |

※ Op. : Operating Area, Ser. : Service Area
Int. : Air bumper Area, Iso. : Isolation Room
Hea. : Health Physics Room

### 3.1 Room Air Monitor

Room air monitors are for detecting particulates & iodine simultaeneously in operating area and service area each. These monitors are expected to secure clean work area by surveying nuclides which could induce hazardous human's intake.

### 3.2 Area Monitor

Area monitors are installed in 3 positions; operating area, service area and air bumper zone(opposite side wall of M8b cell rear door). These positions represent most detectable point of each zone, therefore the efficiency of gamma ray detection is high.

### 3.3 Hotcell Monitor

When examination material (i.e. radioactive spent fuel) is carried to hotcell inside, the radiation intensity goes up rapidly. This means that hotcell monitoring detecter should cover very wide range of detection; normal condition and extremely high radiacive condition. Two hotcell monitor which could follow up previously described conditions are set up in each hotcells. As long as the radiation intensity of hot cell is over 2.5 mSv/h [3], the hotcell rear door must not open for safety of hotcell outside. For this reason, hotcell monitors send 'Interlock' signal to the rear door whenever radiation level is over it's limit.

### 3.4 Duct Monitor & Iodine Monitor

As RIPF[5] & ACPF belong to IMEF and these two facilities also share all utilities of it, the radiation safety manager of IMEF needs to distinguish radioactive ventilation contamination from each facilities. Duct & Iodine monitors are installed in the middle of outline duct of ACPF to meet previously mentioned necessity.

### 3.5 Closed Circuit TeleVision

The facility manager regularly should watch the operating area where most working is performed and the rear door opening position where first level shieding is performed. In order to do this easily, one CCTV is installed in the operating area and two at the back of rear door.

### 3.6 Management Server

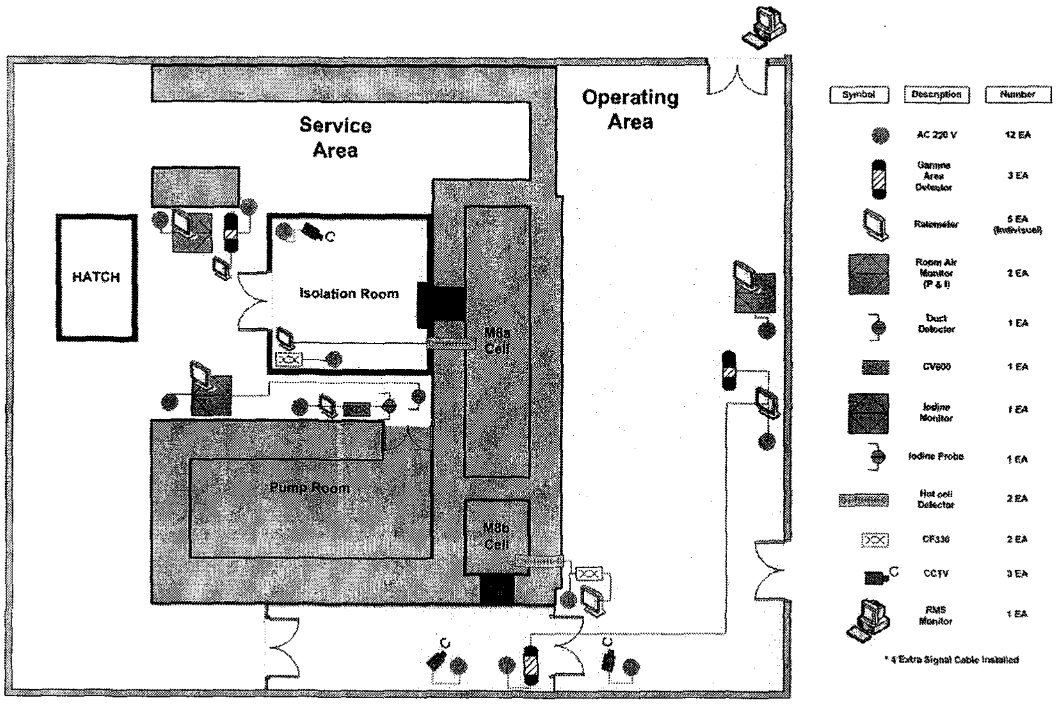
RMS management server receives system units's all signal remotely by network. It also shows the detecting trends of each units for various optional time step which user can tune and always record CCTV's screen.

Fig. 3 shows RMS units's position in the ACPF. Blue area means 7000 zone, yellow 8000, and violet 9000. All units are positioned at the representative point for each own purpose.

## 4. Conclusions

Radiation monitoring system is essential to run the ACPF because the final goal of this facility is to demonstrate that oxided uranium from highly radioactive spent fuel could be converted into metal uranium in molten salt. Conservative and safe RMS design is expected to ensure safety of work place and finally freedom from radioactive danger.

FIGURE 3. Unit Configuration

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5 RIPF: Radio Isotope Production Facility

## REFERENCES

[1] KAERI, Conceptual Design Report of Hotcell Facilities for Demonstration of Advanced Spent Fuel Management Process, KAERI/TR-2092/2002, 2002

[2] KAERI, Design Requirements of Hot Cell Facilities for Demonstration of Advanced Spent Fuel Management Process, KAERI/TR-2004/2002, 2002

[3] KAERI, Safety Analysis Report of KMRR , KAERI/TR-322/92, 1992