

# DIN 6847-2:2014-03 (E)

## Medical electron accelerators - Part 2: Rules for construction of structural radiation protection

---

| <b>Contents</b>   | <b>Page</b> |
|---|-------------|
| Foreword .....  | 4           |
| Scope .....   | 51          |
| Normative references .....  | 52          |
| Terms and definitions; indices .....  | 53          |
| 3.1 Terms and definitions .....   | 5           |
| 3.2 Indices .....   | 8           |
| Dose and dose rate information .....  | 84          |
| Maximum values for the dose behind the shielding .....  | 85          |
| Room requirements .....   | 96          |
| Specifications of the manufacturer and of the person responsible for radiation protection .....                     | 10          |
| 7.1 Specifications of the manufacturer .....  | 10          |
| 7.2 Specifications of the person responsible for radiation protection .....   | 11          |
| Operating data .....  | 118         |
| 8.1 Radiation energy .....  | 11          |
| 8.2 Dose rate .....   | 12          |
| 8.3 Working load .....  | 12          |
| 8.4 Direction factor .....  | 13          |
| 8.5 Occupation factor .....   | 13          |
| 8.6 Interaction of factors U and T .....  | 14          |
| Maximum permissible area dose .....   | 149         |
| Rating of radioprotective shielding .....   | 1410        |
| 10.1 General .....  | 14          |
| 10.2 General calculation scheme .....   | 15          |
| 10.3 Shielding against bremsstrahlung in the useful radiation direction .....                                       | 16          |
| 10.4 Shielding against electron useful radiation .....  | 17          |
| 10.5 Shielding against leakage radiation .....  | 18          |
| 10.6 Shielding against secondary bremsstrahlung .....   | 21          |
| 10.7 Shielding at the access to the irradiation room .....  | 23          |
| 10.7.1 Shielding at the radiation protection labyrinth .....  | 23          |
| 10.7.2 Shielding at the gate of an irradiation room without a radiation protection labyrinth .....                  | 25          |
| 10.8 Shielding against neutron radiation .....  | 25          |
| 10.9 Shielding the radiation protection labyrinth .....   | 30          |
| 10.10 Interaction of several radiation sources, types and components .....  | 33          |
| 10.11 Structural radiation protection measures against radioactive material created by nuclear photoprocesses ..... | 34          |
| Constructional radiation protection drawing .....   | 3411        |

|  |   |      |
|--|---|------|
| 11.1   | Specifications of the installer .....   | 34   |
| 11.2   | Safekeeping of the as-built radiation protection drawing .....  | 34   |
| Check for compliance with radiation protection rules ..... |   | 3412 |
| 12.1   | Requirements placed on the rooms in accordance with 6 c) to 6 i) .....  | 34   |
| 12.2   | Check of the structural shieldings which may be hit by the radiation beam .....   | 35   |
| 12.3   | Check of the structural shieldings which cannot be hit by the radiation beam .....  | 35   |
| Test of ventilation system .....                           |   | 3613 |
| Annex A (informative) Calculation example .....            |   | 37   |
| Bibliography .....   |   | 46   |
| Index of defined terms .....                               |   | 47   |
| Figures  | Figure 1 -- Example of the distance $a_n$ for useful radiation .....  | 16   |
|  | Figure 2 -- Example of the distance $a_n$ for leakage radiation .....   | 18   |
|  | Figure 3 -- Product of the thickness at tenth maximum $z_X$ and density for bremsstrahlung, leakage radiation, X-ray radiation share in the radiation field of the electron radiation, and bremsstrahlung in the useful radiation direction generated by electrons outside the radiation head, for the materials specified in the key ..... | 19   |
|  | Figure 4 -- Product of the thickness at tenth maximum $z_X$ and density for bremsstrahlung, leakage radiation, X-ray radiation share in the radiation field of the electron radiation, and bremsstrahlung in the useful radiation direction generated by electrons outside the radiation head, for the materials specified in the key ..... | 20   |
|  | Figure 5 -- Factor $k_{XE}$ for calculation of shieldings against bremsstrahlung in useful radiation direction generated outside of the radiation head .....  | 21   |
|  | Figure 6 -- Example of the distance $a_{Xs}$ for secondary bremsstrahlung .....   | 22   |
|  | Figure 7 -- Example of the distance $a_{Xt}$ and surface $AX_t$ for tertiary bremsstrahlung .....   | 24   |
|  | Figure 8 -- Example of the distance $a_{Nn}$ for direct neutron radiation .....   | 27   |
|  | Figure 9 -- Examples of distance $a_{Ns}$ for scattered neutron radiation .....   | 28   |
|  | Figure 10 -- Labyrinth length and width (schematic) .....   | 29   |
|  | Figure A.1 -- Floor plan view for the rating of radioprotective shielding in electron accelerator installations (calculation example) .....   | 38   |
| Tables   | Table 1 -- Maximum permissible area dose $HW$ .....   | 14   |
|  | Table 2 -- Product of thickness at tenth maximum $z_Xs$ or $z_{Xt}$ and density for secondary or tertiary bremsstrahlung .....  | 22   |
|  | Table 3 -- Thicknesses at tenth maximum $z_{Nn}$ and $z_{Ns}$ for neutron radiation .....   | 28   |
|  | Table 4 -- Parameters for rating radioprotective shielding according to 10.2 to 10.9 .....  | 31   |
|  | Table 5 -- Reinforcing shieldings against the interaction of several radiation components .....   | 33   |
|  | Table A.1 -- Radiation conditions according to specifications of the person responsible for radiation protection for the calculation example to rate the radioprotective shielding according to Figure A.1 .....  | 39   |

**Table A.2 -- Operating data according to specifications of the manufacturer for the calculation example to rate the radioprotective shielding according to Figure A.1 .....40**

**Table A.3 -- Calculation data to rate the radioprotective shielding for the various radiation components and occupied areas in the calculation example according to Figure A.1 .....41**