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**Clearance of Materials, Buildings and Sites
with Negligible Radioactivity
from Practices subject to Reporting or Authorisation**

Recommendation by the German Commission on Radiological Protection^{*)}

Adopted at the 151st session of the Commission on Radiological Protection on 12 February, 1998

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**Freigabe von Materialien, Gebäuden und Bodenflächen mit geringfügiger
Radioaktivität aus anzeige- oder genehmigungspflichtigem Umgang**

Empfehlung der Strahlenschutzkommission

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Foreword

The German Commission on Radiological Protection (Strahlenschutzkommission, SSK) has issued a number of recommendations on the clearance of substances containing negligible quantities of radionuclides ([SSK 87], [SSK 92], [SSK 96], [SSK 97]) and prepared drafts of further recommendations [BMU 95]. These individual recommendations are brought together in the present overall recommendation. At the same time they are brought into line with the latest scientific findings in the individual areas.

1 Introduction

It is nationally and internationally recognised that practices involving radioactive substances may be carried on without the need for reporting or authorisation if the associated individual radiation exposure is negligible and the radiological protection measures can on the whole be regarded as optimised. Having regard to normal and accident scenarios, guidelines for total activity or activity concentration exemption levels below which reporting and authorisation can be dispensed with have been published. Such cases typically involve small radiation sources such as tracers in research, calibration preparations and utility items with small radiation sources or low specific activities.

If slightly contaminated or activated material, buildings or sites from practices subject to reporting or authorisation are to be cleared, i.e. released from the scope of the Nuclear Energy Act (*Atomgesetz – AtG*), the same principles essentially apply as in the derivation of exemption levelsⁱ. As a rule the materials for clearance originate from nuclear installations, which give rise to wastes and recyclable materials with low specific activity, and from other establishments such as hospitals, research centres and industry. The quantities in question may be considerably greater than the quantities taken as a basis for deriving the exemption levels [EUR 93]. This is taken into account in the calculation of clearance levels.

If the future recycling, reuse, disposal or final destination of the materials is not known or not defined at the time of clearance from a practice that is subject to reporting or authorisation, clearance is said to be unconditional. In such cases exposure scenarios for all the above-mentioned areas must be considered. Conditional clearance (clearance subject to certain limiting conditions) may be given if the use and destination of the material are defined. In such cases clearance is qualified by an indication of the planned treatment or destination, e.g. clearance of scrap metal for recycling.

There are many publications on clearance of radioactive substances [IAE 96], [DEC 93], [JOH 94], [POS 95]. A European Union working party has also investigated the subject of recycling of metals from the dismantling of nuclear installations [EUR 98]. The new EURATOM Directive [EUR 96] states the basic criteria for the calculation of exemption levels for exemption from reporting or authorisation. It does not however explicitly state any clearance levels for the disposal, recycling or reuse of radioactive materials resulting from a practice subject to reporting or authorisation.

The present recommendation brings together existing recommendations and draft recommendations by the Commission on Radiological Protection with regard to conditional and unconditional clearance.

2 Scope

The following procedures and criteria relate to clearance of negligibly radioactive solids, buildings and sites from practices that are subject to reporting or authorisation. The individual solids concerned are as follows:

- Components, objects and equipment,
- Scrap iron and steel,
- Scrap non-ferrous metals,
- Building rubble and residual building material,
- Miscellaneous solids (e.g. glass, plastic, glass wool, asbestos).

The recommendation specifically does not apply to the discharge of radioactive substances with air or water, nor to enclosed radiation sources, contaminated food, intervention cases and the remediation of former mining sites.

Radionuclides need not be taken into account unless they are a part of the practice with radioactive substances that is subject to reporting or authorisation requirements. The same applies to buildings and nuclear sites.

3 General prerequisites and protection targets

Before clearance is given for negligibly radioactive solids, buildings or sites, the question of whether reuse or recycling within the nuclear sector is possible under reasonable conditions should be investigated. In the case of scrap this may for example take the form of its being melted down under an authorisation and the resulting raw material being used to make containers, shielding or other parts that can be used in nuclear installations or for the final deposition of radioactive waste.

The precondition for clearance from practices subject to reporting or authorisation is verification that the existing radioactivity is negligible and that the clearance procedure set out below is complied with. Clearance requires authorisation except insofar as it is otherwise permitted under radiological protection legislation. Verification of negligible radioactivity is provided by compliance with the criteria set out below.

In justified individual cases verification of negligible radioactivity may be provided by means of procedures and criteria other than those described here. This may in particular be of interest for waste management and recycling options for which no clearance levels are recommended. In such cases it must be shown that the potential exposure of individual

persons, also taking account of different areas of use (multiple exposure), does not exceed the overriding protection target of several 10 μSv in a year [IAE 88].

Deliberately mixing contaminated or activated substances with substances that have little or no radioactivity with the sole aim of obtaining clearance is unacceptable.

3.1 Concept of negligible radiation exposure and activity

The International Atomic Energy Agency (IAEA) recommends that individual exposure due to various areas of use (in the sense of "practices" as defined by the IAEA) be limited to an annual effective dose of some tens of μSv [IAE 88]. Such a dose may be regarded as negligible. Since an individual may be exposed to radiation from more than one practice, the IAEA recommends limiting the dose to the order of 10 μSv per year for each individual practice. On this basis the term "negligible activity", as in [SSK 87], [SSK 92], [SSK 96] and [SSK 97], is taken as the criterion for clearance.

The new EURATOM Directive [EUR 96] takes the 10 μSv concept set out in [IAE 88] as a basis for clearance. Since the Commission on Radiological Protection's clearance recommendations were made on this basis, they already conform to the requirements of the new EU Directive.

The materials, buildings or sites for clearance typically include radionuclides that make only a very small contribution to the total activity. Such radionuclides may be neglected where their total contribution to the individual dose is less than 10 percent.

Moreover, according to [EUR 96] and [IAE 88] the collective annual dose due to clearance is not to exceed approx. 1 manSievert. Otherwise it would be necessary to show by assessing the optimisation of protection that clearance is the optimum solution. The Commission on Radiological Protection is of the opinion [SSK 85] that although the collective dose may be useful as an aid to optimising work flows and precautionary measures in the field of occupational exposure, it is not suitable as a meaningful measure of radiation-induced damage to the general public, especially where, as in the case of clearance, the individual doses remain low and thus well below natural radiation exposure and its regional variations.

Moreover estimates have shown that the calculated collective dose due to the clearable substances occurring in Germany in the foreseeable future assuming compliance with the clearance criteria is less than 1 manSievert per year (see for example [GÖR 89], [JOH 94], [DEC 97], [EUR 98]).

Thus as far as its practical impacts are concerned, the collective dose criterion of less than 1 manSievert per year may be regarded as satisfied for the clearance of materials, buildings and nuclear sites in Germany and is not considered any further in the calculation of the clearance criteria.

3.2 Clearance procedures

Clearance is subject to compliance with certain conditions relating to the nature, quantity and activity of the materials, buildings and sites for clearance. To satisfy the conditions for clearance, the following measures or combinations of measures are possible:

- Decontamination,
- Allowing to decay,
- Melting down (e.g. for metals)¹.

The clearance procedure should in particular include the report or application to the competent authority, clearance measurement and documentation of the measurement results. The method of measurement should yield representative results. For every clearance a suitable bookkeeping or documentation system should register and document all materials, buildings and sites for clearance. In particular, the nature, quantity, activity concentration, destination (consignee) and time of transfer of the substances for clearance are to be documented. Details of the clearance measurement methods can be found in the standards series DIN 25457 and the relevant documentation [DIN 96]ⁱⁱ.

Once clearance has taken place, the materials, buildings and sites are no longer deemed radioactive according to the Nuclear Energy Act (*AtG*). Markings and notices drawing attention to radioactivity should therefore be removed or rendered illegible after clearance.

4 Clearance criteria for solids

The following criteria are to be applied when clearing solids from practices subject to reporting or authorisation. These clearance criteria do not apply to liquid or gaseous substances or to contaminated sites or buildings.

1. In general compliance with both the mass-specific clearance levels in Table 1 and the surface-specific contamination clearance levels in Table 2 are to be verified by measurement. Determination of surface contamination is only required if there is a solid surface on which a contamination measurement can be performed and the items in question can be expected to be handled after clearance.

The procedure for verifying compliance with the clearance levels depends on the nature and properties of the substances.

2. The specific activity must not exceed the relevant mass-specific clearance level in Table 1. For a radionuclide mixture the sum of the coefficients $f_i = C_i / R_i$ is to be calculated from the specific activity for clearance (C_i) and the relevant clearance levels (R_i) of the individual radionuclides in accordance with Table 1 (summation formula). This total must not exceed a value of 1. Radionuclides for which as a whole the partial sum of the coefficients f_i does not exceed 10 % of the total sum of the coefficients f_i may be disregarded when calculating the summation formula.

If parent-daughter radionuclide mixtures are present in the substances for clearance, the daughter nuclides are disregarded in the summation formula, provided they appear in column 2 of Table 3 and they do not exceed the secular equilibrium activity.

¹ What is meant here is melting down under an authorisation prior to unconditional clearance.

3. The individual sum of the surface-specific activities per radionuclide group in column 1 of Table 2 must not exceed the relevant group-specific contamination level in column 2.
4. As a rule the averaging mass should not exceed 300 kg. As a rule the averaging area for contiguous surfaces should not exceed a few 100 cm². The averaging criteria are to be defined in the authorisation and selected appropriately having regard to the substances subject to clearance and the selected clearance measurement method.

If an unlisted radionuclide is relevant, the clearance level may be derived by analogy with the calculation methods described and having regard to the conditions and protection targets stated in Chapter 3.

Table 1: Mass-specific clearance levels for solids

Radio-nuclide	Uncon- ditional clearance Bq/g	Clearance for disposal ⁱⁱⁱ Bq/g	Clearance of scrap metal for recycling Bq/g	Radio- nuclide	Uncon- ditional clearance Bq/g	Clearance for disposal ⁱⁱⁱ Bq/g	Clearance of scrap metal for recycling Bq/g
H 3	1E+3	1E+3	1E+3	As 73	1E+2	1E+3	1E+2
Be 7	3E+1	2E+2	3E+2	As 74	5E+0	1E+1	1E+1
C 14	8E+1	2E+3	8E+1	As 76	1E+2	1E+2	1E+2
O 15	1E+2	1E+2	1E+2	As 77	1E+3	1E+3	1E+3
F 18	1E+1	1E+1	1E+1	Se 75	3E+0	3E+1	3E+0
Na 22	1E-1	4E+0	1E-1	Br 82	1E+1	1E+1	1E+1
Na 24	1E+1	1E+1	1E+1	Rb 86	2E+1	9E+1	2E+1
Si 31	1E+3	1E+3	1E+3	Sr 85	1E+0	2E+1	1E+0
P 32	2E+1	1E+3	2E+1	Sr 85m	1E+2	1E+2	1E+2
P 33	2E+2	4E+4	2E+2	Sr 87m	1E+2	1E+2	1E+2
S 35	6E+1	2E+2	6E+2	Sr 89	2E+1	1E+3	2E+1
Cl 36	8E+0	8E+0	1E+1	Sr 90	2E+0	2E+0	9E+0
Cl 38	1E+1	1E+1	1E+1	Sr 91	1E+1	1E+1	1E+1
K 42	1E+2	1E+2	1E+2	Sr 92	1E+1	1E+1	1E+1
K 43	1E+1	1E+1	1E+1	Y 90	1E+3	1E+3	1E+3
Ca 45	7E+1	7E+3	6E+2	Y 91	2E+1	1E+3	3E+1
Ca 47	1E+1	1E+1	1E+1	Y 91m	1E+2	1E+2	1E+2
Sc 46	3E-1	4E+0	3E-1	Y 92	1E+2	1E+2	1E+2
Sc 47	1E+2	1E+2	1E+2	Y 93	1E+2	1E+2	1E+2
Sc 48	1E+1	1E+1	1E+1	Zr 93	1E+1	1E+3	1E+1
V 48	1E+0	3E+0	1E+1	Zr 95	5E-1	5E+0	6E-1
Cr 51	1E+2	3E+2	1E+3	Zr 97	1E+1	1E+1	1E+1
Mn 51	1E+1	1E+1	1E+1	Nb 93m	4E+2	1E+4	4E+2
Mn 52	1E+1	1E+1	1E+1	Nb 94	2E-1	6E+0	4E-1
Mn 52m	1E+1	1E+1	1E+1	Nb 95	2E+0	1E+1	1E+1
Mn 53	1E+3	1E+3	1E+4	Nb 97	1E+1	1E+1	1E+1
Mn 54	4E-1	1E+1	2E+0	Nb 98	1E+1	1E+1	1E+1
Mn 56	1E+1	1E+1	1E+1	Mo 90	1E+1	1E+1	1E+1
Fe 52	1E+1	1E+1	1E+1	Mo 93	2E+1	4E+1	2E+2
Fe 55	2E+2	1E+4	1E+4	Mo 99	1E+2	1E+2	1E+2
Fe 59	1E+0	7E+0	1E+1	Mo 101	1E+1	1E+1	1E+1
Co 55	1E+1	1E+1	1E+1	Tc 96	1E+1	1E+1	1E+1
Co 56	2E-1	2E+0	4E-1	Tc 96m	1E+3	1E+3	1E+3
Co 57	2E+1	1E+2	2E+1	Tc 97	1E+2	1E+2	4E+2
Co 58	9E-1	9E+0	1E+0	Tc 97m	8E+1	1E+3	1E+3
Co 58m	1E+4	1E+4	1E+4	Tc 99	1E+1	1E+1	4E+1
Co 60	1E-1	4E+0	6E-1	Tc 99m	1E+2	1E+2	1E+2
Co 60m	1E+3	1E+3	1E+3	Ru 97	1E+2	1E+2	1E+2
Co 61	1E+2	1E+2	1E+2	Ru 103	4E+0	2E+1	4E+1
Co 62m	1E+1	1E+1	1E+1	Ru 105	1E+1	1E+1	1E+1
Ni 59	8E+2	5E+3	1E+4	Ru 106	1E+0	4E+1	1E+0
Ni 63	3E+2	3E+3	1E+4	Rh 103m	1E+4	1E+4	1E+4
Ni 65	1E+1	1E+1	1E+1	Rh 105	1E+2	1E+2	1E+2
Cu 64	1E+2	1E+2	1E+2	Pd 103	3E+2	1E+3	3E+2
Zn 65	5E-1	1E+1	5E-1	Pd 109	1E+3	1E+3	1E+3
Zn 69	1E+4	1E+4	1E+4	Ag 105	4E+0	2E+1	4E+1
Zn 69m	1E+2	1E+2	1E+2	Ag 108m	2E-1	6E+0	8E-1
Ga 72	1E+1	1E+1	1E+1	Ag 110m	1E-1	3E+0	5E-1
Ge 71	4E+3	1E+4	4E+3	Ag 111	4E+1	4E+2	4E+1

Table 1: Mass-specific clearance levels for solids

Radio-nuclide	Uncon- ditional clearance Bq/g	Clearance for disposal ⁱⁱⁱ Bq/g	Clearance of scrap metal for recycling Bq/g	Radio- nuclide	Uncon- ditional clearance Bq/g	Clearance for disposal ⁱⁱⁱ Bq/g	Clearance of scrap metal for recycling Bq/g
Cd 109	2E+1	4E+3	2E+1	Ce 144	9E+0	1E+2	1E+1
Cd 115	1E+2	1E+2	1E+2	Pr 142	1E+2	1E+2	1E+2
Cd 115m	2E+1	4E+2	2E+1	Pr 143	4E+1	1E+4	4E+1
In 111	1E+2	1E+2	1E+2	Nd 147	5E+1	8E+1	5E+1
In 113m	1E+2	1E+2	1E+2	Nd 149	1E+2	1E+2	1E+2
In 114m	1E+1	8E+1	1E+1	Pm 147	2E+2	1E+4	6E+3
In 115m	1E+2	1E+2	1E+2	Pm 149	1E+3	1E+3	1E+3
Sn 113	2E+0	4E+1	2E+0	Sm 151	5E+2	5E+3	7E+3
Sn 125	2E+1	3E+1	2E+1	Sm 153	1E+2	1E+2	1E+2
Sb 122	1E+2	1E+2	1E+2	Eu 152	2E-1	8E+0	5E-1
Sb 124	5E-1	5E+0	5E-1	Eu 152m	1E+2	1E+2	1E+2
Sb 125	8E-1	2E+1	3E+0	Eu 154	2E-1	7E+0	5E-1
Te 123m	1E+1	9E+1	1E+1	Eu 155	3E+1	1E+2	3E+1
Te 125m	6E+1	1E+3	6E+1	Gd 153	2E+1	1E+2	2E+1
Te 127	1E+3	1E+3	1E+3	Gd 159	1E+3	1E+3	1E+3
Te 127m	2E+1	1E+3	5E+1	Tb 160	6E-1	9E+0	6E-1
Te 129	1E+2	1E+2	1E+2	Dy 165	1E+3	1E+3	1E+3
Te 129m	2E+1	1E+2	2E+1	Dy 166	1E+3	1E+3	1E+3
Te 131	1E+2	1E+2	1E+2	Ho 166	1E+3	1E+3	1E+3
Te 131m	1E+1	1E+1	1E+1	Er 169	1E+2	1E+4	1E+2
Te 132	1E+2	1E+2	1E+2	Er 171	1E+2	1E+2	1E+2
Te 133	1E+1	1E+1	1E+1	Tm 170	4E+1	1E+3	7E+1
Te 133m	1E+1	1E+1	1E+1	Tm 171	5E+2	1E+4	7E+2
Te 134	1E+1	1E+1	1E+1	Yb 175	1E+3	1E+3	1E+3
I 123	1E+2	1E+2	1E+2	Lu 177	1E+3	1E+3	1E+3
I 125	3E+0	1E+2	3E+0	Hf 181	4E+0	1E+1	1E+1
I 126	2E+0	2E+1	2E+0	Ta 182	5E-1	7E+0	5E-1
I 129	4E-1	4E-1	4E-1	W 181	6E+1	1E+3	6E+1
I 130	1E+1	1E+1	1E+1	W 185	1E+2	1E+4	7E+2
I 131	2E+0	2E+1	2E+0	W 187	1E+2	1E+2	1E+2
I 132	1E+1	1E+1	1E+1	Re 186	1E+3	1E+3	1E+3
I 133	1E+1	1E+1	1E+1	Re 188	1E+2	1E+2	1E+2
I 134	1E+1	1E+1	1E+1	Os 185	5E-1	1E+1	5E-1
I 135	1E+1	1E+1	1E+1	Os 191	9E+1	1E+2	9E+1
Cs 129	1E+2	1E+2	1E+2	Os 191m	1E+3	1E+3	1E+3
Cs 131	9E+2	1E+3	9E+2	Os 193	1E+2	1E+2	1E+2
Cs 132	1E+1	1E+1	1E+1	Ir 190	2E+0	3E+0	1E+1
Cs 134	2E-1	6E+0	2E-1	Ir 192	1E+0	1E+1	2E+0
Cs 134m	1E+3	1E+3	1E+3	Ir 194	1E+2	1E+2	1E+2
Cs 135	2E+1	7E+2	2E+1	Pt 191	1E+2	1E+2	1E+2
Cs 136	2E+0	4E+0	1E+1	Pt 193m	1E+3	1E+3	1E+3
Cs 137	5E-1	1E+1	6E-1	Pt 197	1E+3	1E+3	1E+3
Cs 138	1E+1	1E+1	1E+1	Pt 197m	1E+2	1E+2	1E+2
Ba 131	2E+1	2E+1	9E+1	Au 198	1E+2	1E+2	1E+2
Ba 140	2E+0	3E+0	1E+1	Au 199	1E+2	1E+2	1E+2
La 140	1E+1	1E+1	1E+1	Hg 197	1E+2	1E+2	1E+2
Ce 139	9E+0	8E+1	9E+0	Hg 197m	1E+2	1E+2	1E+2
Ce 141	7E+1	1E+2	7E+1	Hg 203	1E+1	4E+1	3E+1
Ce 143	1E+2	1E+2	1E+2	Tl 200	1E+1	1E+1	1E+1

Table 1: Mass-specific clearance levels for solids^{*)}

Radio-nuclide	Uncon- ditional clearance Bq/g	Clearance for disposal ⁱⁱⁱ Bq/g	Clearance of scrap metal for recycling Bq/g	Radio- nuclide	Uncon- ditional clearance Bq/g	Clearance for disposal ⁱⁱⁱ Bq/g	Clearance of scrap metal for recycling Bq/g
Tl 201	1E+2	1E+2	1E+2	U 239	1E+2	1E+2	1E+2
Tl 202	2E+1	2E+1	1E+2	U 240	1E+3	1E+3	1E+3
Tl 204	4E+1	1E+4	3E+2	Np 237	9E-2	1E+0	6E-1
Pb 203	1E+2	1E+2	1E+2	Np 239	1E+2	1E+2	1E+2
Pb 210	3E-2	1E+1	6E-2	Np 240	1E+1	1E+1	1E+1
Pb 212	1E+1	1E+1	1E+1	Pu 234	1E+2	1E+2	1E+2
Bi 206	1E+1	1E+1	1E+1	Pu 235	1E+2	1E+2	1E+2
Bi 207	2E-1	6E+0	6E-1	Pu 236	1E-1	1E+1	7E-1
Bi 210	1E+3	1E+3	1E+3	Pu 237	2E+2	3E+2	5E+2
Bi 212	1E+1	1E+1	1E+1	Pu 238	4E-2	1E+0	3E-1
Po 203	1E+1	1E+1	1E+1	Pu 239	4E-2	1E+0	2E-1
Po 205	1E+1	1E+1	1E+1	Pu 240	4E-2	1E+0	2E-1
Po 207	1E+1	1E+1	1E+1	Pu 241	2E+0	1E+2	1E+1
Po 210	4E-2	1E+1	1E+0	Pu 242	4E-2	1E+0	3E-1
At 211	1E+3	1E+3	1E+3	Pu 243	1E+3	1E+3	1E+3
Ra 223	5E-1	2E+1	5E-1	Pu 244	4E-2	1E+0	3E-1
Ra 224	1E+1	1E+1	1E+1	Am 241	5E-2	1E+0	3E-1
Ra 225	2E-1	9E+0	4E-1	Am 242	1E+3	1E+3	1E+3
Ra 226	3E-2	1E-1	4E-1	Am 242m	5E-2	1E+0	3E-1
Ra 227	1E+2	1E+2	1E+2	Am 243	5E-2	1E+0	3E-1
Ra 228	7E-2	8E+0	7E-1	Cm 242	8E-1	5E+1	5E+0
Ac 228	1E+1	1E+1	1E+1	Cm 243	7E-2	1E+0	4E-1
Th 226	1E+3	1E+3	1E+3	Cm 244	8E-2	1E+1	5E-1
Th 227	2E-1	7E+0	3E-1	Cm 245	4E-2	1E+0	3E-1
Th 228	1E-1	1E+0	4E-1	Cm 246	5E-2	1E+0	3E-1
Th 229	2E-2	1E+0	1E-1	Cm 247	5E-2	1E+0	3E-1
Th 230	5E-2	1E+0	3E-1	Cm 248	1E-2	1E+0	8E-2
Th 231	1E+3	1E+3	1E+3	Bk 249	3E+1	1E+3	2E+2
Th 232	3E-2	1E+0	3E-1	Cf 246	1E+3	1E+3	1E+3
Th 234	1E+1	5E+2	1E+1	Cf 248	5E-1	1E+1	3E+0
Pa 230	6E+0	1E+1	1E+1	Cf 249	7E-2	1E+0	4E-1
Pa 231	7E-3	8E-2	2E-1	Cf 250	1E-1	8E+0	9E-1
Pa 233	2E+1	5E+1	6E+1	Cf 251	7E-2	1E+0	4E-1
U 230	3E-1	1E+1	9E-1	Cf 252	2E-1	1E+1	1E+0
U 231	1E+2	1E+2	1E+2	Cf 253	4E+0	1E+2	4E+1
U 232	6E-2	1E+0	8E-1	Cf 254	1E-1	1E+0	7E-1
U 233	4E-1	2E+0	3E+0	Es 253	2E+0	9E+1	8E+0
U 234	5E-1	9E+0	2E+0	Es 254	4E-1	8E+0	3E+0
U 235	5E-1	3E+0	8E-1	Es 254m	1E+2	1E+2	1E+2
U 236	5E-1	1E+1	3E+0	Fm 254	1E+4	1E+4	1E+4
U 237	1E+2	1E+2	1E+2	Fm 255	1E+3	1E+3	1E+3
U 238	6E-1	1E+1	2E+0				

*) The EU Basic Safety Standards [EUR 96] do not contain an exemption level for the radionuclide Ac 227; this radionuclide is therefore not included in the above table. Using the calculation method described, the mass-specific clearance levels for Ac 227 are as follows:

Unconditional clearance: 7E-3 Bq/g;

Clearance for disposal: 3E-1 Bq/g.

Table 2: Clearance levels for surface contamination

Radionuclides						Clearance levels for surface contamination* [Bq/cm ²]	
H 3	Be 7	C 14	F 18	Si 31	P 33	5	
S 35	Cl 38	K 40	Ca 45	V 48	Cr 51		
Mn 51	Mn 52m	Mn 53	Mn 56	Fe 55	Co 58m		
Co 60m	Co 61	Co 62m	Ni 59	Ni 63	Ni 65		
Cu 64	Zn 69	Ge 71	Sr 85m	Sr 87m	Y 91m		
Nb 97	Nb 98	Mo 101	Tc 96m	Tc 97	Tc 99		
Tc 99m	Rh 103m	In 113m	In 115m	Te 127	Te 129		
Te 131	Te 133	Te 134	I 129	I 134			
Cs 129	Cs 131	Cs 134m	Cs 135	Cs 138			
Nd 149	Pm 147	Dy 165	W 181	Os 191m			
Pt 197m	Tl 201	Po 203	Po 205	Po 207			
Ra 227	U 239	Np 240	Pu 235	Pu 243			
Na 22	Na 24	P 32	Cl 36	K 42	K43		0.5
Ca 47	Sc 46	Sc 47	Sc 48	Mn 52	Mn 54		
Fe 52	Fe 59	Co 55	Co 56	Co 57	Co 58		
Co 60	Zn 65	Zn 69m	Ga 72	As 73	As 74		
As 76	As 77	Se 75	Br 82	Rb 86	Sr 85		
Sr 89	Sr 90	Sr 91	Sr 92	Y 90	Y 91		
Y 92	Y 93	Zr 93	Zr 95	Zr 97	Nb 93m		
Nb 94	Nb 95	Mo 90	Mo 93	Mo 99	Tc 96		
Tc 97m	Ru 97	Ru 103	Ru 105	Ru 106	Rh 105		
Pd 103	Pd 109	Ag 105	Ag 108m	Ag 110m	Ag 111		
Cd 109	Cd 115	Cd 115m	In 111	In 114m	Sn 113		
Sn 125	Sb 122	Sb 124	Sb 125	Te 123m	Te 125m		
Te 127m	Te 129m	Te 131m	Te 132	Te 133m	I 123		
I 125	I 126	I 130	I 131	I 132	I 133		
I 135	Cs 132	Cs 134	Cs 136	Cs 137	Ba 131		
Ba 140	La 140	Ce 139	Ce 141	Ce 143	Ce 144		
Pr 142	Pr 143	Nd 147	Pm 149	Sm 151	Sm 153		
Eu 152	Eu 152m	Eu 154	Eu 155	Gd 153	Gd 159		
Tb 160	Dy 166	Ho 166	Er 169	Er 171	Tm 170		
Tm 171	Yb 175	Lu 177	Hf 181	Ta 182	W 185		
W 187	Re 186	Re 188	Os 185	Os 191	Os 193		
Ir 190	Ir 192	Ir 194	Pt 191	Pt 193m	Pt 197		
Au 198	Au 199	Hg 197	Hg 197m	Hg 203	Tl 200		
Tl 202	Tl 204	Pb 203	Pb 210	Pb 212	Bi 206		
Bi 207	Bi 210	Bi 212	At 211	Ra 224	Ac 228		
Th 226	Th 231	Th 232	Th 234	Pa 230			
Pa 233	U 231	U 235	U 236	U 237			
U 238	U 240	Np 239	Pu 234	Pu 237			
Pu 241	Pu 244	Am 242	Bk 249	Cf 246			
Cf 253	Es 253	Es 254m	Fm 254	Fm 255			
Po 210	Ra 223	Ra 225	Ra 226	Ra 228	Th 227	0.05	
Th 228	Th 229	Th 230	Pa 231	U 230	U 232		
U 233	U 234	Np 237	Pu 236	Pu 238	Ac 227		
Pu 239	Pu 240	Pu 242	Am 241	Am 242m			
Am 243	Cm 242	Cm 243	Cm 244	Cm 245			
Cm 246	Cm 247	Cm 248	Cf 248	Cf 249			
Cf 250	Cf 251	Cf 252	Cf 254	Es 254			

* These values must in each case be complied with for the sum of the surface-specific activities in each radionuclide group in column 1. A summation formula does not have to be used.

Table 3: List of radionuclides in secular equilibrium

Parent nuclides	Daughter nuclides
Sr 90	Y 90
Zr 95	Nb 95, Nb 95m
Ru 103	Rh 103m
Ru 106	Rh 106
Pd 103	Rh 103m
Ag 108m	Ag 108
Ag 110m	Ag 110
Cd 109	Ag 109m
In 114m	In 114
Sn 113	In 113m
Sb 125	Te 125m
Te 127m	Te 127
Te 129m	Te 129
Cs 137	Ba 137m
Ba 131	Cs 131
Ba 140	La 140
Ce 144	Pr 144, Pr 144m
Ir 190	Os 190m
Pb 210	Bi 210
Ra 223	Rn 219, Po 215, Pb 211, Bi 211, Tl 207, Po 211
Ra 225	Ac 225, Fr 221, At 217, Bi 213, Tl 209, Po 213, Pb 209
Ra 226	Rn 222, Po 218, Pb 214, Bi 214, Po 214
Ra 228	Ac 228
Th 227	Ra 223, Rn 219, Po 215, Pb 211, Bi 211, Tl 207, Po 211
Th 228	Ra 224, Rn 220, Po 216, Pb 212, Bi 212, Tl 208, Po 212
Th 229	Ra 225, Ac 225, Fr 221, At 217, Bi 213, Tl 209, Po 213, Pb 209
Th 234	Pa 234m, Pa 234
U 230	Th 226, Ra 222, Rn 218, Po 214
U 235	Th 231
U 238	Th 234, Pa 234m, Pa 234
Np 237	Pa 233
Pu 244	U 240, Np 240m, Np 240
Am 242m	Np 238, Am 242
Am 243	Np 239
Cm 247	Pu 243
Cf 253	Cm 249, Es 253
Es 254	Bk 250

4.1 Unconditional clearance

The clearance levels listed in column 2 of Table 1 apply to solids from practices subject to reporting or authorisation requirements. Examples are reusable components, scrap or residual building material. In unconditional clearance, the destination and the condition of the solids are immaterial. After clearance the solids may be reused, recycled or disposed of as normal waste.

4.2 Clearance for disposal

The clearance levels in column 3 of Table 1 apply to nonrecyclable solid waste. It must therefore be ensured that the waste for clearance is disposed of either on a landfill site or in a thermal treatment plant (formerly known as waste incineration plant), i.e. reuse and material recovery must be ruled out. This is to be verified in the individual case. Disposal of toxic waste (i.e. mixed waste) requires a case by case decision (cf. Chapter 3)^{iv}.

4.3 Clearance of scrap metal for recycling

The clearance levels in column 4 of Table 1 apply to all types of metal that are cleared as scrap for melting down. The clearance levels do not apply to metals that have been melted down under an authorisation before clearance. Composite substances, such as electrical scrap, electrical cables or reinforced concrete are to be separated before clearance, after which clearance may be given for the metal fraction, provided it does not exceed these clearance levels.

It must be ensured that after clearance the scrap metal is actually melted down.

5 Clearance criteria for buildings

The following criteria relate to buildings of nuclear installations and to buildings in which handling of other radioactive substances subject to reporting or authorisation requirements has taken place. The term "building" embraces individual buildings, rooms, parts of rooms and building components.

Clearance measurement for a building should in general be performed on the standing structure. Loose building rubble that inevitably occurs during decommissioning or renovation and refurbishing work may be cleared in accordance with mass-specific clearance criteria (see Sections 4.1 or 4.2).

The following criteria are to be satisfied when clearing buildings.

1. The contamination on the building surfaces is less than the clearance levels in column 2 of Table 2. The contamination on the building surfaces is defined as the ratio of the sum of the fixed, nonfixed and penetrated activity that is under the area to be measured for clearance, and the area to be measured for clearance.

The surface-specific clearance levels apply to the relevant sum of the surface-specific activities per radionuclide group in column 1 of Table 2.

The procedure for verifying compliance with the clearance levels is to be defined in the context of the authorisation and chosen appropriately having regard to the situation in the buildings to be cleared.

2. As a rule the averaging area should not exceed 1 m². If it is ensured that the building will be demolished after clearance, the averaging area may also be larger than 1 m². The averaging area may consist of individual contiguous surfaces, such as walls, ceilings or floors. The measurements on which the decisions are to be based may be made using a suitable random sampling method.

6 Clearance criteria for nuclear sites

For unconditional clearance of contaminated sites, compliance with the guide value of 10 µSv in one year must be verified by means of relevant calculations. Consideration must be given to the relevant uses of the land after clearance, which must be taken as realistic for the location, and to the relevant exposure paths. Compliance with the above-mentioned guide value is to be verified by performing dose calculations with realistic conditions.

Conditional clearance of a contaminated site may be considered if certain requirements are satisfied even after it is released from the scope of the Nuclear Energy Act. In that case there is no need to consider those exposure paths, which can be ruled out when the appropriate restrictions are imposed, when performing the dose calculations.

Existing natural radioactivity in the soils in the vicinity, and contamination resulting for example from nuclear weapons testing and the accident at the Chernobyl nuclear power station or from the fertilising of farmland, are not to be taken into account when performing dose calculations in respect of the above-mentioned guide value.

When determining the correction factor to account for existing radioactivity and selecting reference areas in the neighbourhood of the nuclear site, the following must be taken into account:

- a) The reference areas in the neighbourhood of the nuclear site should be similar to the site for clearance in terms of soil properties and composition.
- b) The measurements to determine the radiological situation at the site to be cleared and the existing radioactivity at the reference areas are to be representative. The measurement method must be appropriate for the expected or suspected distribution of contamination.

7 Information on verification procedures in connection with clearance

The DIN standards series [DIN 96] contains information on verification methods. The following remarks therefore address overall aspects without going into the details of verification methods.

Basically the method for verifying compliance with the clearance levels should take account of the nature and properties of the materials, buildings or sites being cleared. Care should be taken that when determining the activities in the substances or buildings for clearance, adequate account is taken of the radionuclide mix in accordance with DIN 25457. For radionuclides which cannot be registered by gamma spectrometry, direct measurement of the radionuclide can be difficult, complicated and expensive. In such cases one can consider determining the nuclide by calculation. In this context the German standards organisation DIN has developed the key nuclide method (fingerprinting), which is in many cases very suitable for determining radionuclides that are difficult to measure.

7.1 Waste from the use of isotopes

For small users and for the use of radionuclides (e.g. in medicine and research) where the quantity of activity used is known, it may be possible to determine the activity by using accounting methods without undertaking clearance measurements. This should however be examined by the competent authority in the individual case. The following points may be used in determining the activity:

- the total activity quantities used,
- dilution occurring as a result of experiments or manipulation,
- allowance for radioactive decay,
- process-induced enrichment or depletion,
- known losses (e.g. when transferring or pipetting).

7.2 Buildings

It is essential that measurement methods used to determine the surface contamination when clearing standing buildings register the activity which has penetrated from the surface into the volume to a depth determined in preliminary studies. This is relevant in particular for measurements on wall and floor surfaces that may have had several coats of decontamination paint. If the chosen verification method is not able to register sufficiently both the surface activity and the activity that has penetrated into the underlying material, it may be necessary to perform suitable mass-specific measurements on wall samples in addition to the surface measurements.

Depending on the activity distribution in the building and its rooms, random sampling methods in accordance with DIN 25457 [DIN 96] which verify compliance with the surface specific clearance levels may be applied.

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Translator's notes:

- i The German atomic law allows only material which contains negligible activity to be deregulated. Over the last decade "negligible" has been interpreted to mean the amount of activity which causes a dose in the range of 10 $\mu\text{Sv/a}$ per practice. In general practices are taken to mean one waste stream for all Germany, i.e. the clearance of scrap metal from all the nuclear sites in Germany.
- ii DIN stands for Deutsches Institut für Normung and is the official national body which publishes standards. The DIN 25457 is the series of standards for clearance measurements and documentation.
- iii Disposal is used here to mean disposal at either a landfill or an incinerator.
- iv The German waste laws divide waste for disposal into conventional and toxic waste. These laws require special treatment of the toxic waste so that depending on the disposal facility higher clearance levels may be possible for toxic mixed waste.