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The use of Conversion Coefficients (CC) in the calibration of radiation monitoring instruments

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SCAN ME

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1. Radiation monitoring instruments (RMI) used in the Philippines

RMI used to measure radiation levels and exposure are:

- Dose rate / survey meters: **ambient dose equivalent H*(10)**
- Active personal dosimeters: **personal dose equivalent Hp(10)**

However, some RMI units are expressed in: Roentgen (R)

*unit **Sv** = SI unit for equivalent dose related to the biological effects of ionizing radiation.*

2. Regulatory Annual Safety Limits

Dose limits for Adult Workers:

- Effective dose = 20 mSv/yr averaged over 5 yrs (max 50 mSv/yr)
- Equivalent eye lens dose = 20 mSv/yr averaged over 5 yrs (max 50 mSv/yr)
- Equivalent dose to the extremities or skin = 500 mSv/yr
- For pregnant women = not exceeding 1 mSv/yr

3. Main objectives of using CC

- Directly convert the readings from ***R*** to ***Sv***
- Help workers interpret the readings of their RMI
- Directly compare the reading of RMI (from ***R*** to ***Sv***) to existing safety standards (in Sv)
- Relate results of their RMI measurements to levels of radiation hazards in facilities

4. Calibration of RMI in Philippine SSDL

Calibration of RMI for H*(10) and Hp(10) [Photon]

- Utilizes a 370 GBq Cesium-137 with FTS F500 Irradiator
- Radiation field standardized in terms of air kerma in Gray (Gy)
- Traceability of the reference ion chamber PTW/LS-01 32002 - International Bureau of Weights and Measures (BIPM)

4.1 Calculations for reference values

Air kerma measurements were done at various source-detector-distance (SDD)

4.1.1 Air kerma to H*(10)

$$H^*(10)_{ref}(Sv) = K_{air}(Gy) \times \frac{H^*(10)}{K_a}(\frac{Sv}{Gy})$$

$\frac{H^*(10)}{K_a}$ = conversion coefficient for normal incidence (1.20 for Cesium)

4.1.2 Air kerma to Hp(10)

$$H_p(10)_{ref}(Sv) = K_{air}(Gy) \times \frac{H_p(10)}{K_a}(\frac{Sv}{Gy})$$

$\frac{H_p(10)}{K_a}$ = conversion coefficient for normal incidence (1.21 for Cesium in slab phantom)

4.1.3 Air kerma to Exposure

The Exposure (in R) is then determined from the air kerma measurements based on the following relationships:

$$K_{air} = \frac{W \times Exposure}{1-g} = \frac{33.97\ \frac{J}{C} \times (2.58 \times 10^{-4}\ \frac{C}{kg})}{1-0.002} = 8.781823647 \times 10^{-3} Gy$$

where **W** is w-value (*average energy needed to ionize air*), **g** is g-value (*air kerma lost due to bremsstrahlung for Cs-137*), **Exposure** is value of *1 R in terms of C/kg*

$$Conv = \frac{1\ R}{8.781823647 \times 10^{-3} Gy} = 113.8715647 \approx \mathbf{113.87}\ \frac{R}{Gy}$$

$$Exposure_{ref}(R) = K_{air}(Gy) \times Conv(\frac{R}{Gy})$$

4.2 RMI response and Calibration Factor (CF)

*The **Response** of the instrument determines the accuracy of its readings:*

$$Res = \frac{M}{H^*(10)_{ref}\ or\ H_p(10)_{ref}\ or\ Exposure_{ref}}$$

where **M** = indicated dose or dose rate reading of the RMI.

*The **CF** is the reciprocal of response. It's multiplied to **M** to determine true value (dose/dose rate)*

$$CF = \frac{1}{Res}$$

*The **CC** is calculated by dividing the **reference values** (in Sv) to **M** (in R)*

$$CC = \frac{H^*(10)_{ref}\ or\ H_p(10)_{ref\ (in\ Sv)}}{M\ (in\ R)}$$

5. Reporting RMI Calibration Factor (CF) AND Conversion Coefficient (CC)

- Improved calculations for **reference exposure rates** paved to more accurate RMI response since values are not overestimate/underestimate.
- Both CF and CC are being reported at the Certificate of Instrument Calibration.
- The use of CC was explained to all customers of calibrated RMI.
- Customers can use CC to directly compare the exposure readings to dose limits in Sv.

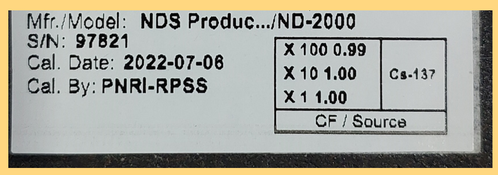
RESULT OF CALIBRATION

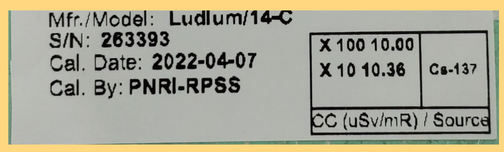
The calibration factor and conversion coefficient of the instrument is/are as follow/s:

Selector / Multiplier Switch	Calibration Factor (CF)	Conversion Coefficient (µSv/mR)
X 100	0.98	**10.37**
X 10	1.03	**10.97**

The response of the calibrated instrument is linear within the range of ***0-50*** **mR/h**
The response of the instrument is within the acceptable limit **0.80 to 1.20**
The linearity of the instrument response is shown in Page 2.

Important Note: a) Use the calibration factor to determine the true reading of the instrument.
True Reading, (in mR/hr) = Instrument Reading (mR/hr) x CF
b) Use the conversion coefficient to convert exposure rate (mR/hr) to H*(10) (µSv/hr).
True Reading, H*(10) (in µSv/hr)= Instrument Reading (mR/hr) x CC (µSv/mR)





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