Design of a Clean Room for Quality Control of an Environmental Sampling in KINAC

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1. Introduction

The KINAC in collaboration with the KAERI (Korea Atomic Energy Research Institute) and the ITU receives and analyzes environmental swipe samples taken during safeguards verification activities. The objective of environmental sampling and analysis for safeguards is to characterize the nuclear materials handled and the activities conducted at the specific locations [1].

The KINAC is responsible for the conclusions drawn from the analytical results provided by the analytical laboratories. To assure the KINAC of the continuity of the quality of the analytical results provided by the laboratories, the KINAC will implement a quality control(QC) programme. One of the QC programme is to prepare QC samples. The establishment of a clean room is needed to handle QC samples due to stringent control of contamination [2].

The KINAC designed a clean facility with cleanliness of ISO Class 6, the Clean Room for Estimation and Assay of trace Nuclear materials(CREAN) to meet conflicting requirements of a clean room and for handling of nuclear materials according to Korean laws.

2. The CREAN facility

2.1 Guideline and limitation

The criteria for environmental clean rooms to prepare QC samples are [2];

- All spike, reference material and reagent processing rooms to be Class 1000 or better
- All spike, reference materials and reagents to be handled only in Class 100 work area

However, nuclear materials have to be kept inside a facility according to the nuclear safety act. In addition, unfortunately, the clean room will be established at a spare place in the KINAC/INSA.

2.2 Basic specification

The clean room has a floor area of about 155m^2 space and is divided into two areas, ISO class 5(20m^2) and ISO class 6(65m^2). Figure. 1 shows a layout of the clean room.

Chemical rooms for preparation of QC samples are designed to be kept at ISO class 5 level. On the other hand, most of the instrumental analysis area for validation of QC samples is designed to be kept at ISO class 6. The room temperature and the relative humidity were designed to be kept at 20℃ ~ 24℃ and at 45% ~ 55% respectively excluding rainy season because of space limitation.

In order to achieve the cleanliness, sequential air filtrations are adopted. The supply air to the clean zone is filtered by a high efficiency particulate air filter in the air handling-unit. Then, the air in the clean zone is re-circulated independently to each room by blower filter unit(BFU). The effective air change rates are designed to be 60 renewals/h in the ISO class 5 area, and 30 renewals/h in the ISO class 6 area [3-5].

In order to prevent cross-contamination inside the clean zone, pressure differentials are established to make air flows from areas at higher cleanliness to areas at lower cleanliness. The pressure of each room is set to be slightly higher than the facing corridor [5].

In the chemical rooms, nitric and acids are usually used for sample pretreatment when using the alpha spectrometry and ICP-MS equipment. Therefore, PVC and PP materials are selected for components surrounding chemical rooms because of avoiding contamination caused by metallic particles released from construction materials.

2.3 Special specification

In order to solve the conflicting problem related to the pressure control of the CREAN facility, ISO class 6 area themselves are designed to be kept at negative pressure relative to the outside, while three chemical treatment rooms are to be kept at positive pressure in order to maintain cleanness. To maintain ISO class 5 cleanliness level in three chemical rooms, clean booth and hood are stood close to each other. In addition, the pressure differentials had to be set up not to give an overload to the wall panel of the clean room module. Though the area kept at positive pressure (clean zone) is to be adjacent to that at negative pressure (instrument area) in this facility is limited to 30 Pa (between rooms in the chemical treatment area and the corridor) [5].

The controlled zone except the chemical rooms is set at negative pressure by damper in the supply air system to each room, detecting the pressure differential at each room relative to the atmospheric pressure. To ensure the "containment of radioactivity," interlocking systems are adopted. Additional exhaust system for the clean zone is also applied to provide against emergencies.

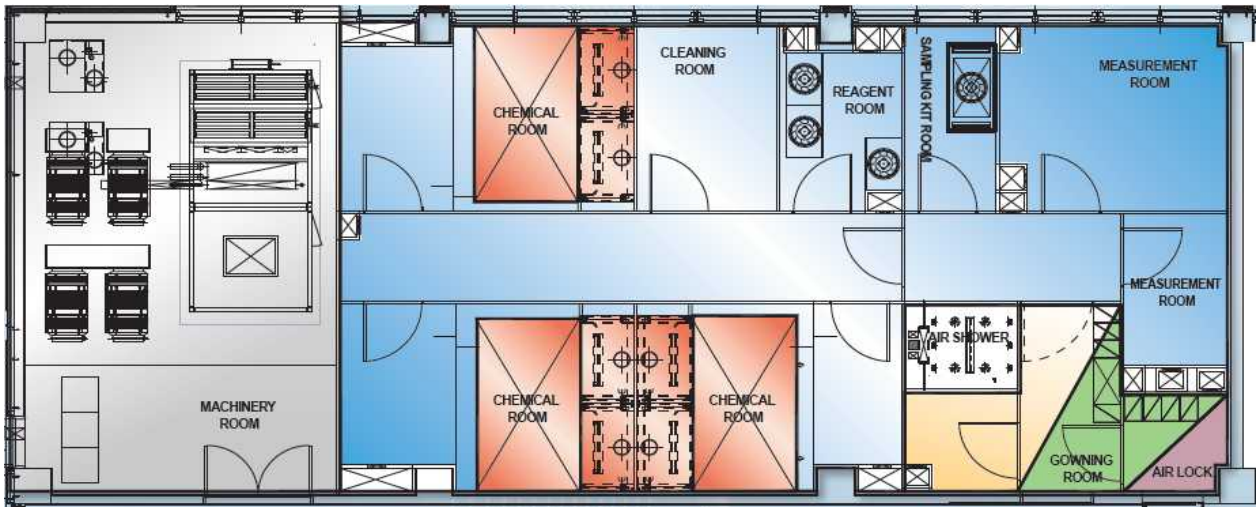

Fig. 1. Layout of clean room

Table I. Main area equipment in the clean zone

Area	Cleanliness	Purpose	Equipment
Chemical treatment area	ISO class 5	· Sample pretreatment · Chemical treatment · Apparatus cleaning · Reagent preparation · Reference material preparation	· Fume hood · Clean booth · Sample digestion device · Gas service · Work bench · Glove box
Instrumental analysis area	ISO class 6	· Mass spectrometry or Q spectrometry · Radiometry · Apparatus cleaning · Equipment entrance	· ICP-MS (tentative) · TXRF · CSS · Sink · MMC (tentative) · MMXRF · Clean bench · Liquid nitrogen service

3. Conclusions

The clean room will be expected to acquire of a radiation safety license under these conditions in this year and continue to improve it. The construction of the CREAN facility will be completed by the middle of 2015.

In terms of QC programme, the establishment of a clean room is essential and will be not only very helpful for setting of quality control system for the national environmental sampling programme but also be applyed for the environmental sample analysis techniques to the nuclear forensics.

4. References

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