

PROCEDURE

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ZONING AND WARNING SIGNS OF AREAS WHERE SOURCES OF IONIZING RADIATION ARE HANDLED

INTRODUCTION

In areas where sources of ionizing radiation are handled, a risk of being exposed to ionizing radiation arises. Legal obligations have been formalised to indicate this risk, by applying clear and functional warning signs or pictograms and/or notices.

This procedure explains how to follow the legal directions for signalling areas and rooms where sources of ionizing radiation are used. This procedure also formalises the agreements on assigning zoning to rooms with specific function, as have been made within the institutions that participate in the complex license Randwyck.

Lastly, the tasks and responsibilities of employees involved in radiation protection are described.

AIM

Formalising both the classification of areas and rooms with specific functions, as well as the corresponding obligatory warning signs and signals as applied within the institutions that participate in the complex License Randwyck.

LEGAL CONTEXT

As stated in the Dutch radiation protection act '*Besluit basisveiligheidsnormen stralingsbescherming*' (*Bbs*), an employer (license holder) is obligated to mark rooms as either controlled – or supervised zones, whenever that is deemed necessary with regards to the protection against ionizing radiation. The classification of these zones is based on the effective and/or equivalent dose that may be received in the rooms in question (*art. 7.7*).

Zoning is therefore based on dose limits that have been established for exposure in the work area (*art. 7.3*).

Furthermore, rooms that have been classified as either controlled – or supervised zone, must be equipped with efficient and clear warning signs, pictograms and/or notices at suitable spots (*art. 4.1*).

This also applies to (containers of) sealed sources and devices generating ionizing radiation.

The required way to execute proper signalling can be found in the Dutch 'Regulations radiation protection exposed employees' (*'Regeling stralingsbescherming blootgestelde werknemers'*, *art. 4.1 t/m 4.4*), which also refers to the requirements in the Dutch 'Regulations working conditions' (Dutch: '*Arbeidsomstandighedenregeling*', *addendum XVIII*).

CRITERIA FOR ZONING OF ROOMS

Zoning of work areas/rooms is based on either the exposure that employees may receive in this area/room, or the dose that may be received by persons outside the area/zone as a consequence of spreading of radioactive substances from the area/room.

The following table shows the criteria that apply when classifying zones (controlled or supervised zones).

Table 1: *Criteria for classifying a room as supervised – or controlled zone, based on the exposure of employees in the room and exposure of persons as a consequence of spreading from the room*

| | Exposure of employees | | Exposure of persons | |
|-------------------|-----------------------|-----------------|---------------------|--|
| | [mSv / year] | | [mSv / year] | |
| Effective dose | > 1 and ≤ 6 | > 6 | > 1 | |
| Equivalent dose | | | | |
| eye lens | | > 15 | > 15 | |
| skin ¹ | > 50 and ≤ 150 | > 150 | > 50 | |
| extremities | > 50 and ≤ 150 | > 150 | > 50 | |
| Classification | supervised zone | controlled zone | controlled zone | |

The possible exposure of employees is established by drawing up a risk analysis. In this analysis, that is drawn up before any proceedings with sources of ionizing radiation are executed, the possible exposure of employees and persons is analysed. For this purpose, both regular working conditions as well as foreseen unintentional events (Dutch: 'voorziene onbedoelde gebeurtenissen' or VOG) which may lead to exposure, are considered, as per the legal guidelines.

¹ averaged over any exposed skin surface of 1 cm²

REQUIREMENTS FOR SUPERVISED – AND CONTROLLED ZONES

After the classification of a room as supervised – or controlled zone has been established by means of a risk analysis, measures to protect employees must be taken with regards to these zones.

Requirements that apply to both zones

1. in compliance with the nature and scale of the risks within the zone, suitable supervision must be appointed, aimed at the protection against ionizing radiation;
2. warning signs must be installed on suitable spots²;
3. employees involved must be provided with suitable written working instructions, tailored to the sources present and the actions to be performed with these sources;
4. the extent and quality of measures aimed at protection against ionizing radiation are fitting for the risks that arise from the actions with and presence of the sources at hand;
5. there is monitoring of
 - relevant dose rates, making mention of the nature and quality of the ionizing radiation;
 - in case of the presence of a source in dispersible form; the concentration of activity in air and surface contamination, making mention of the nature, physical - and chemical state.

Additional requirements for controlled zones

1. the controlled zone is well-defined and the access to the zone is limited to employees that have been authorised for entrance by the employer. Also, these employees have received fitting instructions in writing and are supervised following written procedures that were drawn up for this purpose;
2. arrangements have been made for the cases where there is a substantial risk at spreading of radioactive sources, these arrangements include measures concerning the entrance to the zone by both employees and goods, and monitoring of the zone, and in some cases, the adjacent zone(s);
3. employees are offered a specific educational program that is tailored to the specifics of the work environment and actions to be performed;
4. employees have suitable protective measures at their disposal; they use them in accordance to the manual and other given instructions.

CONSTRUCTIONAL AND TECHNICAL PROVISIONS

Areas where radioactive substances in dispersible form are handles, must be equipped and organised in accordance to the directions in the 'Addendum radionuclides laboratories' (Dutch: 'Bijlage radionuclidenlaboratorium'), which is a part of the granted Complex License Randwyck. This addendum contains requirements for positioning, equipment, ventilation and finishing of radionuclides laboratories.

These requirements do not fully apply to for instance patient treatment rooms, as the comfort of patients is a consideration. For all rooms, the fact remains that provisions, installations and (radiation)measuring devices must be in good condition and be checked for functionality and accuracy at least annually, or as many times as necessary.

² also see paragraph 'Warning signs and pictograms' (page 5-6)

ZONING OF ROOM SWITH SPECIFIC FUNCTIONS

Within the institutions that participate in the complex license, there are rooms dedicated to specific functions, of which the zoning has been determined to obtain uniformity in all institutions. Of course, this zoning is based on legislation and results of risk analyses. *Table 2* offers insight into these specific functions.

Table 2: Specific rooms and their zoning

| Room | Classification |
|--|-------------------|
| Cyclotron room | Controlled area |
| Linear accelerator room | Controlled area |
| Therapy treatment room (nuclide therapy) | Controlled area |
| Administration room for nuclide therapy (during administration of nuclide) | Controlled area |
| X-ray intervention room (cardiologic and radiologic intervention) | Controlled area |
| CT-scanner room | Controlled area |
| PET-scanner room | Controlled area |
| Room for administration of PET-nuclides | Controlled area |
| Storage room | No classification |
| Laboratory for preparation of radiopharmaceutical medicines | Controlled area |
| Room for administration of SPECT-nuclides | Supervised area |
| X-ray room | Supervised area |
| Lavatory in PET-area | Supervised area |
| Control room for X-ray devices | No classification |
| Control room for PET and SPECT scanners | No classification |
| Control room for linear - and proton accelerators | No classification |

For all other rooms that are not listed in *Table 2*, the classification is always subject to the risk analysis of the specific actions that are performed in the room.

WARNING SIGNS AND PICTOGRAMS

Rooms

As stated in this procedure, all rooms or situations in which dose limits for exposed employees or members of the public may be exceeded, must be equipped with appropriate warning signs³, which point out the work related risks attached to the use of ionizing radiation. Also sealed sources and ionizing radiation generating devices must, if technically feasible, be equipped with warning signs.

The necessary warning signs are listed below:

1. A sign that acts as a warning for the presence of either radioactive sources or devices, as shown in *Figure 1*, must be installed in all cases. The sign must be at least 7,5 cm wide (and in the colour RAL1003 Signal Yellow⁴).

Figure 1: Icon radioactive substances or ionizing radiation⁵



2. Below or next to the icon as shown in *Figure 1*, yellow, a rectangular sign with a black border that reads in black lettering should be applied:
 - a. RÖNTGENSTRALING (X-rays), in case an X-ray device is the cause of possible exposure;
 - b. RADIOACTIEVE STOFFEN (radioactive substances), in case radioactive substances are the cause of possible exposure;
 - c. BEWAAKTE ZONE (supervised area), in case of a classification as a supervised zone;
 - d. GECONTROLEERDE ZONE (controlled area), in case of a classification of a controlled zone.

This sign needs to be at least 7,5 cm in width, unless this is not technically feasible in the situation the signing applies to. All signing is in Dutch. An example is shown in *Figure 2*.

Figure 2: Example of warning sign for x-ray devices



Supervised area

³ Regeling stralingsbescherming beroepsmatige blootstelling 2018, articles 4.1-4.4

⁴ ISO 3864

⁵ Arbeidsomstandighedenregeling, Addendum XVIII

Gecontroleerde zone

Controlled area

Röntgenstraling

X-ray radiation

Radioactieve stoffen

Radioactive substances

3. For controlled areas (Gecontroleerde zone), the sign with the text for Controlled area (Gecontroleerde zone) must always be accompanied by the text: 'Dosistempo > 10 μ Sv/uur' (Dose rate > 10 μ Sv/hour). If the dose rate in a Supervised area (Bewaakte zone) exceeds 10 μ Sv/h, this sign also needs to be used. An example is seen in Figure 3.

Figure 3: Example of warning sign dose rate

Dosistempo > 10 μ Sv/h

Figure 4 shows an example of a complete set of warning signs for the use of radioactive substances in a controlled area without restricted entrance.

Figure 4: Example of warning signs in the practice of a controlled area



4. Areas where X-rays are applied using a fixed system should, when the room can be entered during the application of X-rays and a risk for exposure of employees arises due to scattering radiation, be provided with a visual indicator (for example an indicator light or 'occupied' light) when the X-ray tube is turned on. This is not applicable for rooms where inherently safe X-ray devices are used, or when the actions are temporary and because of this temporary character it is not technically feasible to install a visual indicator.

Sealed sources, devices and source containers

Not only rooms, but also sealed sources, devices, source containers and all items that regularly contain radioactive substances (e.g. waste bins) must be marked with the correct warning signs and texts.

The following rules apply:

1. On sealed sources and devices, and on source containers holding a radioactive source, the pictogram as shown in *Figure 1* and the rectangular signs with either the text 'Röntgenstraling' (x-ray radiation) or 'Radioactieve stoffen' (radioactive substances), as shown in *Figure 2*, must be applied. The requirements as stated in the paragraph 'Rooms' (page 5, points 1 and 2) of this procedure, apply⁶.
2. Point 1 does not apply to sources that have been taken into use before March 1, 2002⁷. Also, in case the dimensions of the source are too small for attaching a pictogram and text that can be observed with the naked eye, point 1 does not apply (the warning signals have to be applied to the source holder/container)⁸.
3. In the case that a source holder also acts as the source container, which has been equipped with a label that meets the requirements as stated in the Dutch 'Decree transportation of fissionable material, ore and radioactive substances' (Dutch: '*Besluit vervoer splijtstoffen, ertsen en radioactieve stoffen*'), no further warning signs as mentioned in point 1 of this paragraph have to be applied.⁹

Storage

Specific guidelines for Storage rooms are available in the procedure 'Bergplaats' (Dutch only). Storage rooms are not classified as being Supervised (Bewaakte zone) or Controlled (Gecontroleerde zone).

Figuur 5: Example of warning sign Storage room (Bergplaats)



RESPONSIBILITIES

A correct classification of rooms is based on a risk analysis of the procedures that are performed in the room. The radiation protection expert (RPE; Dutch: 'stralingsbeschermingsdeskundige' or SBD, also 'coördinerend deskundige' or CD) is responsible for drawing up this risk analysis, with the support of the radiation protection officer (RPO; Dutch: 'toezichhoudend medewerker stralingsbescherming' or TMS) of the department in question.

⁶ Regeling stralingsbescherming beroepsmatige blootstelling 2018, article 4.3 section 1.

⁷ Regeling stralingsbescherming beroepsmatige blootstelling 2018, article 4.3 section 2.

⁸ Regeling stralingsbescherming beroepsmatige blootstelling 2018, article 4.3 sections 3 and 4.

⁹ Regeling stralingsbescherming beroepsmatige blootstelling 2018, article 4.3 section 6.

The general coordinating expert (Dutch: ‘algemeen coördinerend deskundige’ or ACD) of the radiation protection unit (RPU, Dutch: ‘stralingsbeschermingseenheid’) assesses this risk analysis.

After the correct zoning has been determined, the room needs to be equipped with the correct warning signs and warning texts. Generally, the execution of this task will be done by the TMS.

The RPU will observe if this is done in compliance with this procedure, which is based on the law.

LIST OF ABBREVIATIONS

| Dutch | | English | |
|-------|---|---------|--|
| ACD | Algemeen Coördinerend Deskundige | - | General coordinating expert |
| Bbs | Besluit basisveiligheidsnormen stralingsbescherming | - | - |
| CD | Coördinerend Deskundige | - | Coordinating expert |
| CT | Computed Tomography | CT | Computed Tomography |
| PET | Positron Emission Tomography | PET | Positron Emission Tomography |
| SBD | Stralingsbeschermingsdeskundige | RPE | Radiation Protection Expert |
| | Stralingsbeschermingseenheid | RPU | Radiation Protection Unit |
| SPECT | Single Photon Emission Computed Tomography | SPECT | Single Photon Emission Computed Tomography |
| TMS | Toezichhoudend Medewerker Stralingsbescherming | RPO | Radiation Protection Officer |
| VOG | Voorziene onbedoelde gebeurtenis | - | Foreseen unintentional event |

REFERENCES

- Arbeidsomstandighedenregeling
<https://wetten.overheid.nl/BWBR0008587/2023-07-01>
- Besluit basisveiligheidsnormen stralingsbescherming
<https://wetten.overheid.nl/BWBR0040179/2021-07-01>
- Besluit vervoer splijtstoffen, ertsen en radioactieve stoffen
<https://wetten.overheid.nl/BWBR0002668/2024-01-01>
- Regeling stralingsbescherming beroepsmatige blootstelling 2018
<https://wetten.overheid.nl/BWBR0040573/2022-01-01>
- Complexvergunning Randwyck (2017/0511-12) en hierop volgende wijzigingen
- Regeling stralingshygiëne Randwyck

| Revision table | |
|---------------------------|---|
| Version 1 – November 2018 | Initial version |
| Version 2 – August 2020 | New lay-out |
| Version 3 – April 2024 | Update hyperlinks to relevant legislation. Recommendations that apply to both areas §5 removed. Warning signs §4 removed; §4 added (visual indicator). Foot notes 3, 4, 6-9 added. Figure 3 added. Figure 2 extended. |
| Version 4 – August 2024 | Indication ‘Storage’ (Bergplaats) added. Storage is not a classified room. |