APPLICATION OF THE ALARA PRINCIPLE IN MINIMIZING THE EXPOSURE OF OPERATORS OF RADIOTHERAPY Co-60 UNITS

Jana Hudzietzová, Jozef Sabol, Václav Navrátil

Presenting author: jozef.sabol@gmail.com

Faculty of Biomedical Engineering, Czech Technical University in Prague
Nám. Sítná 3105, 272 01 Kladno, Czech Republic

Introduction

The paper presents the results of the mapping of stray radiation fields in three different radiotherapy treatment rooms equipped with three different Co-60 machines. Based on the distribution of the ambient dose equivalent rate, the effective dose to the personnel under various scenarios has been assessed with regard to their movement and position in the room during the preparation of the machine and the patient for treatment. The radiation field formed in the treatment room is generally not homogenous because of the asymmetrical shape of the source shielding as well as the effect of various surrounding materials and accessories which may scatter photons unevenly in different directions

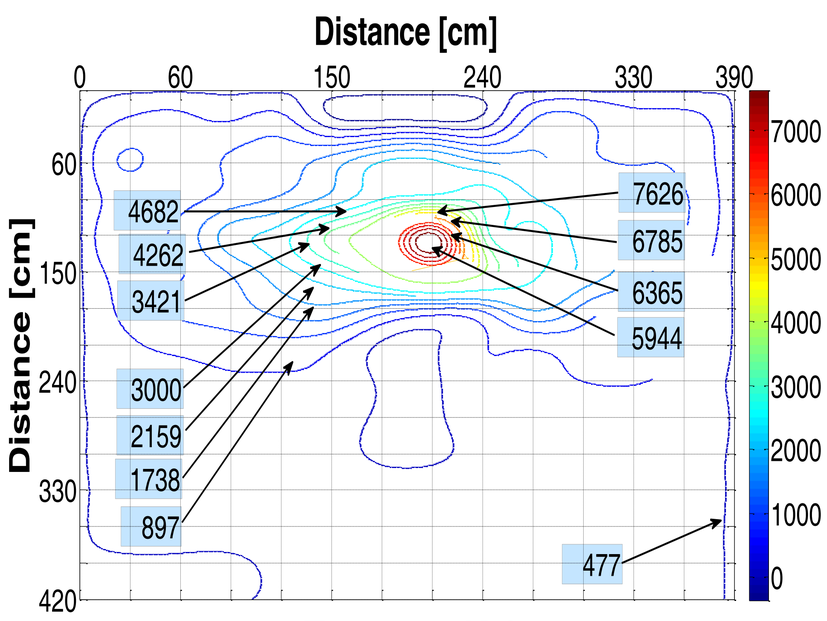
Radiotherapy facilities

Monitoring and analysis of leakage and scattered gamma fields in treatment rooms of different Co-60 units installed in three hospitals were performed. Two of these hospitals were in Prague while one was located in the nearby city of Kladno. Each of these facilities (Teragam K-2 [1], Theratron 1000 [2], Terabalt ASC 100 [3]) was unique not only because of different irradiators but also because of differences in the treatment rooms. This surely affects the distribution of the radiation field in any of these installations with respect to the fluence rate due to the leakage and scatter gamma photons.

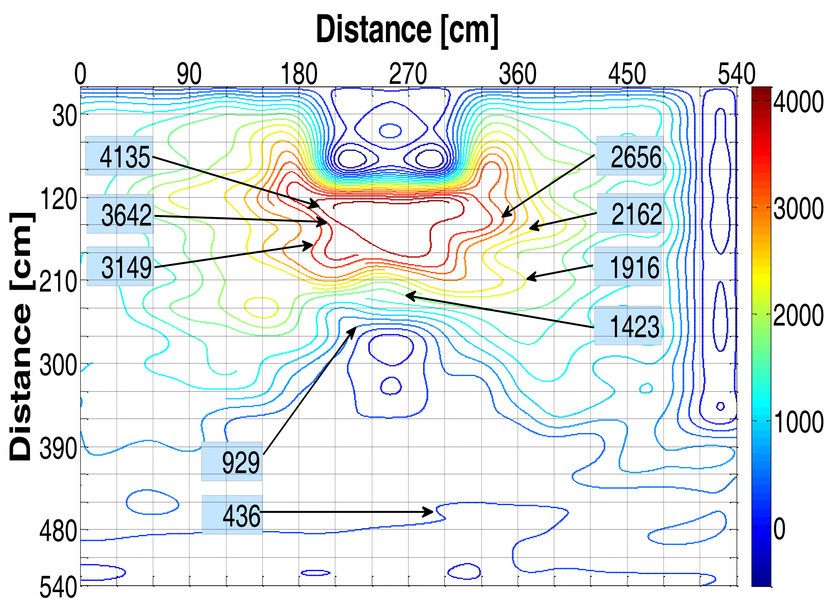
Terabalt ASC 100

Radiation fields in treatment rooms

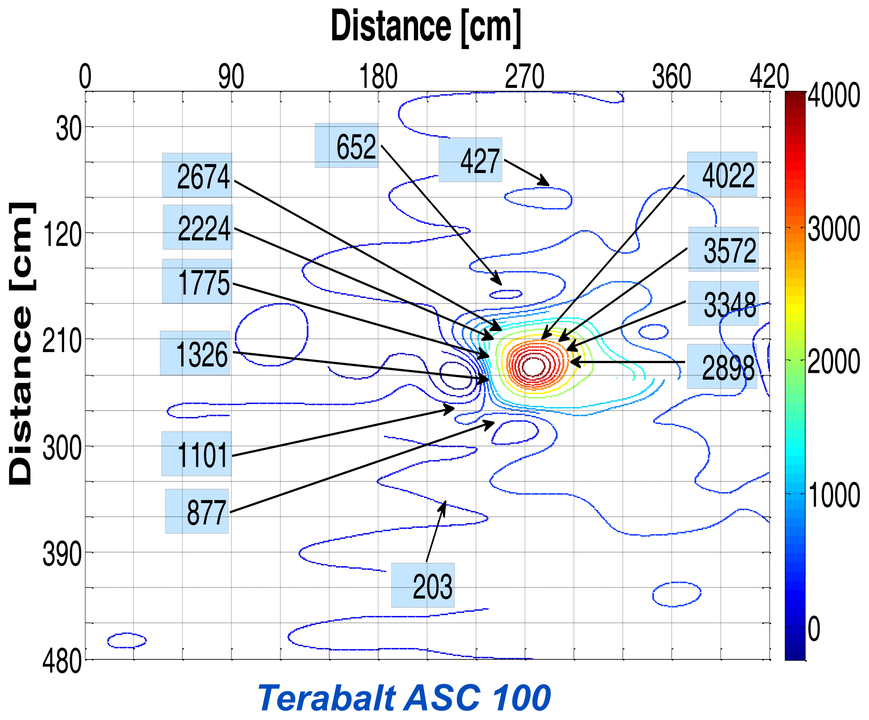
The spatial distributions of $H^*(10)$ at 1 m above the floor in nSv/h around the Co-60 head in the treatment rooms are illustrated in the following figures:



Teragam K-2



Theratron 1000



Terabalt ASC 100

Interpretation of monitoring results

The exposure received by an operator of Co-60 machines during his/her presence in the treatment room are shown in the table below. All data are normalized to the same annual workload. The exposure is expressed in terms of the total effective dose in mSv/y. The best scenario reflects the optimum procedures adopted in order to minimize the exposure taking into account the actual distribution of the radiation field. The behaviour of operators was analyzed paying special attention to how much time was spent at specific locations during the preparation of a patient for treatment. The total time per year an operator typically spends in the room is estimated taking into account three scenarios corresponding to (i) the worst case resulting in the highest exposure, (ii) the best possible practice resulting in the lowest exposure, and (iii) the outcome when the operator takes no account of the variation in the radiation field in which s/he is working.

Scenario	Facility equipped with the following Co-60 unit		
	Teragam K-2	Theratron 1000	Terabalt ASC 100
Worst	3.81	7.32	1.60
Optimized	0.76	2.56	0.87
Routine	1.49	3.42	1.26

Conclusion

The monitoring of radiation levels in terms of the ambient dose equivalent rate around the Co-60 units in the treatment rooms at three different radiotherapy departments has shown that the iso-levels always follow some specific distributions unique for each installation. Taking into account the spatial radiation field distribution one can considerably reduce the exposure received by operating personnel during their work in the treatment room, where they spend some time setting up the machine and preparing patients for treatment. The reduction in exposure may be as much as about 40% of normal exposure where the operator does not take into account the surrounding radiation field which is not usually known. The proposed approach is aimed at minimizing exposure to personnel applying the ALARA principle. In general, such procedure does not affect the normal operation of the source or machine and can be used in any similar situations around powerful sealed radioactive sources or radiation generators.

References

[1] Teragam K-2, UJP Praha, a.s., Nad Kamínkou 1345, Prague, Czech Republic; http://www.ujp.cz/? lang=en.

[2] Theratron 1000, MDS Nordion, 447 March Road, Otawa, Canada; http://www.theratronics.ca/.

[3] Terabalt ACS 100, UJP Praha, a.s., Nad Kamínkou 1345, Prague, Czech Republic; http://www.ujp.cz/? lang=en.

Acknowledgment:
Work presented here was partially funded by the project Education and Innovation of the Czech Ministry of Education, Youth and Sports under the OP VK programme.