



---

## RECOMMENDATIONS FOR EQUIPMENT REQUIREMENTS AND SPECIFICATIONS FOR DIGITAL AND INTERVENTIONAL RADIOLOGY: DOSIMETRIC ASPECTS

I.I. SULIMAN

Interfaculty Reactor Institute, Delft University of Technology  
Delft, the Netherlands

J. ZOETELIEF

Interfaculty Reactor Institute, Delft University of Technology  
Delft, the Netherlands

The recognition of radiation induced injuries from fluoroscopically guided interventional procedures has resulted in the current demand for development of recommendations and standards to limit dose to both patients and staff.

This paper outlines the recommendations drafted within the framework of European Project DIMOND III. The actual work involves survey and review of national and international documents as well as scientific publications in areas relevant to the digital and/or interventional radiology with an aim of developing recommendations for equipment requirements and specifications for digital and interventional radiology. A pilot study of experimental investigations in at least three hospitals will be conducted to test the requirements and the specifications, the result of which will be presented. The recommendations are expected to provide an effective means of dose reduction to both patients and staff while maintaining image quality adequate for the specific diagnosis or interventional procedure.

Different components of x-ray systems that have direct impact on patient and staff doses have been considered (table 1). Where necessary a compromise between patient dose and image quality has been made.

Table 1. Aspects of digital (interventional) radiology equipment for which detailed requirements are proposed in relation to patient and staff dosimetry.

---

1. Patient entrance surface dose rate
  2. Image intensifier or image receptor input dose rate
  3. Maximum fluoroscopic dose rate in air
  4. Automatic dose and dose rate control
  5. Pulsed fluoroscopy
  6. Low dose rate fluoroscopy
  7. Radiation quality, added (Cu) filters and HVL
  8. Undercouch x-ray tube/overcouch II
  9. X-ray field limitation and alignment
  10. Anti-scatter grids
  11. Dose displays and record keeping
  12. Devices to reduce occupational exposure
- 

The dosimetric aspects of the recommendations propose detailed descriptions and limits to dosimetric information relevant to patient and staff doses. International recommendations on maximum patient entrance surface dose rate vary in the range from 25 to 65 mGy.min<sup>-1</sup> for normal mode fluoroscopy [1]. Maximum image intensifier or image receptor input dose rate around 0.1 Gy min<sup>-1</sup> at a distance 30 cm from the image intensifier input surface has been generally recommended. Maximum fluoroscopic dose rate in air must not exceed 50 mGy.min<sup>-1</sup> at a location depending on the

configuration e.g. for undertable x-ray tube at 10 mm from the patient support on the patient side of the support [2]. The use of pulsed fluoroscopy or low dose fluoroscopy is proposed as good options to minimize dose and hence radiation induced injuries during interventional radiology [3]. Measurements made in practice will provide an indication of the magnitude of the dose reduction, and will be used in establishment of reference dose levels.

The recommendations prepared within DIMOND III also propose an increase in the half value layer (HVL) higher than that used in normal practice [4]. Therefore, the use of additional copper filtration has also been proposed to reduce patient dose. The undercouch x-ray tube overcouch image intensifier configuration is recommended as this will reduce scatter radiation otherwise reach to the radiologist [5]. The recommendations also require restriction on x-ray field to be not larger than image receptor, the use of anti-scatter grid to reduce scatter radiation and possibility of removing it in procedures that do not require it's use, such as paediatric cardiology and most of interventional neuroradiology procedures. The proposals made will be compared to the results met in practice concerning doses to patients and staff.

Digital (interventional) radiology equipment should provide the interventionalist means of online dose display during interventions including patient entrance skin dose, total dose-area product, fluoroscopy dose-area product, fluoroscopy time and number of exposures taken [6]. The possibility of deducing patient entrance surface dose from other dosimetric parameters such as fluoroscopic dose area product (DAP) will be investigated in practice.

It is also necessary to use means of occupational dose reduction such as lead equivalent aprons, gloves and protective thyroid shield. The present study provides information on their uses.

#### REFERENCES

- [1] FAULKNER K. Introduction to constancy check protocols in fluoroscopic systems. *Radiat. Prot. Dosim.* 94, 65-68 (2001).
- [2] HEALTH DEPARTMENT OF WESTERN AUSTRALIA. Radiation safety act 1976, diagnostic x-ray equipment compliance testing. Program Requirements 2000, Australia.
- [3] WORLD HEALTH ORGANIZATION. Efficacy and radiation safety in interventional radiology. Report of Joint Institute of Radiation Hygiene, Federal Health office (Germany) and WHO held in Neuherberg, Germany from 9 to 13 October 1996. (WHO, Geneva 2000).
- [4] INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC). International Standards 60601-2-43 Medical Electrical Equipment. Part 2-43: Particular Requirements for Safety of x-Ray Equipment for interventional Procedures. (Geneva: IEC) (2000).
- [5] ZOETELIEF J., FAULKNER K. Equipment Requirements and specification for digital and interventional Radiology. *Rad. Prot. Dosim.* Vol. 94, Nos 1-2, pp. 43-48 (2001).
- [6] FAULKNER K. Dose Display and Record Keeping. *Radiat. Prot. Dosim.* 94, 105-114 (1999).