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ENG-07

Internal Exposure Dose Assessment Using Urine Analysis

RADIATION & ENVIRONMENT DEPT. RyuJi Chang
T. 042-869-3076 E. ryujc@knfc.co.kr

A technique which evaluates internal exposure doses of radiation workers using indirect method(In-vitro). Internal exposure dose means exposure by radioactive materials in the body. To evaluate this, a detector(HPGe or NaI(Tl)) can be used outside of body or a radioactive material in urine can be measured. Internal exposure does assessments using urine are effective way to detect low-exposure dose compared with the direct method and it takes shorter analysis times giving high convenience to the radiation worker.

Description

● Background

- Internal exposure dose assessments are essential for the radiation safety management of radiation workers. In the case of nuclide which emits low-energy gamma rays like uranium, it takes a lot of time and is difficult to detect low-exposure dose by direct method. To overcome these shortcomings and manage low-exposure dose, internal dose assessments using indirect method are necessary.

● Purpose and Necessity

- Development of an internal exposure dose assessment system for radiation workers using indirect method
 - Nitric acid dilution method, microwave method, UTEVA resin method, etc. are used
 - Measurement of minimum uranium(about 20~200 ng/L) from the urine sample using ICP-MS

- The only way to measure Type F uranium which is quickly absorbed from the lungs to the blood
 - Establishing a system that can respond quickly in case of an emergency such as UF_6 leakage accident, etc.
- Exposure dose can be assessed according to a various intake situation
 - Evaluating internal dose by ingestion, which cannot be evaluated by direct method
- Reducing radiation worker's inconvenience
 - Shorten more than 30 minutes compared to lung radioactivity measuring system
 - Increase convenience of worker's sample submission thanks to using spot urine sample

● Technical Composition and Procedure

- Technical Composition
 - Urine sample quality management: Use sterilized sample bottle and keep it in the refrigerator which can control temperature
 - Quadrupole ICP-MS: Analyse uranium in the sample after pre-processing



< ICP-MS >

< Pre-processing room >

- Creatinine analysis: Convert spot samples to 24-hour samples



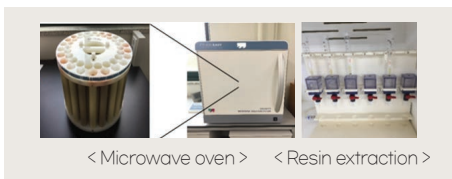
< Creatinine measurement >

- Internal dose assessment: Evaluate worker's intake amount and assess committed effective dose.

- Work Procedure
 - Registration of personal details : Management of working days, uranium enrichment information of working process and radioactive concentration information in the air during the process.
 - Applying the analysis information of working area environment : uranium dust size during the process(AMAD) and uranium chemical type(Type F, M, S).



- Collect worker's urine sample: Submitting urine samples within the monitoring period
- Pre-processing of urine sample : Analyse uranium in urine sample by ICP-MS after pre-processing such as nitric acid dilution method, microwave method and UTEVA resin extraction method

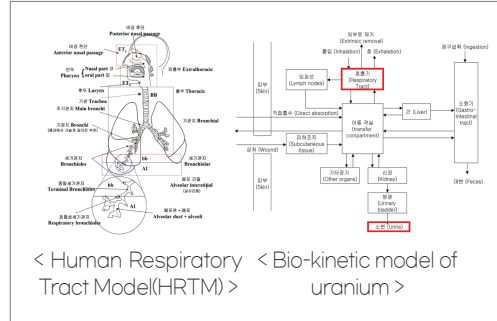


- Measurement of uranium and elimination of background : Analyse uranium concentration in worker's sample after removing the background, the amount of uranium contained in the urine of the public.
- To minimize errors caused by matrix effect, the results of uranium measurements are calibrated by the internal standard
- Convert spot urine sample to 24-hour : Convert the amount of uranium in the spot sample to the amount of uranium released 24 hours using the creatinine concentration
- Exposure dose assessment: Evaluation of worker's exposure dose using computer program considering intake type(inhalation/ ingestion), chemical type, intake pattern(acute/ chronic), working time and remaining uranium.



Estimation of internal exposure dose by

multiplying the amount of uranium intake by effective dose coefficients(e_{50}). (Using HRTM and GI model from ICRP)



Technology Readiness Level (TRL)

Actual system proven through operation

Business Model

Technology Transfer

Licensing

Joint Search

Service Execution

Others

Distinctiveness

• Characteristics

- Providing measurement for low exposure dose by intake of uranium
- Deliver faster results than direct measurement
- Providing analysis of F uranium(UO_2 , UO_2F_2) Type

• Benefits

- Convenient analysis method compared to lung radioactivity measuring system
- Providing exposure dose by uranium ingestion in daily life
- Providing alternative method of analysis other than lung measurement in case of an emergency situation
- Providing results of exposure dose assessment which is faster than direct method to a large number of workers

Experience

- Performing internal exposure dose assessments for radiation workers(2018.1.~)
- Preparing for the registration of dose assessment licence
- Development of urine sample analysis on the beta/gamma rays emit nuclides

Deliverables

- Establishment of bioassay laboratory
- Provide an internal dose assessment method manual
- Provide the information of exposure dose assessment for uranium-intake workers