Investigation of radiation doses and dose constraint values of non-medical planned exposure radiation practices in Taiwan

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Introduction

In Taiwan, the Atomic Energy Council (AEC) is the competent authority in charge of the safety of ionizing radiation operations. In recent years, the AEC hopes to introduce the concepts of as low as reasonably achievable and dose constraint recommended by the International Commission on Radiological Protection (ICRP), timely grasp and control the radiation safety situation of different radiation practices, and review the protective control measures, so that the industry understand the concepts of optimization of radiation protection of planned exposure situations.

Methods

This study focuses on the radiation safety investigation of the facility operators who use the non-medical planned exposure radiation sources (such as open beam/mobile X-ray detectors, X-ray tube static eliminators, ion implanters, cabinet-type X-rays and sealed radioactive material) in Taiwan. The AEC provides equipment rosters for sampling and the investigated objects were randomly selected. On-site radiation safety surveys are carried out with radiation survey meters, which measure the doses of radiation workers and the general public that may be caused by normal operations, and evaluate the impact of possible abnormal doses on some high-risk radiation operations; and evaluate the dose constraint values of different types of radiation practices by data statistical analysis.

Results

During the years from 2020 to 2022, a total of 1122 radiation sources (including 783 equipment capable of producing ionizing radiation and 339 sealed radioactive material) were subjected to on-site radiation safety investigations by this study. Besides, the dose constraint values of different types of radiation practices were proposed.

Conclusions

This paper conducted the investigations, evaluated the radiation doses according to the type and use of radiation sources, and proposed dose constraint values of different types of radiation practices to AEC in Taiwan for reference.

Thermoluminescence and phototransferred thermoluminescence of radiation dosimeters: analysis of the effect of UV light for transfer of charges from deep traps

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Introduction

The stored energy by some solid-state materials in the form of trapped electronic charges, after exposure to ionizing radiation, can be measured when the stimulation of those charges occurs; one way is the heating of the sample, to observe its luminescent signal by the thermoluminescence (TL) technique. Another form to study the luminescence of these materials is by means of the phototransferred thermoluminescence (PTTL) technique, that allows the observation of the light-induced transfer of charges from one kind of trap to another. The main objective of this work was to study the TL and PTTL of radiation dosimeters in ^{60}Co and UV beams.

Methods

The responses of LiF:Mg,Ti, CaF_2:Dy, CaF_2:Mn and $CaSO_4$:Dy commercial dosimeters were studied in the sequence: 1) TL after irradiation; 2) TL after irradiation + thermal treatment (TTPI); and 3) PTTL after irradiation + TTPI + illumination. The irradiations were performed using a ^{60}Co source from a Gamma-Cell system, and all the measurements were taken using the Risø reader system, model TL/OSL-DA-20. The absorbed doses were: 0.7 Gy (LiF:Mg,Ti and $CaSO_4$:Dy), 20 Gy (CaF_2:Dy) and 50 Gy (CaF_2:Mn), for the first step, and 5 Gy (LiF:Mg,Ti), 100 Gy (CaF_2:Dy), 200 Gy (CaF_2:Mn) and 25 Gy ($CaSO_4$:Dy), for the second and third steps.

Results

In the initial step, TL emission maximum peaks were observed for all four materials: at about 250ºC (LiF:Mg,Ti), 300ºC (CaF_2:Dy and $CaSO_4$:Dy) and 385ºC (CaF_2:Mn). After TTPI, in the second step of the experiments, the TL peaks arised at about 365ºC for LiF:Mg,Ti, and for the other materials no peaks were observed. In the final step, after exposure to UV light, PTTL signals appeared for LiF:Mg,Ti at 260ºC and 370ºC, for CaF_2:Mn at 398ºC and for $CaSO_4$:Dy at 200ºC; no PTTL was observed for CaF_2:Dy.

Conclusions

According to the results obtained, it was possible to study the occurrence of the phototransferrence signal of the materials, present for LiF:Mg,Ti, CaF_2:Mn and $CaSO_4$:Dy.