ANTI-SCATTER GRIDS, APPLIED IN DIAGNOSTIC RADIOLOGY

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Abstract

A new edition of the international standard IEC 60627 of anti-scatter grids will be published within some months. The presentation deals with the most important characteristics of anti-scatter grids according to the standard.

Introduction

During imaging in diagnostic radiology, X-ray beam is scattered on all media between X-ray source and X-ray image receptor. The most important one from these is the patient itself. Scattered radiation, reaching the X-ray image receptor – which may be even 5-6 times more intensive than X-ray pattern, in case of imaging of the pelvis of a corpulent patient – reduces image contrast, impairs detail visibility and, moreover – in case of examinations during which staff stays in the controlled area –, it causes radiation exposure of the staff. For diminishing scattered radiation, in principle, there are two possibilities. One of them is the so-called air gap, i.e. increasing the distance between the patient and the X-ray image receptor; however, because of the geometric magnification it is not always applicable or appropriate. The other way is application of anti-scatter grids directly in front of the X-ray image receptor. A sketch of the physical arrangement of an anti-scatter grid is shown in Figure 1.



Figure 1. Physical arrangement of an anti-scatter grid in an X-ray imaging chain

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Primary interest of the patient is the image, appropriate for diagnosis, and only after it the possible lowest radiation exposure. In most cases radiation exposure is optimized if image quality impairing effect of scattered radiation is decreased, although entrance skin dose and so radiation exposure of the patient may increase then by a factor of 2 to 5. Examinations of babies and small children as well as extremities, however, are exceptions: in these cases anti-scatter grids are to be removed from the beam as amount of scattered radiation is very small, therefore optimizing radiation exposure in these cases is reached by examination without grid.

Materials and Methods

Properties, manufacturing technology and testing procedures of diagnostic anti-scatter grids have had a long development. Scientist, founding this topic was *W. Hondius Boldingh* (Amsterdam 1896 – Eindhoven 1976), one of the leaders in X-ray equipment design at Philips, who has published many papers about grids, and also his PhD thesis dealt with grids [1] (Figure 2).



Figure 2. PhD thesis of W. Hondius Boldingh about grids (1964)

The first international performance standard of anti-scatter grids IEC 60627 was published in 1978 while a similar one for mammographic anti-scatter grids in 1997. The second edition of IEC 60627 published in 2001 [2] (Figure 3) merged together the earlier two separate standards for general purpose and mammographic anti-scatter grids. Since then a need has arisen for technical revision of this standard. The revision was initiated above all by the fact that calcium tungstate phosphors have become obsolete and is no longer available. Instrumentation with fluorescent screens made of gadolinium oxysulphide (GOS) is the present state of the art. It was also investigated whether any new quality parameter can be introduced which better describes properties of anti-scatter grids, especially for digital detector applications. Special laboratory provisions and carefully controlled test conditions are needed for the measurements described in the standard; it means that these tests are type tests to be performed at the manufacturer's site or in specially equipped type testing laboratories only. There was also a need for a restructuring of the text, to be aligned to the 3rd edition of the general safety standard for medical electrical equipment IEC 60601-1.

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Equipements de diagnostic par imagerie à rayonnement X –

Caractéristiques des grilles antidiffusantes d'usage général et de mammographie

Diagnostic X-ray imaging equipment – Characteristics of general purpose and mammographic anti-scatter grids



The second edition of IEC 60627 defines three groups of terms, used for characterizing antiscatter grids. First (general terms) are: anti-scatter grid, linear grid, parallel grid, focused grid, tapered grid, cross-grid (orthogonal, oblique), stationary grid, moving grid, and mammographic anti-scatter grid. The second group of terms contains geometrical characteristics: grid ratio (r), focusing distance (f_0), application limits (f_1, f_2), true central line, central line indication, and strip frequency (N). For r and N see Figure 4. The third group of terms contains physical characteristics which are related to transmission of radiation: transmission of primary radiation (T_p), transmission of scattered radiation (T_s), transmission of total radiation (T_t) (these are to be measured); grid selectivity (Σ), contrast improvement ratio (K), and grid exposure factor (known also as *Bucky* factor) (B) (these are calculated from the measured ones).



Figure 4. Structure of anti-scatter grids and definition of main geometrical parameters

Measurement of transmission factors T_p , T_s , and T_t is performed with a special radiation detector using a fluorescent screen (Figure 5), applying special phantoms, diaphragms and specified geometric arrangements. Parameters f_1 , f_2 , Σ , K, B are calculated from the former ones.



Figure 5. Radiation detector, used for radiation transmission measurements of grids

Results and discussion

In testing conditions of anti-scatter grids, the earlier calcium tungstate phosphor which is not available any more, was replaced by gadolinium oxysulphide (GOS). Applicability of GOS phosphor was investigated both theoretically and experimentally – these considerations are attached to the standard as an informative annex. Furthermore, a new quality parameter, the so-called "image improvement factor" or *Q*-factor, is introduced which better describes the properties of the anti-scatter grid, especially for digital detector applications. $Q = (T_p^2 / T_t)$ increases with the square of the signal-to-noise ratio of the image. A new possibility is offered to

manufacturers in calculating application limits: if wished it is allowed to take into account also the absorption of absorbing strips. Structure of the standard was adapted to the new approach of IEC standardization. Moreover, some minor improvements were also made.

This work was performed by Maintenance Team MT50 of IEC SC62B during the period 2010-2012. Convenor of the team was *Joos van Vroonhoven* (Philips, Holland) while the most active participants were *Christiaan Kok* (Philips, Holland) and *Peter Strattner* (Siemens, Germany). Author of this paper was also a member of the group. There were only two meetings of the group (November 8-9, 2010, Eindhoven, Holland and May 23-24, 2011, Frankfurt, Germany) while the joint work was completed by four telephone (internet) conferences.

Conclusion

The third edition of the standard is now in final draft stage, it will be issued probably in January 2013. Therefore an updated and usable standard, aligned also to the new approach of IEC standards, will be available for evaluating parameters of general purpose and mammographic ant-scatter grids.

References

- Hondius Boldingh, W. Grids to reduce scattered X-rays in medical radiography, Thesis, 90 pages, Philips, 1964.
- International Electrotechnical Commission (IEC). IEC 60627:2001, Diagnostic X-ray imaging equipment – Characteristics of general purpose and mammographic anti-scatter grids. 2nd ed.