Structural Shielding Design for Medical X-ray Imaging Facilities, NCRP Report No. 147, 2004, 194 pp. (hardcover), $100.00, National Council on Radiation Protection and Measurement, 7910 Woodmont Avenue, Suite 400, Bethesda, MD 20814-3095; ISBN 0-929600-83-5; http://www.ncrp.com.

For those in the business of designing shielding within medical facilities, it has long been known that the NCRP has been working to replace the previous shielding standards within NCRP Report 49. NCRP Report 147 is the start of that replacement process. The emphasis of this report is to provide updated shielding calculation methodologies for diagnostic x-ray facilities. Report 147 does not cover shielding for radiotherapy facilities using x and/or gamma rays. As stated in the preface to this report, the NCRP is preparing to address radiotherapy shielding aspects in a forthcoming report. However, for those responsible for shielding diagnostic x-ray facilities, Report 147 offers a vast number of improvements over Report 49.

One of the major changes in the shielding recommendations is discussed in Chapter 1. The shielding design goals for controlled areas have been reduced from 1 to 0.1 mGy per week and for uncontrolled areas from 0.1 to 0.02 mGy per week. The latter change generated a significant amount of controversy after the release of the draft report a few years ago because this equates to an annual dose of 1 mGy per year in uncontrolled areas. This uncontrolled area design goal is equal to the NCRP's recommended public dose limit. As a result, several pages have been added to the report explaining why these shielding methodologies will result in actual unrestricted dose rates significantly less than what the design goals would indicate.

Chapter 4 is the most important section of Report 147. It discusses the principle methodology used for determining shielding needs. Those who have seen previous shielding publications by Archer, Dixon, and Simpkin will recognize their significant contributions to this report. While one can clearly see some similarities to the air kerma calculation equations of Report 49, the new methodology has significantly changed the factors used within these equations. The concept of workload has probably changed the most. As opposed to the Report 49 method of determining the weekly x-ray tube current workload (mA min per week), in this report workload is based solely upon the number of patients seen in the room per week. Then using the provided air kerma at one meter per patient and room/application type, the user determines the resulting unshielded air kerma at the point of interest. For anyone who has had to determine workload information in the past, it is much easier to get an average number of patients passing through a facility per week than it is to determine the average tube current workload per week.

The concepts of area occupancy factor and of x-ray beam use factor remain unchanged from Report 49. However, the report updates the recommended values for both factors. Another change is that all secondary radiations (leakage and scatter) are typically calculated together, removing the Report 49 recommendation to add an extra half value layer when both leakage and scatter shielding are needed. There is also a new allowance for "pre-shielding" of the primary x-ray beam from the image receptor.

Once the final air kerma and barrier transmission are calculated, there are two methods that can be used for determining final barrier thickness. There are graphs that can be used to determine the necessary shielding. This graphical method is essentially the same as used in Report 49. However, a second method is given that uses a mathematical calculation to determine the final shielding needed. While the equations are rather complex, I believe that most physicists will be able to understand their use and will prefer this method. One advantage to the mathematical calculation method is that the user can directly determine shielding needs for a variety of materials in addition to lead and concrete. Shielding equation factors are provided for gypsum wallboard, steel, plate glass, and wood.

Another improvement in this report is that it covers shielding for many more diagnostic imaging modalities. Some of the new imaging modalities not previously covered in Report 49 are mammography, CT, and bone mineral densitometry (DEXA). Within Chapter 5, three different methods for determining CT shielding are demonstrated. Readers of the draft version of this report will recognize the first CT shielding method. There were several errors in the draft report that have been fixed, and I found the methodology much easier to understand in its final form. Additionally, there is a new CT dose-length-product (DLP) shielding method and a discussion of the use of manufacturer-provided isodose maps as alternative CT shielding methods. While the DLP method appears to be the easiest method to use, I found that all three methods were not too difficult to comprehend and use. All three would typically provide essentially the same shielding needs for most CT shielding projects. However, when I used the three CT shielding methods on a few sample CT rooms, the isodose map method seemed to always result in the need for slightly thicker shielding.

Also contained within Chapter 5 are discussions of shielding for bone mineral densitometry (DEXA) units. While I found the bone mineral shielding discussion rather simplistic, anyone who has dealt with these units knows that the scatter dose rates are very low and, thus, probably not worthy of a complex calculation.

Over all, I believe the report will be a valuable tool for those health and medical physicists needing to perform diagnostic x-ray shielding calculations as a part of their job. The methodology is complex at times and may take some effort to get through the first time. However, I think that most competent health and medical physicists will quickly understand the report and will find it a vast improvement over the previous NCRP Report 49.

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