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Intorduction

Before using Radico

Ionization is the phenomenon that radiation ionizes material directly or indirectly when it penetrates material. α ray, β ray, neutron, X ray and γ ray is called as ionizing radiation for it has ionizing capability, generally radiation means ionizing radiation. Compared with it, ultraviolet and visible light is called as non ionizing radiation because the effect on material is very weak though we cannot say that it doesn't have any ionizing capability. Ionizing radiation exists in the nature like earth, space and crops and continues to affect human body. And it is generated by artificial radiation source like medical x ray equipments and nuclear power plant.

Type of important ionizing radiation is as follows.

α ray is generated from nucleus and may be shielded by a piece of thin paper. It is hard to penetrate and affect human body unless it is absorbed by eating food or through cut. Therefore, protection from external radiation exposure is not considered for it.

β ray is electron that comes out of nucleus of radioactive atoms. It is smaller particle than alpha particle but has higher energy and moves very fast. And it may penetrate 1~2cm thickness of water. It may easily penetrate the same thickness of human body.

Neutron may come from the space far away or may be generated when atoms in the air collide with each other. And it may be created from nuclear fission of uranium atoms in nuclear reactor. Because generating source is limited, only in special case, protection is considered, though it has strong penetration capability.

X ray is electro magnetic wave like light but has high energy, and γ ray is high energy level radiation generated when unstable radioisotope decays. X ray and γ ray has characteristic to penetrate human body, and the penetration depends on the energy level of radiation applied. Because X ray has wide range of penetration according to energy level and γ ray has strong penetration capability, protection from radiation should be considered.

As mentioned above, the effect on human body from radiation exposure in daily life happens due to γ ray and β ray, therefore this equipment which measures private Dose focuses on measuring these two radiations.

Main subject

Thank you for purchasing Radico Radiation Dosimeter (Hereafter 'Dosimeter').

This manual is made to explain operating principle and operating method of Radico to users. And it includes necessary information and proper directions for good performance and use.
Radico docimeter is manufactured for the general public, and professional level in function and performance is not guaranteed when it is used for expert test. Radico dosimeter was calibrated with standard radiation source after it was made, but it is not the object that should be verified. Dose Rate of Radico always displays some test value due to background radiation even though there is no radiation source. Background radiation is different by region, and Dose Rate displayed by Radico due to background radiation is 0.1~0.3μSv/h when it is made.

Radiation Dose (unit: "Roentgens"("R")) is absorbed radiation energy per unit mass of air, but effective Dose (unit: "Sieverts"("Sv")) expresses the effect of radiation on human body. Therefore displayed unit of Dose in Radico is Sv, general μSv 100.0μR. Here is relation Sv = 1000mSv = 1,000,000μSv. For reference, people are exposed to 2.4mSv of background radiation a year, and exposed to 0.3mSv of radiation for 1 time of chest X-ray.

1. Purpose of product

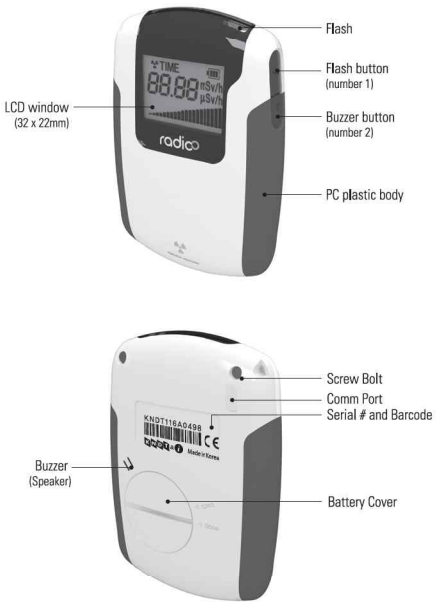
Radico was made to measure exposure Dose of human body to gamma ray and beta ray.
Alarm function to warn emergency situation and flashlight function for emergency was added. Radico may be used for daily life, monitoring of facilities like apartments or office buildings, monitoring of the surface of earth and water quality, gamma ray source of each food, estimation of radioactive pollution by strong beta ray source, and dosimeter for educational purpose.

2. Specification

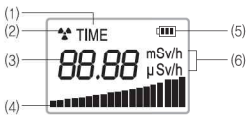
A. Summary

Item	Description
Model name	· Radico
Purpose	· Electronic private dosimeter for the general public
Size and weight	· H*W*D : 92.8x64x21.7mm · Weight : Less than 100g
Range of measurement (Deep Dose)	· Dose: 1μSv ~ 10Sv · Dose Rate: 1μSv/h ~ 10mSv/h (In case of slow mode, 0.01 μSv/h~)
Response time	· 4sec, Fast Mode, update time of measured value: 1 sec.
Energy range	· 60keV ~1.5 MeV, ±30%
Display	· Mono LCD · Dose Rate(μSv/h, mSv/h), Dose(μSv, mSv, Sv), time, Dose Rate bar graph
Battery	· Duration: 650 hours(Operated in basic function without flashlight or alarm) · Battery: 620mAh (LiMnO2 CR2450, TOSHIBA/SONY)
Alarm	· Sound: Tone (>~75dB at 10cm) · Alarm by each step (Dose Rate & Dose)
Detector	· GM Tube · Temperature for use: -10~50℃ · Sensitivity: 7.5cps per mrem/hr
Accuracy	· For Cs-137 source ±15%

B. Name of each part



C. Description of LCD window



(1) It is displayed when time is set up or it is time mode.
(2) It appears when cumulative Dose is over than alarm level.
(3) Measured value or time is displayed in number.
(4) It displays measured Dose Rate graphically
(5) It indicates battery duration left and time to change battery.
(6) It is visible in Dose and Dose Rate measurement mode, and unit changes automatically according to measured value.

3. Components

Components are composed of parts and documents expressed at Table 3.1.

Table 3.1. Components

Type	quantity	Remarks
Radico packaging box	1	
Radico main body	1	
Radico pouch	1	
Qucik guide	1	
Manual	1	
Battery(CR 2450)	1	TOSHIBA/SONY

4. Operating principle and design

A. General information

Radico is designed to make simple integrated system structure including the parts of gamma ray and beta ray detector (Geiger-Müller counter), printed circuit board where each electronic component is installed, and battery. Operating principle is as follows, radiation is detected by GM counter and is transformed to electric signal and the voltage is measured, and the principle is used that number of signal is proportional to strength of radiation. Power is supplied by one coin cell (surely TOSHIBA/SONY CR2450 should be used).

B. Explanation of design structure

Outside of Radico is composed of round rectangular PC plastic plate associated with pebble and LCD window, inside is composed of PCB circuit, detector and battery. All the operations may be controlled by two buttons which are located on the right side of equipment when it is viewed from the front side of equipment. The speaker that makes alarm sound is on the bottom cover, GM tube that detects radiation is located at radiation mark of lower end. If you want to change battery, the battery cover may be easily opened using coin and so on. In case of batter change, after battery cover is turned open, old battery may be removed by slightly lifting up the old battery using tool that is sharp at the end. It is designed that new battery may be easily installed, inserting it by finger. Upper and lower plate is fixed firmly by 2 plastic holders and 2 pieces of screw bolt.

5. Preparation

Procedure for preparation to use Radico is as follows

① Open product packaging
② Open battery cover and insert battery in right direction after checking battery state.
③ As battery is inserted, product starts to operate
④ Check whether the product operates properly or not, following the method of use below.

6. Method of use

A. Device On/Off

· Pressing the buzzer button for 3 seconds will turn the power On/Off
※ The device capacity becomes stabilized for 4 seconds after Power On and then it shows Dose Rate / Dose measurements.

B. Measurement of Dose Rate

· Dose Rate measurement mode is basic measurement mode and is displayed when power is turned on first.
· At the removal of radiation source, the measurement reverts to the background level within 4 seconds (when it's in the fast response time)
· The measurements are updated every 1 seconds and the units for the measurement are μSv/n mSv/n, and change automatically.
· The response time can be selected at the setup mode [Fast(4 seconds)/Medium(10 seconds)/Slow(20 seconds)]
· When the setup alarm level is exceeded, it beeps and shows the radiation mark and it sets the warning level in the setup mode (1μSv/h / 10μSv/h / 100 μSv/h / 1000 μSv/h / 10mSv/h)

· When the Dose Rate reverts to below the warning level, the alarm automatically stops.

C. Measurement of Cumulative Dose

· Cumulative Dose measurement mode is activated when pressing two buttons simultaneously in the Dose Rate measurement mode
· Cumulative Dose is calculated and displayed every 1 seconds, and the units for the measurement are μSv, mSv, Sv, and change automatically
· When the setup alarm level is exceeded, it beeps and shows the radiation mark, alarm level may be set up to 1mSv, 20mSv and 100mSv.
· After the alarm happens, pressing the buzzer button (button 2) twice continuously will stop the alarm.
※ when power is off, the cumulative Dose value is initialized.

D. Display of Time

· Time display mode –activated when pressing two buttons simultaneously in cumulative Dose measurement mode.
· Display by 24-hour clock.
· when pressing two buttons simultaneously in the time display mode, it will revert to the Dose Rate measurement mode.

E. Flash and SOS function

· Flash function
- Pressing the Flash button more than 2 seconds in the Dose Rate / cumulative Dose / Time display mode will activate the Flash function. At this time, for Flash function to be maintained, the button should be kept pressed.
- Even though the power is Off, the Flash function works.

· SOS function
- Pressing buzzer button twice in a row in Dose Rate /Cumulative Dose / Time display mode will activate the alarm sound.
- Pressing the buzzer button twice in a row at alarming state will stop the alarm.
· Even though the power is Off, SOS function works.
※ Frequent use of Flash/SOS will abridge the life of the battery.

F. Warning level/Response time/Setting up time

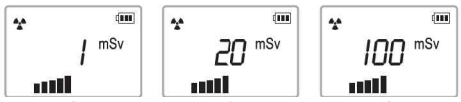
· Pressing the Flash button twice in a row in Dose Rate /Cumulative Dose / Time display mode activates the setup mode
· After set up mode is activated, buzzer button is used to set up arbitrary value and change it, and Flash button saves set up value and proceeds with each step of ① ② ③ ④ in order.

① ② ③ ④

① Setting the Dose Rate warning level (Default : 10µSv/h)
· As pressing the buzzer button, it changes to ⓐ ⓑ ⓒ ⓓ ⓔ ⓐ····· sequentially.
· As Flash button, displayed warning level is saved, and it changes to ②.

ⓐ ⓑ ⓒ ⓓ ⓔ

② Setting Cumulative Dose warning level (Default : 1mSv)
- As pressing buzzer button, it changes to ⓐ ⓑ ⓒ ⓐ····· sequentially
- As pressing Flash button, warning level is saved, and it changes to ③.
- For reference, 1 mSv is annual Dose limit for ordinary people recommended by IAEA, and 20mSv is annual Dose limit of the radiation workers recommended by IAEA



ⓐ ⓑ ⓒ

③ Setting the response time (Default : Slow)
- As pressing buzzer button, it changes to ⓐ ⓑ ⓒ ⓐ····· sequentially.
- As pressing Flash button, displayed response time is saved, and it changes to ④.
- Time for each sign displayed is Fast: 4seconds, Medium: 10seconds, Slow: 20seconds.
- In low Dose Rate, setting to the Slow is recommended for more precise measurements.

ⓐ ⓑ ⓒ

④ Setting the time (Default : 00 : 00)

- As pressing buzzer button at ⓐ it changes time unit. As pressing Flash button, displayed time unit is saved, and it changes to ⓑ.
- As pressing buzzer button at ⓑ it changes minute unit. As pressing Flash button after finishing setup, displayed minute unit is saved, and it changes screen to Dose Rate/Cumulative Dose/time display mode.

ⓐ ⓑ

G. Precautions

- Never dissemble this product as there is 500V high voltage in it.
- It is advised not to use in strong external collision or in environments of high temperature and high humidity.
- This device uses a coin cell (3V, CR-2450, TOSHIBA/SONY)
- If causing any damage to the QA sticker for quality guaranteed, our warranty service may be limited.
  (Do not disassemble or assemble the product)

7. Repair of problem

Possible problem and the how to fix the problem is expressed in Table 7.1

Table 7.1. Problem and Repair

Problem	General cause	Repair
Power doesn't work	·Battery discharge ·Bad contact between battery and compartment	·Check insertion of battery ·Fix battery to compartment ·Change faulty battery
Button doesn't work	·Damage by external shock ·Failure due to electric problem	·Contact manufacturer
If "Err" appears on screen	·Error to the Detector	·Contact manufacturer
If "ouEr" appears on screen	·Measuring range exceeded	·Re-measuring required where dose is low ·If appearing again, contact the manufacturer

If the problem of table 7.1 is not fixed, or new problem is found, please contact manufacturer surely without disassembling the product.

8. Safety measure

Radico doesn't include the electric device that may be threat to user's body. There is no danger when users utilize it for general purpose, and they may use it more conveniently and safely as they are accustomed to use. The user is absolutely responsible for the safety accident caused by disassembling of dosimeter and careless management. User is absolutely prohibited from disassembling the dosimeter because 500V high voltage circuit for operating dosimeter is included inside of it. Please be careful for baby or kid not to swallow a coin cell.