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Radiation shielding requirements in room of radiotherapy installations - Part 1: General principle

放射治疗机房的辐射屏蔽规范 第 1 部分：一般原则

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Foreword

This Standard was drafted based on *Law of the People 's Republic of China on Prevention and Control of Occupational Diseases*.

GBZ/T 201 *Radiation shielding requirements for radiotherapy room* was issued in parts. It consists of the following five parts:

- *Part 1: General principle*;
- *Part 2: Radiotherapy room of electron linear accelerators*;
- *Part 3: Radiotherapy room γ-ray sources*;
- *Part 4: Radiotherapy room of 252Cf neutron after loading*;
- *Part 5: Radiotherapy room of proton accelerators*.

This Part is the first part of GBZ/T 201.

Annex A, Annex B and Annex C of this Part are informative.

This Part was proposed by Ministry of Health Radiation Health Protection Standards Professional Committee.

This Part was approved by Ministry of Health of the People 's Republic of China.

The drafting organization of this Part: Beijing Center for Disease Control and Prevention.

Main drafters of this Part: Wei Yun, Wang Shijin, Meng Qinghua, Zhang Zhuo.

Radiation shielding requirements in room of radiotherapy installations - Part 1: General principle

1 Scope

This Part specifies the dose reference control level, general shielding requirements and radiation shielding evaluation requirements for radiation shielding of room of radiotherapy installation (hereinafter referred to as therapy room).

This Part is applicable to the room of external irradiation source treatment device.

This Part is not applicable to the radiotherapy room of human body implantation of radionuclide particle source and the room of radionuclide source applicator therapy.

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

2.1 controlled areas out of radiotherapy room

radiation staff working area directly connected with the radiotherapy room and related to the treatment device in the room, such as treatment device control room, treatment device auxiliary room, etc.

2.2 uncontrolled areas out of radiotherapy room

outside the radiotherapy room, other area except the controlled area out of radiotherapy room, including radiation oncologist clinic, waiting room, etc.

2.3 T occupancy factor

within the start time of radiation source, the share of the average time spent on the maximum exposure of the radiated person occupying the start time within the area

2.4 U use factor

the share of the time at which the primary radiation beam (useful beam) is irradiated in a direction of beam shielding occupying the total exposure time

$\dot{H}_c$ ≤ 2.5 μSv/h (staff total occupancy place, T>1/2)

$\dot{H}_c$ ≤ 10 μSv/h (staff partial and occasional occupancy place, T≤1/2)

3.2 Radiation dose rate reference control level of therapy room roof shield

3.2.1 At the built, to-be-built two-storey building above therapy room or when the height of neighboring building near therapy room exceeds the area from radiation source point to the solid angle area of surface edge inside the room roof, at the place 30 cm from therapy room roof external surface or at the staff stay location in the high-rise building within this solid angle area, the radiation dose rate reference control level shall be the same with 3.1.

3.2.2 In addition to 3.2.1 conditions, it shall consider the radiations of skyshine radiation and side-scattered radiation to the public near the ground and in the building outside the therapy room, as well as the illumination of the radiation getting through the therapy room roof to the staff who occasionally reach the top. Use equation (1) and take H_c=5 μSv/week, T=1/40. Use the ambient dose equivalent rate determined at the place 30 cm from the therapy room external surface as the radiation dose rate reference control level of therapy room roof shielding.

3.3 Procedures for determination of ambient dose equivalent rate reference control level

3.3.1 Ambient dose equivalent rate reference control level of therapy room wall and at the place 30 cm from entrance door external surface

(1) select the assessment points and identify the partitions where the assessment points are located (controlled areas out of radiotherapy room and uncontrolled areas out of radiotherapy room);

(2) according to the radiotherapy workload given by the radiotherapy organization, determine the week workload (W) of radiotherapy device used, and refer to the method in Annex B to estimate the maximum illumination time (h) of therapy device;

(3) estimate $\dot{H}_c$; compare it with the dose rates in 3.1 and 3.1.2 and take the smaller one as the ambient dose equivalent rate reference control level.

3.3.2 Ambient dose equivalent rate reference control level of lager occupancy factor (T>1/4) of neighboring therapy room

4.3.6 Secondary shielding radiation might contain the compound effect of leakage radiation and scattered radiation. Usually, it shall respectively estimate the leakage radiation and each scattered radiation. When the difference between their shielding thicknesses is one layer (TVL) or more, it shall use a thicker shielding. When the difference is less than one TVL, it shall add half a layer (HVL) of thickness on the thicker shielding.

4.4 Considerations of therapy room shielding

4.4.1 In a choice of therapy conditions for radiotherapy device, it shall take radiant matter of which the penetrating ability is relatively strong and commonly used highest therapeutic output as radiation source parameters. It shall also consider all the primary and secondary radiation factors of each shielding locations.

4.4.2 Radiation dose rate reference control level of therapy room shielding

4.4.3 Week maximum workload and week therapy illumination time of therapy device application

4.4.4 Use factor (U) of possible useful beam illumination direction during the use of wide beam therapy device

4.4.5 See Annex A for personal area occupancy factor (T) in different places at the peripherals of therapy room. The staff at the peripherals of therapy room and at the neighboring places of therapy device are major consideration objects. When some place that is directly connected with therapy room is used for the place of smaller occupancy factor (T<1/8), it shall also consider the public members at the far place of larger occupancy factor.

4.5 Considerations of therapy room shielding with labyrinth

4.5.1 At the mouth of labyrinth, it shall prevent direct illumination of wide beam useful beams on labyrinth external wall (see position k in Annex C). And try to avoid the direct illumination of 4π useful beam and leakage radiation on labyrinth external wall.

4.5.2 When 4.5.1 is met, position k in Annex C shall consider the possible scattered radiation illumination of useful beam and (or) leakage radiation. When 4.5.1 is not met, position k in Annex C shall consider oblique illumination of 4π useful beam and (or) leakage radiation.

4.5.3 It shall consider the illumination from the radiation source in the therapy room to corresponding wall of labyrinth mouth (see position k in Annex C) and the scattered radiation dose from it to labyrinth mouth (see path o-i-g in Annex C).

compensation to the place where partial shielding is weakened due to inlay installation.

4.6.5 The pipeline holes (including ventilation, electrical appliances, water pipes, etc.) that get through therapy room wall shall avoid the console and other areas where staff often stay. And it shall use multi-fold road to efficiently control the radiation leakage of pipeline hole.

4.7 Considerations of neutron shielding

4.7.1 While neutron shielding, it shall consider the shielding to neutron capture γ ray.

4.7.2 When accelerator therapy X ray is greater than 10 MV, because (γ, n) react to produce “spurious” neutron, it shall consider the neutron shielding in the therapy room according to the indicators that are given by the therapy device manufacturer and not exceed national standard.

4.7.3 For X ray therapy room greater than 10 MV, when it uses single concrete shielding, the wall, roof shielding shall only consider the shielding to X ray and neglect the shielding to “spurious” neutron. But when the venue is restricted or converted, some room shielding might use lead, iron and other substances. At this point, it shall estimate the shielding to X ray, neutron and neutron capture γ ray.

4.7.4 For X ray therapy room greater than 10 MV, the protective door of labyrinth entrance shall also consider the scattered radiation of X ray and “spurious” neutron as well as neutron capture γ ray.

4.7.5 For proton and heavy ion therapy room, it shall consider neutron and tough radiation shielding generated by nuclear reaction.

4.8 Considerations related to other radiations

4.8.1 The X ray tube therapy room might be set with lead glass observation window. Its shielding shall have the same shielding transmission factor with same side protective wall. In addition, other radiotherapy room are not set with observation window and light-taking window.

4.8.2 In the therapy room shielding estimation, it may regard 4π beam and wide beam radiation source as “point” source. For radioactive isotope therapy source, it shall take effective activity radiated from its surface as point source activity.

4.8.3 Therapy room radiation shielding involves a lot of physical quantities: the dose given by therapy device useful beam to patient part for therapy as absorbed dose (Gy), the leakage radiation of therapy device and possible

5.1.3 Verification of therapy device's working conditions

According to the designed therapy room, verify if the designed conditions in 5.1.2 complies with the performance of the therapy device and the actual or planned radiotherapy of the hospital.

5.1.4 Verification of shielding design method

According to the method used in therapy room shielding design and the parameters selected, verify the method's basis and the correctness of the method used.

5.2 Verification of therapy room radiation shielding effect

5.2.1 Basic method

Evaluate the existing therapy room according to detection data of instrument's ambient dose equivalent rate.

5.2.2 Detection conditions

When it uses the instrument to detect the ambient dose equivalent rate, the therapy device in the room, working parameters and conditions shall be set according to 5.1.2.

5.2.3 Requirements for detection instrument

(1) the instrument's measuring range, energy response, anti-jamming capability and other properties of the measured radiation source performance shall meet the radiation source performance to be detected;

(2) the instrument shall have a measurement certificate and is valid for its validity period;

(3) the instrument's measuring results shall be given according to the ambient dose equivalent (rate) H*(10) [$\dot{H}^*(10)$].

5.3 Verification of relevant contents of general shielding requirements of therapy room

The design and evaluation of therapy room shall be carried out according to requirements of Clause 4.

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