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An approach to assessing the effectiveness of individual dose monitoring of medical personnel working with radiation sources

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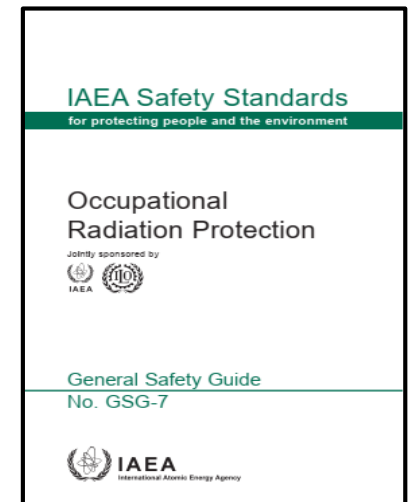
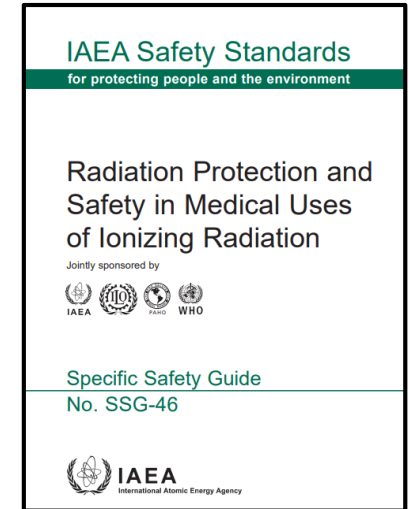
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INTRODUCTION

It is accepted, that protection and safety is required to be optimized in order to the magnitude of individual doses, the number of people exposed and the likelihood of incurring exposures all be kept as low as reasonably achievable, economic and societal factors being taken into account, with the restriction that the doses to individuals delivered by the source be subject to dose constraints

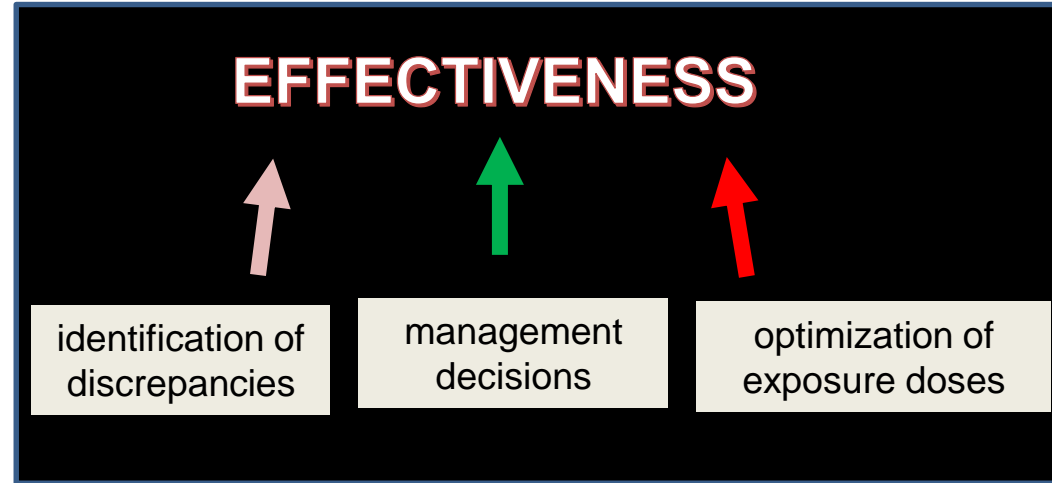
This principle is of particular importance for the implementation of personal radiation protection measures, which, in turn, are based on the results of the individual dosimetry monitoring (IDM) of personnel exposure doses

In order to ascertain where the shortfalls are and where the IDM system requires improvement in a timely manner, it is necessary to periodically assess its effectiveness in terms of ensuring an adequate level of worker protection and compliance with modern regulatory requirements and approaches



INTRODUCTION

Assessment of IDM effectiveness allows to understand extent, to which the volume and quality of dosimetry measurements meet the requirements of regulatory documents and how the results of the IDM are used for making operational decisions in the area of optimization and improvement of radiation protection measures



The paper presents a method for assessing the effectiveness of IDM system of personnel working with radiation sources, developed within the frame of research on State Program «Scientific and technical assurance of quality and availability of medical services» for 2021-2025, task *To develop methods for evaluating radiation safety for the population of radioactive discharges and assessment of the effectiveness of IDM of personnel during the operation of radiation facilities*

The method for the assessment of the effectiveness of personnel IDM is based on a comparison between the *elements* of the IDM system and *the criteria of effectiveness* of IDM system (hereinafter referred to as CEF)

Criteria of effectiveness for IDM system (CEF)

CEFs have been first developed by the authors of this work on the basis of an analysis of the IDM systems of reference institutions of the Ministry of Health, the study of regulatory documents of the Republic of Belarus and the latest recommendations of the IAEA, also taking into account the basic principles of activity effectiveness

CEF is a list of requirements or conditions that determine the effectiveness of the IDM systems, that is the effectiveness of IDM element is directly dependent on the extent to which IDM element meets the relevant CEF requirements and conditions



Criteria of effectiveness of IDM system (CEF)

CEF 1

All individuals working under ionizing radiation exposure conditions or for whom exposure to ionizing radiation is likely to occur during the course of their professional activities shall be under IDM

For example, in medical institutions:
radiologists, cardiologists,
gastroenterologists, endoscopists,
urologists, orthopedic surgeons,
neurosurgeons, respiratory
therapists, anaesthesiologists,
physicists-physicians, biomedical
and clinical engineers, medical
radiologists, nurses



Criteria of effectiveness of IDM system (CEF)

CEF 2

Establishing a proper procedure (regulation) for conducting IDM, in full consistence with regulatory requirements

CEF 3

Applying differentiated approach to establishing the nomenclature of IDM, parameters for different personnel groups depending on the type of their professional activity and the nature of exposure

In situations of heterogeneous exposure, IDM for external exposure of selected organs and tissues is required

Skin and extremity IDMs should be considered as necessary for X-ray surgical teams, specialists involved in minimally invasive surgery, cardiology (cardiovascular contrast studies, technical staff of nuclear medicine departments working with radiopharmaceuticals)

The need for IDM of eye lens should be considered in workplaces where the eyes are particularly close to a beam of radiation: in interventional procedures with visual control, procedures in manual brachytherapy, biopsy under the control of computed tomography, work on cyclotrons and preparation of PET diagnostic RFP

Criteria of effectiveness of IDM system (CEF)

CEF 4

Compliance with all measures and requirements, established to ensure the reliability of the results of dosimetry measurements

CEF 5

Compliance with the technical requirements to the means of measurement of operational values established by the Sub-Committee 45B «Radiation protection devices» of the Technical Committee 45 «Nuclear instrumentation» of the International Electrotechnical Commission (IEC)

CEF 6

Personnel individual doses should be recorded and accounted for in full compliance with the regulatory requirements

CEF 7

Compliance with the recommendations for maintaining a summarized database and analyzing IDC results

CEF 8 (optional):

Orientation towards results. The degree of effectiveness of the IDC under this criterion is determined by the number of reserve opportunities identified on the basis of the monitoring results to reduce the doses of personnel exposure and the effectiveness of management decisions taken to realize these opportunities

INDICATOR OF COMPLIANCE WITH CRITERIA (Compliance Indicator CI)

The CI determines the extent to which the IDM system meets the relevant CEF in numerical terms

The CI value is determined by an expert and is expressed in points on a 5-point scale from 1 to 5, the higher the compliance of the IDC system with the corresponding CEF, the higher number of points is assigned to the evaluated CI:

Degree IDM element compliance with the CEF	fully comply with	more than 80%.	more than 50 %	more than 30 %	less than 10 %
CI value, in points	5	4	3	2	1

INTEGRAL COMPLIANCE INDICATOR (ICI)

The result of the effectiveness evaluation of the IDC system is an **INTEGRAL COMPLIANCE INDICATOR (ICI)**, which is calculated based on the values of individual CIs:

$$ICI (\%) = \sum_i^n CI_i / 5n \times 100$$

where: ICI is an Integral compliance indicator
CI_i - Compliance Indicator, corresponding
the i-th CEF
n – total number of the evaluated criteria

The ICI demonstrates the degree of compliance of the assessed IDM system elements with the regulatory requirements of the Republic of Belarus and the international requirements of the IAEA in the field of radiation protection

Based on the results of the assessment, the experts develop proposals to improve the efficiency of IDC and optimize radiation impact to personnel through management decisions and implementation of appropriate measures

CONCLUSION

- ✓ This paper presents a method for assessing the effectiveness of IDM system for personnel working with radiation sources, based on the analysis of medical institutions' doses by the Belarusian Ministry of Health, information from numerous foreign publications, as well as the results of authors own research
- ✓ Firstly, CEF for IDM system were developed for the purposes of the improved assessment, which define the requirements and measures ensuring an adequate level of radiation protection for different groups of medical workers exposed to occupational exposure
- ✓ The method facilitate assessment of the IDM effectiveness in numerical terms. Moreover, it supports more objective decision making framework for prevention of an excessive level of personnel radiation exposure, providing additional radiation protection tools and measures