IAEA and EC Regulations for Clearance of Materials and Release of Buildings and Sites

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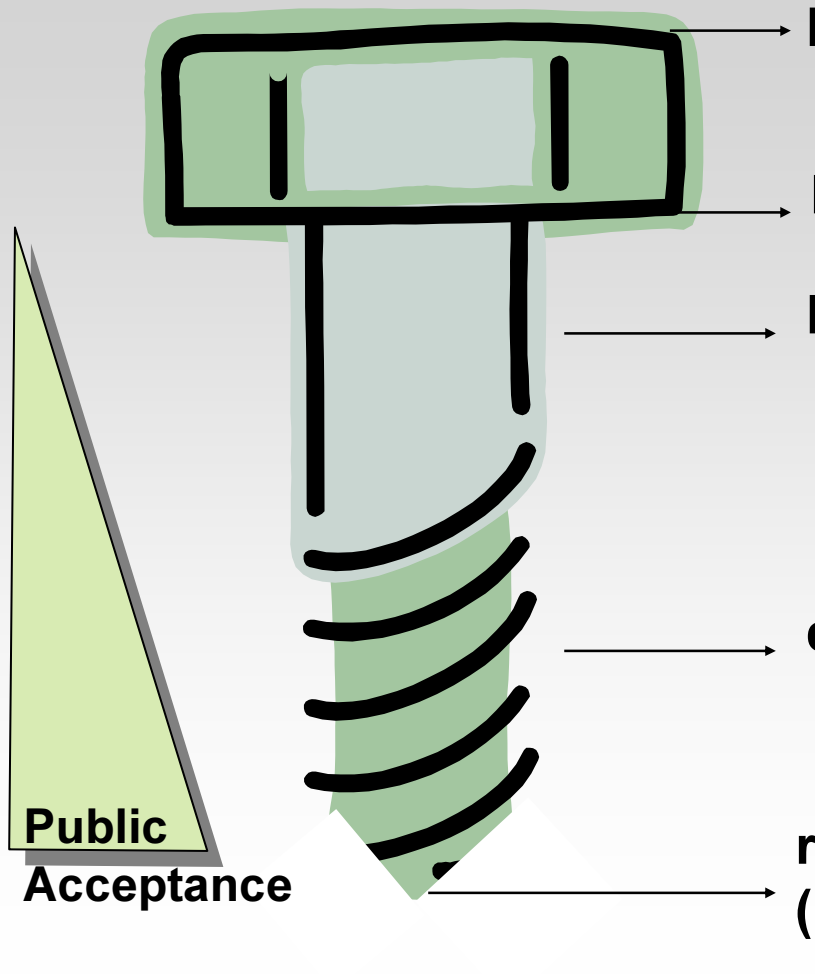
Content

1. Exemption, exclusion and clearance
2. Clearance regulations
3. Zoning Concept
4. Future developments
   - Release of materials
   - Removal of materials, buildings and areas
   - Release of sites

The Screw of Dose Limits



Dose limit for workers 20 mSv/a

Dose limit for the public 1 mSv/a

Dose limit for effluents 0.3 mSv/a

de minimis concept
in the range of 10 µSv/a

removal – detection limit
(10% of de minimis concept)

Exclusion, Exemption, Clearance

Exclusion: the exclusion of certain exposure situations from radiological protection control legislation

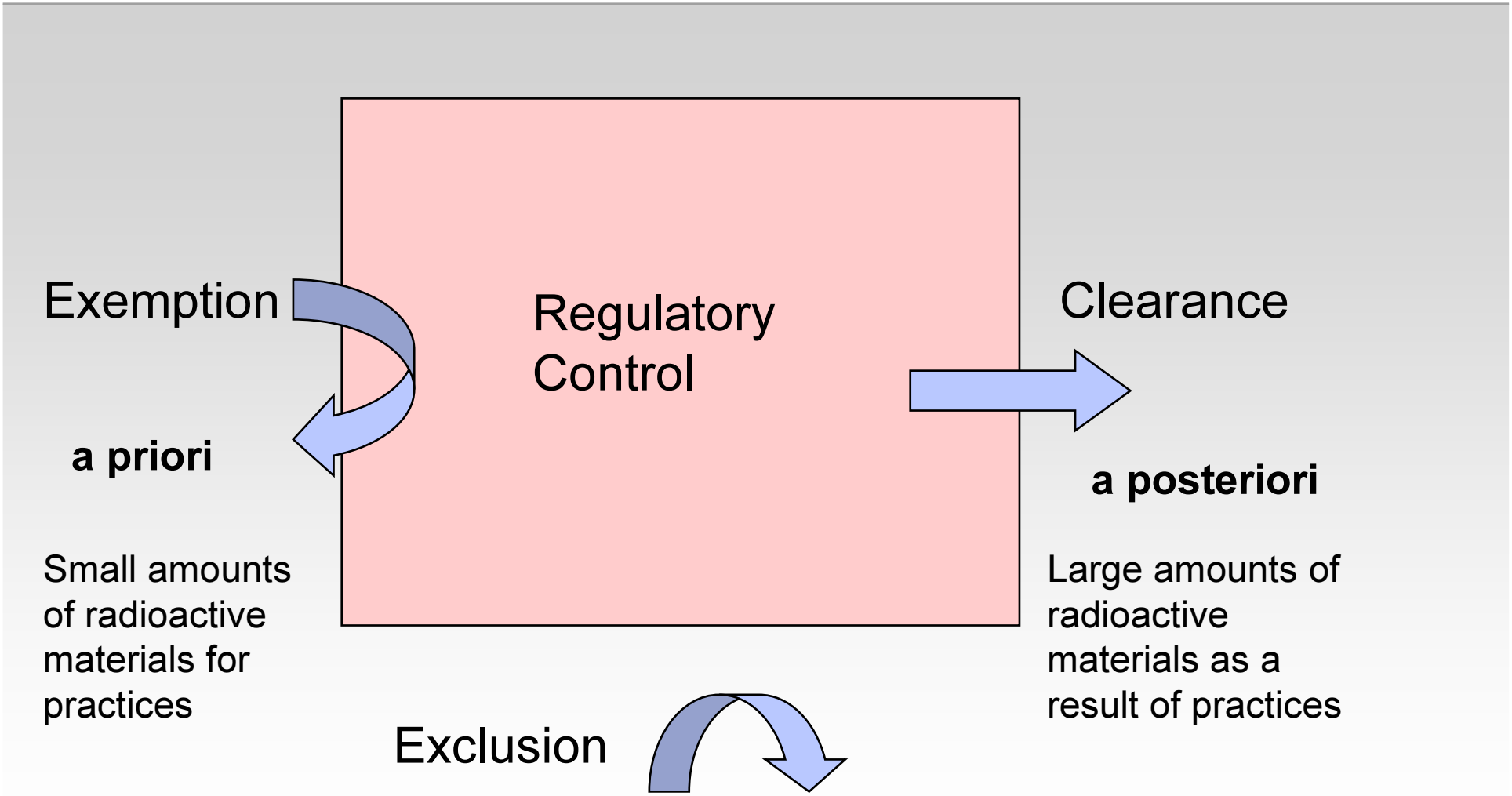
- control cannot be regulated
- examples: K-40 in human bodies
- cosmic rays at ground level

Exemption: the exemption from some or all radiological protection regulatory requirements for situations, where such controls are regarded as unwarranted

- control need not to be regulated (risk<< control effort)
- example: practice with sources of very low activity

Exclusion, Exemption, Clearance

Exemption and Clearance – Two different procedures?



Basic Criteria for Exemption and Clearance

- **Principles for the Exemption of Radiation Sources and Practices from Regulatory Control (IAEA, 1988)**
  provided first guidance on typical levels for the purpose of exemption and clearance
- Two main approaches:

1. to choose a level of risk and the corresponding dose that is of no significance to individuals
2. to use the exposure to the natural background, to the extent that is normal and unavoidable, as a relevant reference.

Basic Criteria for Exemption and Clearance

- Individual radiation dose is likely to be regarded as trivial, if it is of the order of **some ten µSv/year**. No further optimisation is necassary, when the collective dose per year of the unregulated practice is less than about **1 manSievert.**
- This level of dose corresponds to a few percent of the annual dose limit for members of the public and is much smaller than any upper bound set by competent authorities for practices subject to regulatory control.
- This level corresponds to a few percent of the radiation of the natural background.

De Minimis Concept

De minimis non curat lex/praetor. -
The law does not care about trivial things.

- risk factor for mortal cancer induced by radiation is quoted at **10^{-2} Sv^{-1}**.
- Dose rate at approx. **100 µSv/a** leads to a cancer risk induced by radiation at **< $10^{-6}a^{-1}$**, which is to be considered as harmless.
- As different ways of exposition are possible the additional dose **per pathway can be in the range of 10 µSv/a** .

Background – Clearance of Materials

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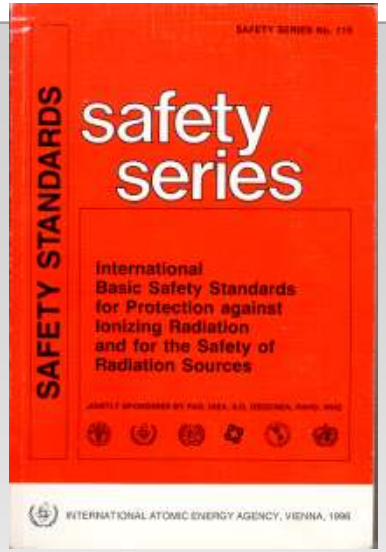
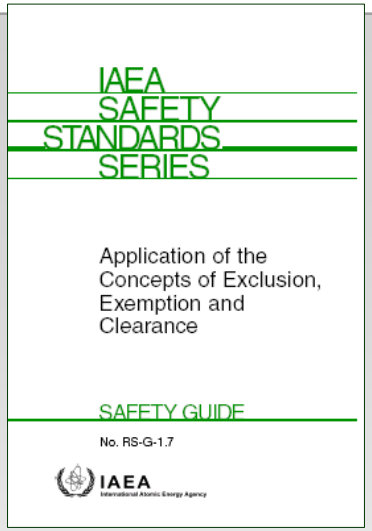
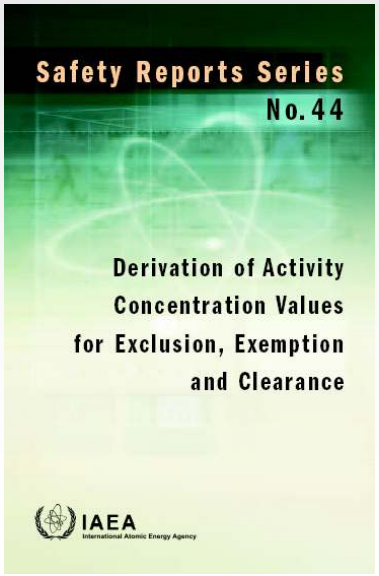
Safety Standard

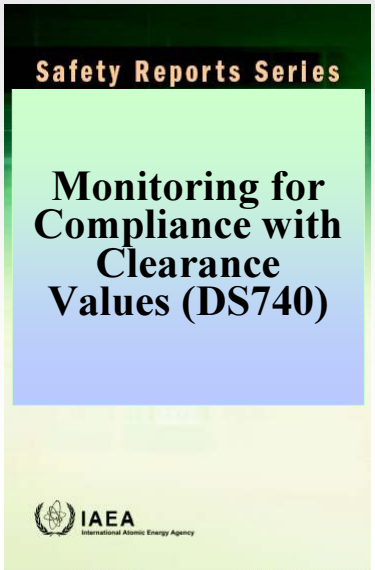


Safety Guide



Supporting documents





Deriving the Levels

- Exemption values are given in the BSS, IAEA and EU Directive 96/29, also used in regulations for safe transport of radioactive materials.
- Prerequisite are realistic scenarios for modelling.
- Scenarios: small-scale usage of radionuclides (< 1 kg) in laboratories including disposal of waste (< 1 Mg) contaminated by this practice => Bq and Bq/g-values
- Bulk material: IAEA RS-G-1.7, 2004 => Bq/g-values
- ingestion of small amounts,
- inhalation during work with the material,
- direct radiation from the material

Recommendations given by the EC

RP 65: Principles and methods for establishing concentrations and quantities (Exemption Values) below which reporting is not required in the European Directive, 1993
RP 89: Recommended radiological protection criteria for the recycling of metals from the dismantling of nuclear installations, 1998
RP 101: Basis for the definition of surface contamination clearance levels for the recycling or reuse of metals arising from the dismantling of nuclear installations, 1999
RP 113: Recommended radiological protection criteria for the clearance of buildings and building rubble from the dismantling of nuclear installations, 2000
RP 117: Methodology and models used to calculate individual and collective doses from the recycling of metals from the dismantling of nuclear installations, 2000
RP 122: Practical use of the concepts of clearance and exemption –
part I: Guidance on general clearance levels for practices, 2000
part II: Application of the concepts of exemption and clearance to natural radiation sources, 2001

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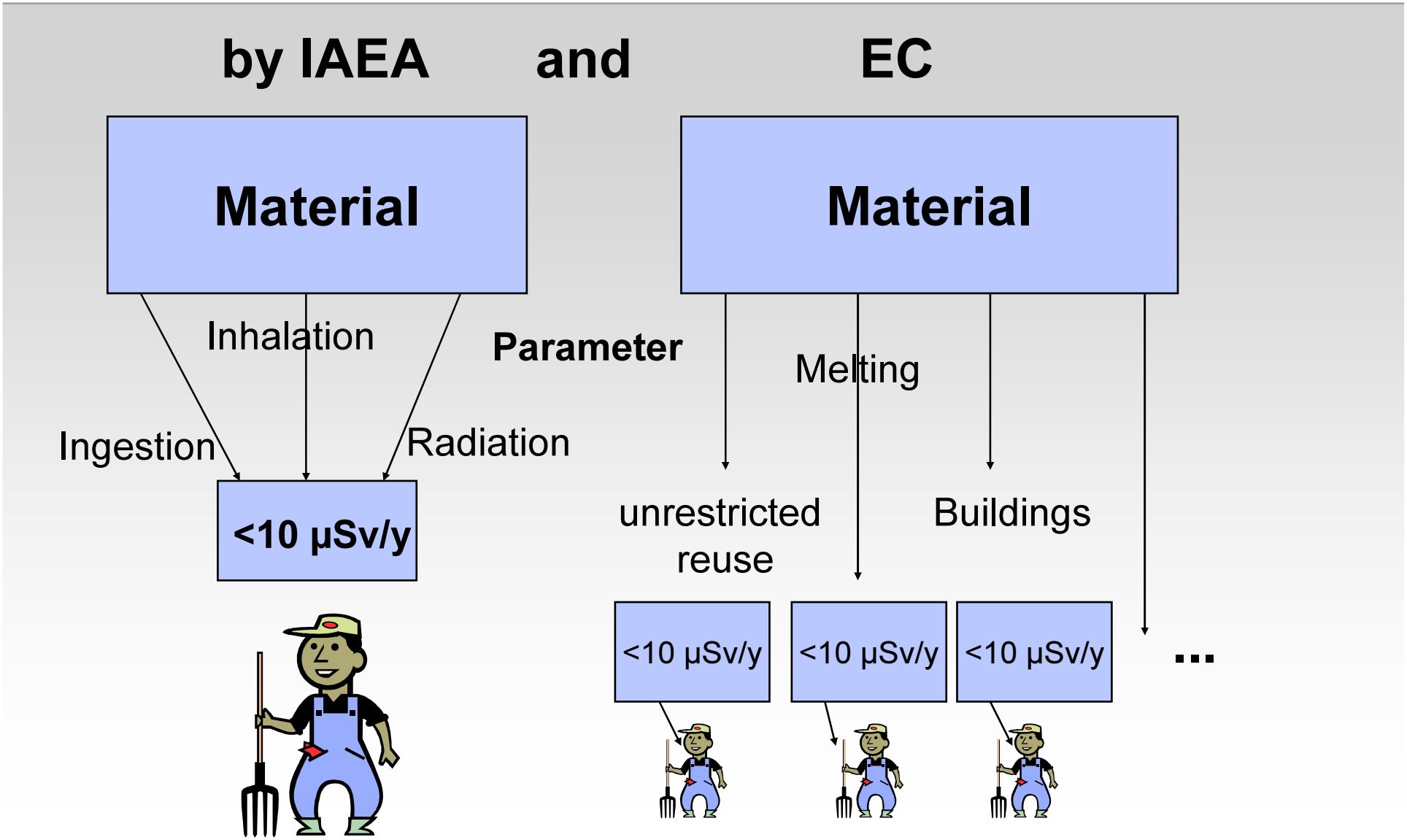
Deriving the Levels



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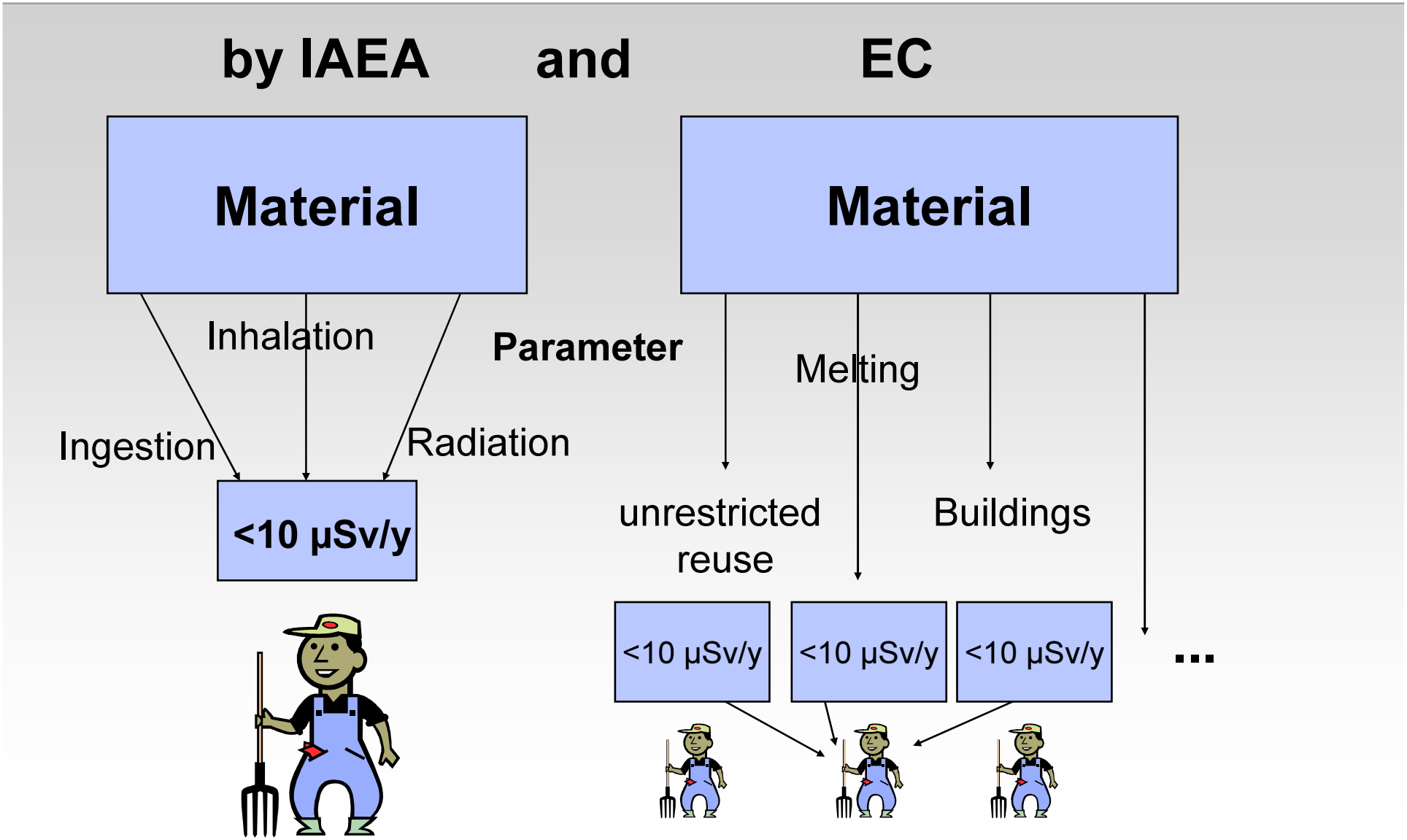


German Regulations

If you have a need, you find the solution!

If you don´t have a need, you don´t see it!

Germany has always a need for reducing radioactive waste:

1978 Asse was closed

1994-1997 Morsleben was opened

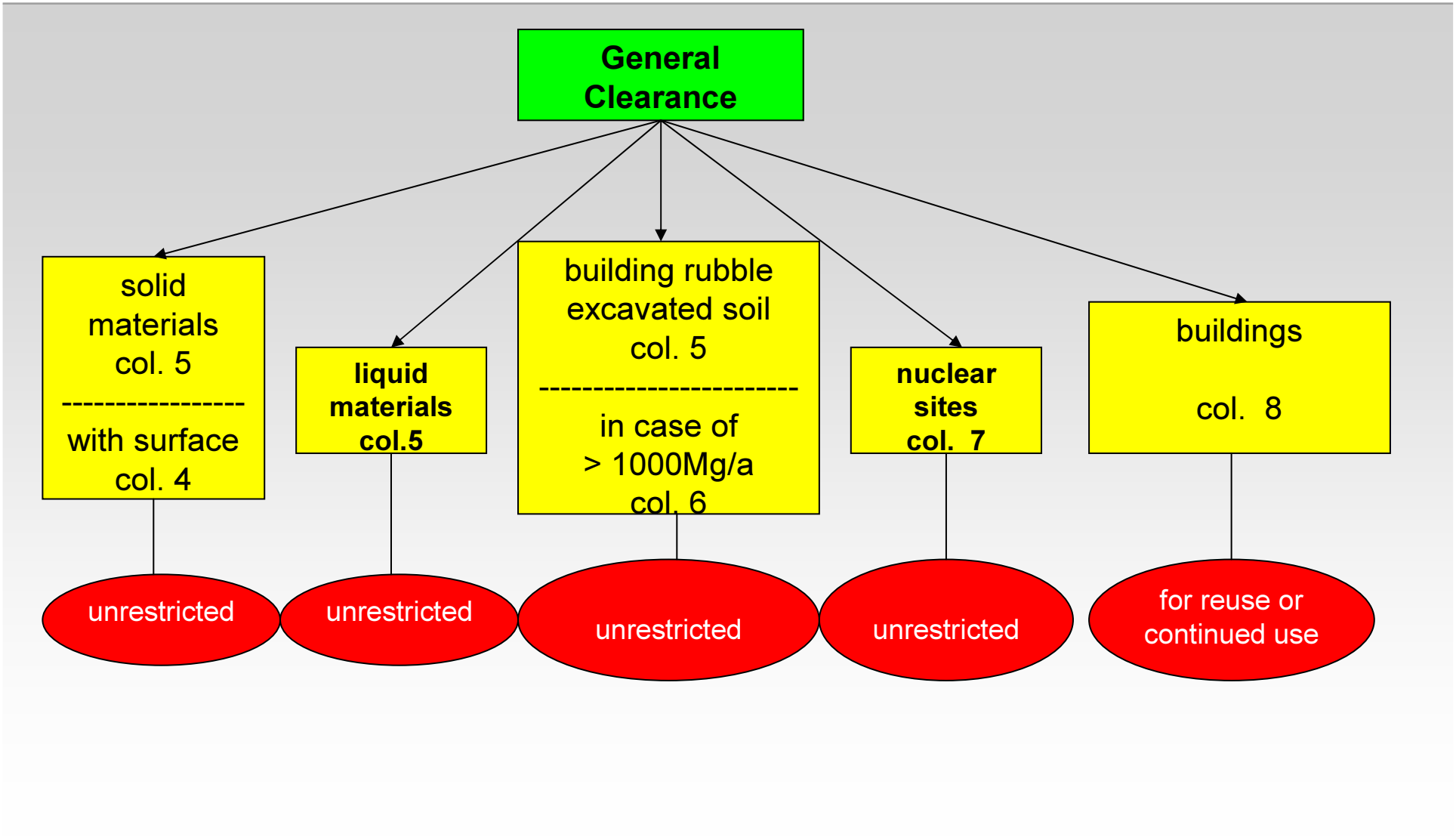
2018 Konrad will open?

⇒strategy for strong use of clearance option

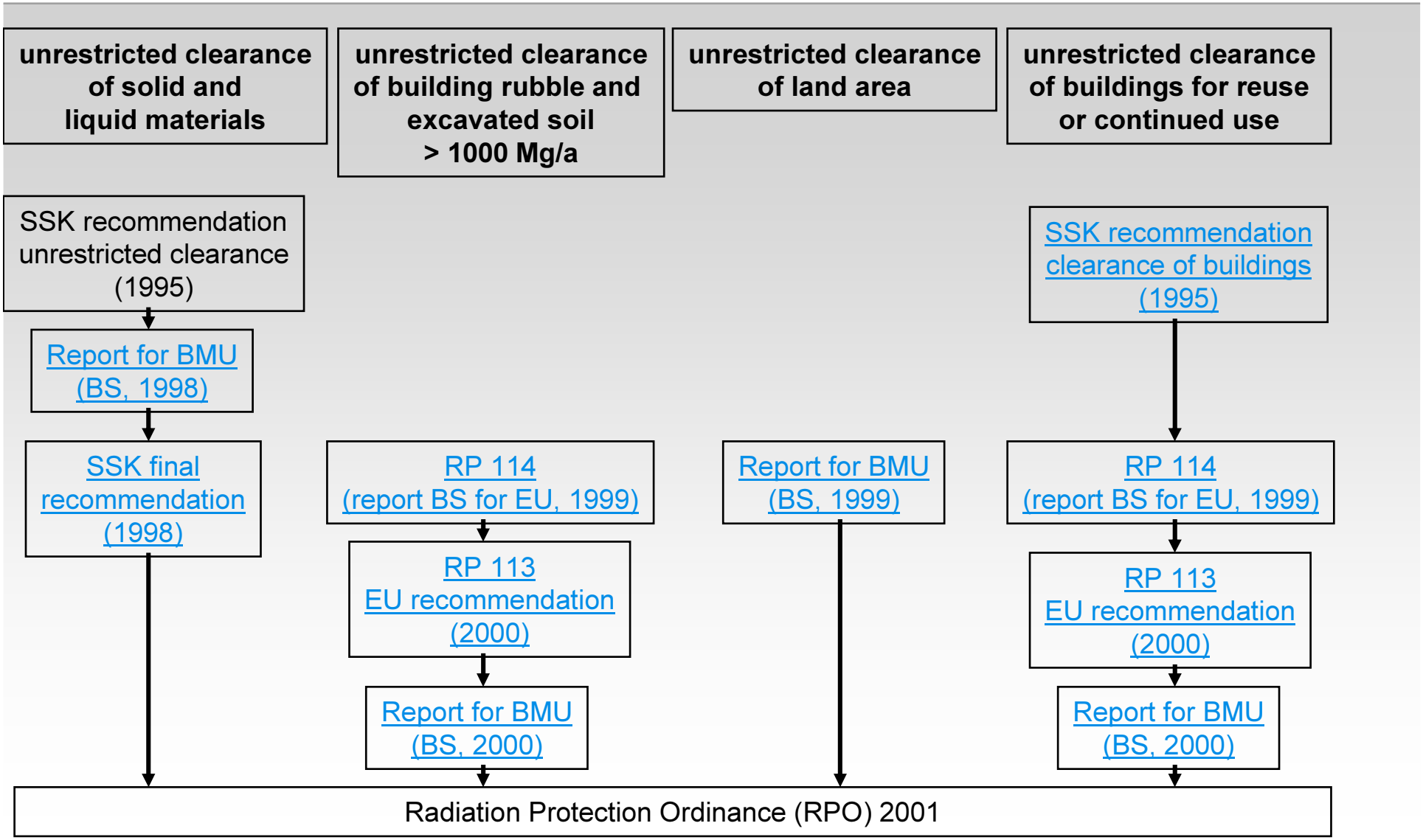
Example: 97% of material from decommissioning to be cleaned for clearance!

IAEA: “In many respects Germany is taking the lead in the application of the clearance concept in the decommissioning of nuclear facilities…”

German Regulations



Development of Clearance Values in the German RPO (2001)



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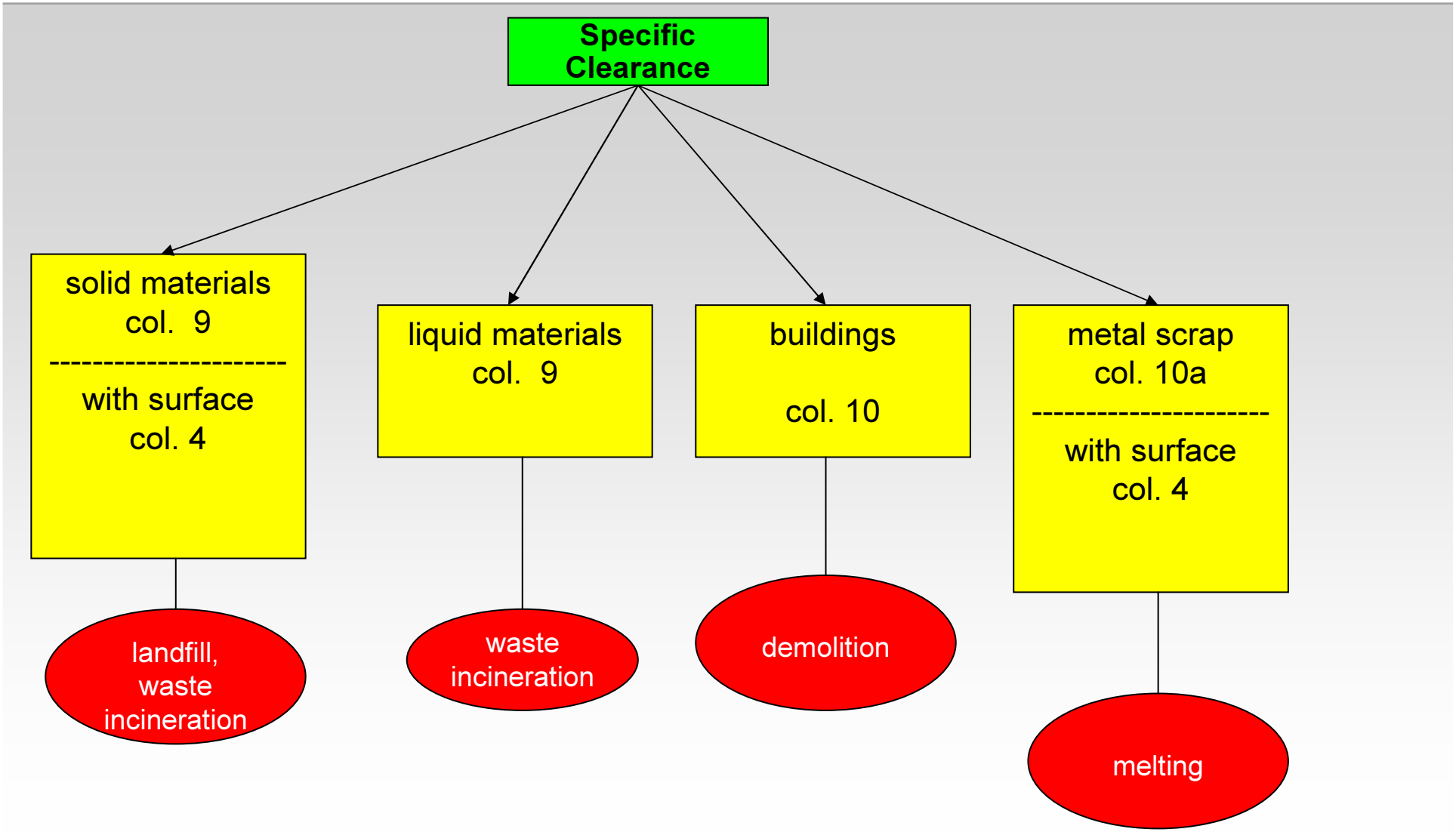

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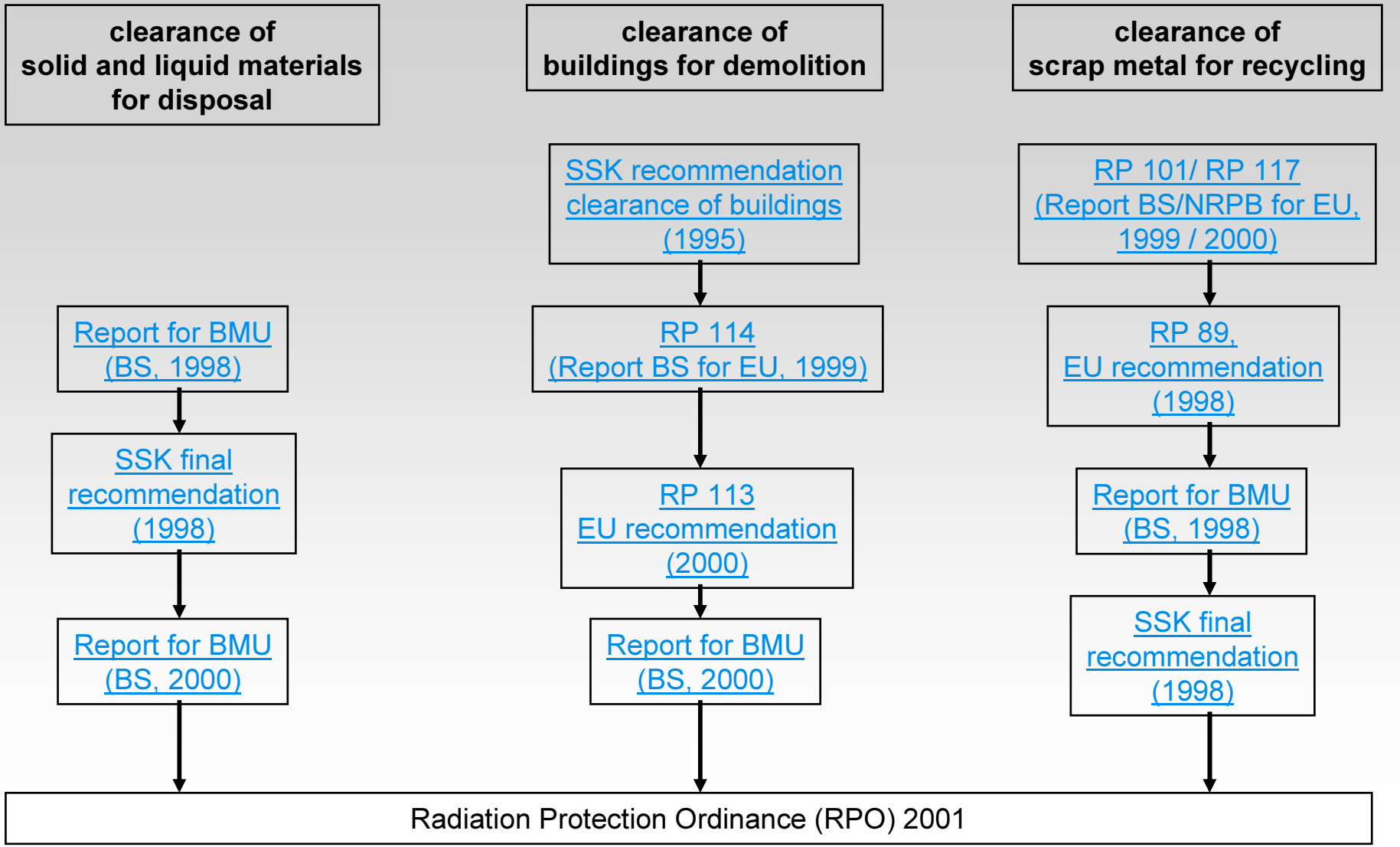


Nuclide	Exemption level		Surface contamination	General Clearance of				Specific Clearance of			Half-life	
	Activity [Bq]	Specific activity [Bq/g]	[Bq/cm^2]	Solid sub-stances, liquids, with the exception of column 6 [Bq/g]	Building rubble, excavated soil, in amounts over 1,000 Mg/a [Bq/g]	Sites [Bq/cm^2]	Buildings for reuse or continued use [Bq/cm^2]	Solid sub-stances and liquids for disposal, with the exception of column 6 [Bq/g]	Buildings for demolition [Bq/cm^2]	Metal Scrap for Recycling [Bq/g]		
1	2	3	4	5	6	7	8	9	10	10a	11	
H-3	1 E+7	1 E+3	100	1 E+3	60	3	1 E+3	1 E+3	4 E+3	1 E+3	12,3	a
Be-7	1 E+7	1 E+3	100	30	30	2	80	200	600	3 E+2	53,3	d
Mn-54	1 E+6	10	1	0,4	0,3	0,09	1	10	10	2	312,2	d
Fe-55	1 E+6	1 E+4	100	200	200	6	1 E+3	1 E+4	2 E+4	1 E+4	2,7	a
Zn-65	1 E+6	10	1	0,5	0,4	0,01	2	10	20	0,5	244	d
Co-60	1 E+5	10	1	0,1	0,09	0,03	0,4	4	3	0,6	5,3	a
Co-58	1 E+6	10	1	0,9	0,2	0,08	1	9	30	1	70,8	d
Ag-110m+	1 E+6	10	1	0,1	0,08	7E-3	0,5	3	4	0,5	249,9	d
Sb-124	1 E+6	10	1	0,5	0,5	0,04	1	5	20	0,5	60,3	d
Cs-137+	1 E+4	10	1	0,5	0,4	0,06	2	10	10	0,6	30,2	a
Cs-134	1 E+4	10	1	0,2	0,1	0,05	0,6	6	5	0,2	2,1	a
Am-241	1 E+4	1	0.1	0.05	0.05	0.06	0.1	1	3	0,3	432,6	a
....												

Clearance procedures

The licensee has two ways according to **§ 29(2)** StrlSchV

unrestricted clearance

or specific clearance in a

simplified procedure

⇒ clearance values according to annex III

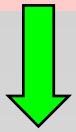
Clearance in

single case procedure

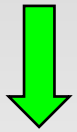
⇒ Single case assessment of compliance regarding the10 µSv concept with the exemption values as upper limit

Clearance procedures

Application of the licensee



Approval of clearance from the responsible authority



Statement of compliance to the specified requirements

and

documentation

The French solution

- A disposal specially designed for VLLW (In Morvillier, near the centre de l'Aube)
- No universal clearance levels
- Approach based on the zoning of nuclear installations
  - In nuclear waste zone : every waste generated are considered as nuclear waste
  - In conventional waste zone : every waste generated is conventional
- The order of 31th December 1999 made this approach binding to nuclear operators (ASN approves the "waste studies")
- Since 2003 : 75 000 tons of concrete, metallic scraps, former transports casks are disposed of in the Morvillier repository

Advantages

- Ethically less questionable: no dissemination of radioactivity into the environment due to the management of large amount of VLLW
- Easier to put in practice for decommissioning : No sophisticated measurements is needed for the clearance of materials during the decommissioning phases of installations in which nuclear activities had been carried out
- A practical way to dispose VLLW which may be beyond clearance levels which are very low

Drawbacks

- Difficulties to clearly define the materials considered to be radioactive as opposed to those be conventional
- The "zoning approach" is hard to apply in "classical" industries
- For decommissioning, the existence of clearance thresholds offers an indisputable and scientific way of proving a radioactive or conventional nature

EC:”The pure zoning policy lacks transparency as to its second line of defence through measurement (the lower limit of detection has the function of a clearance level)…The disposal of materials from dismantling in a VLLW repository is generally not considered the right option; the repository in Soulaines (F) is rapidly filling up. In Member States who have no such repository the dismantling industry tends to make the maximum use of the potential of clearance.”

J. Avérous (2004): Clearance versus VLLW Disposal Strategy

Clearance Strategy:

- Cost is proportional to volume.
- Segregation is labour-intensive.
- Management after clearance is easy, low transportation and disposal costs.

VLLW Disposal Strategy

- Initial investment cost is high, but decrease rapidly with the total amount of waste, as fixed costs are dominant.

J. Avérous (2004): Clearance versus VLLW Disposal Strategy

Country with large decommissioning program

(VLLW 0,1 Mtonne to 1 Mtonne):

- If VLLW disposal site is possible, it is economically preferable not to rely on clearance.
- If a surface ILW disposal is available, it is an option to use this also for VLLW disposal, but availability for the ILW disposal is a more important issue.
- If no surface disposal facility can be created (e.g. D, A, CH), clearance is obviously by far the preferable option from the economics point of view.

J. Avérous (2004): Clearance versus VLLW Disposal Strategy

Country with small nuclear program:

- If a surface disposal facility already exists, it is probably the best solution at a marginal cost.
- If no surface disposal exists, clearance is economically the best option.

Removal of Materials, Buildings, and Areas

de minimis concept **IAEA Safety Series No. 89, 1988:**

- Dose much smaller than any upper bound set by competent authorities
- De minimis non curat lex: Law does not take care about trivial things:

  The de minimis dose should not be of any regulatory concern.

Today: 20% of the pages of the German RPO are clearance regulations!
But what is the dose level of „no regulatory concern“?

Comparison of Removal and Clearance at NPP Stade

11/2003 shut down

9/2005 License

4/2006 Start Clearance

Year	Removal [Mg]	Clearance [Mg]
2004	3962	-
2005	3601	-
2006	1063	95
2007 (Jan-Apr)	-	220
Sum	8626	315

Dismantling of the turbine hall and neighbouring systems

What is Removal?

Scope of Application
Contamination Control, Clearance, Removal

- Material not belonging to the scope of the license

  ⇒**Contamination Control**

- Material belonging to the scope of the license, possibly activated or contaminated

  ⇒**Clearance**

- Material belonging to the scope of the license, not activated and not contaminated (outside of the controlled area)

  ⇒**Removal**

Cut-off Criterion (1)

Annex IV RPO: Radionuclides with contribution < 10% to radiation exposure can be neglected

Nuclide	Nuclide-vector NV Bq/g	Clearence - value CV Bq/g	NV/CV	NV/CV ∑(NV/CV)
Co-60	0,05	0.1	0.5	82.71%
Cs-137	0,05	0.5	0.1	16.54%
Fe-55	0,9	200	0.0045	0.75%
∑	1	--	0.6045	100%

In this case Fe-55 can be neglected

Cut-off Criterion (2)

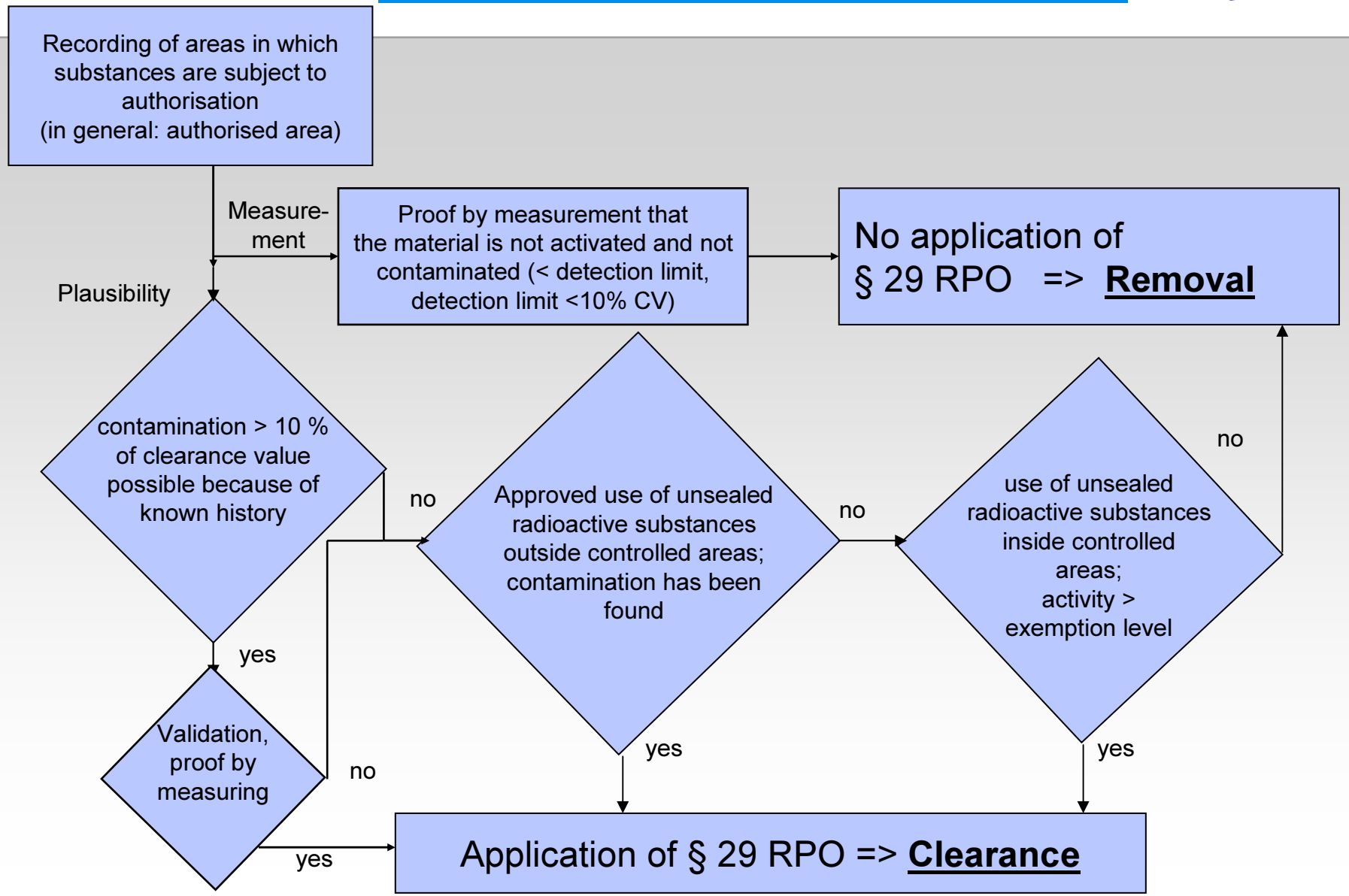
Annex IV RPO: Radionuclides < 10% contribution to radiation exposure can be neglected

Nuclide	Clearence value CV Bq/g	Cut-off 10% Bq/g	Clearance value CV Bq/cm²	Cut-off 10% Bq/cm²
Co-60	0.1	0.01	1	0.1
Cs-137	0.5	0.05	1	0.1
Fe-55	200	20	100	10
Sr-90	2	0.2	1	0.1

In these cases the activity can be neglected.

=> The material is not activated and not contaminated!

Flowchart for Distinction between Removal and Clearance



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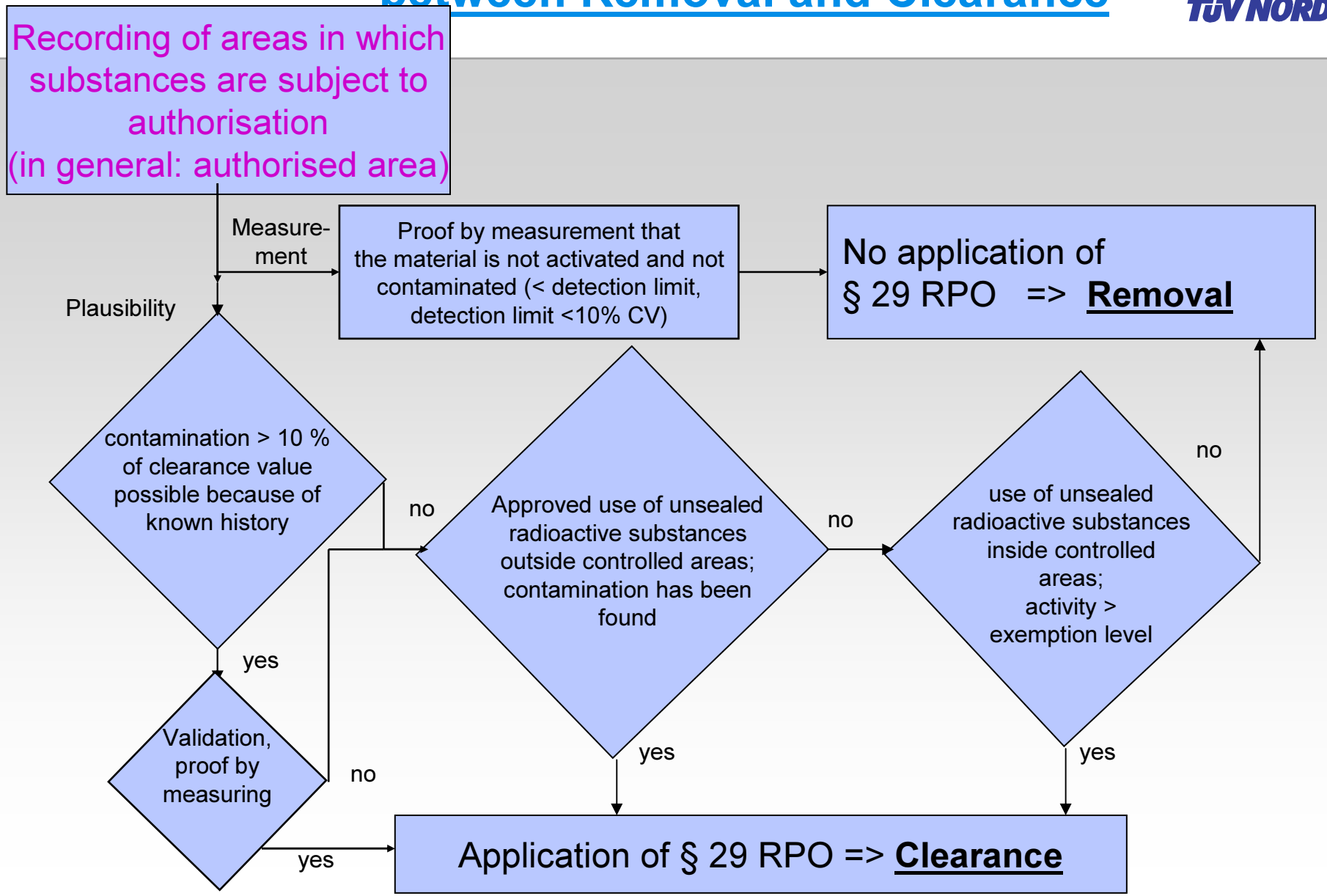

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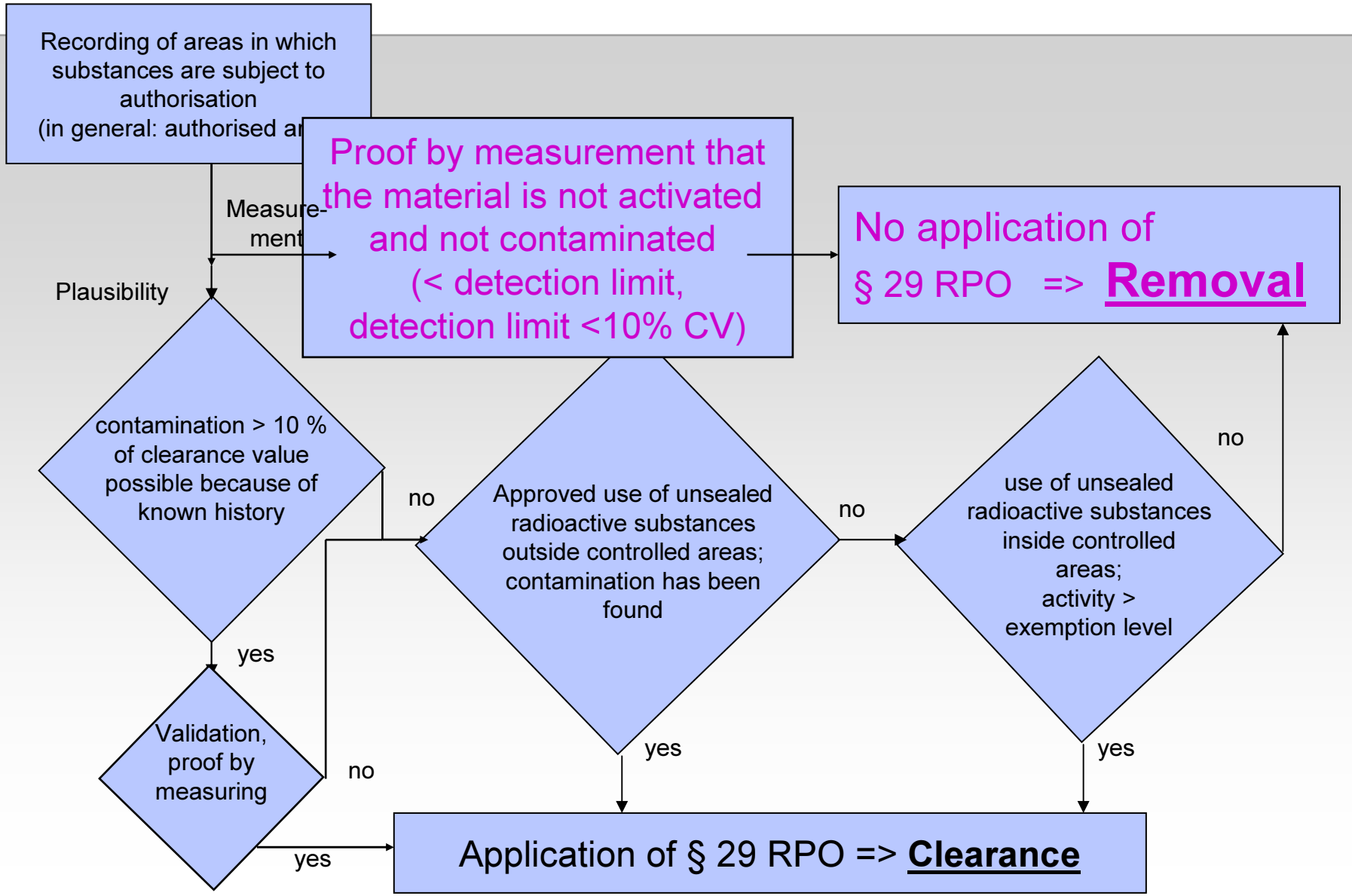

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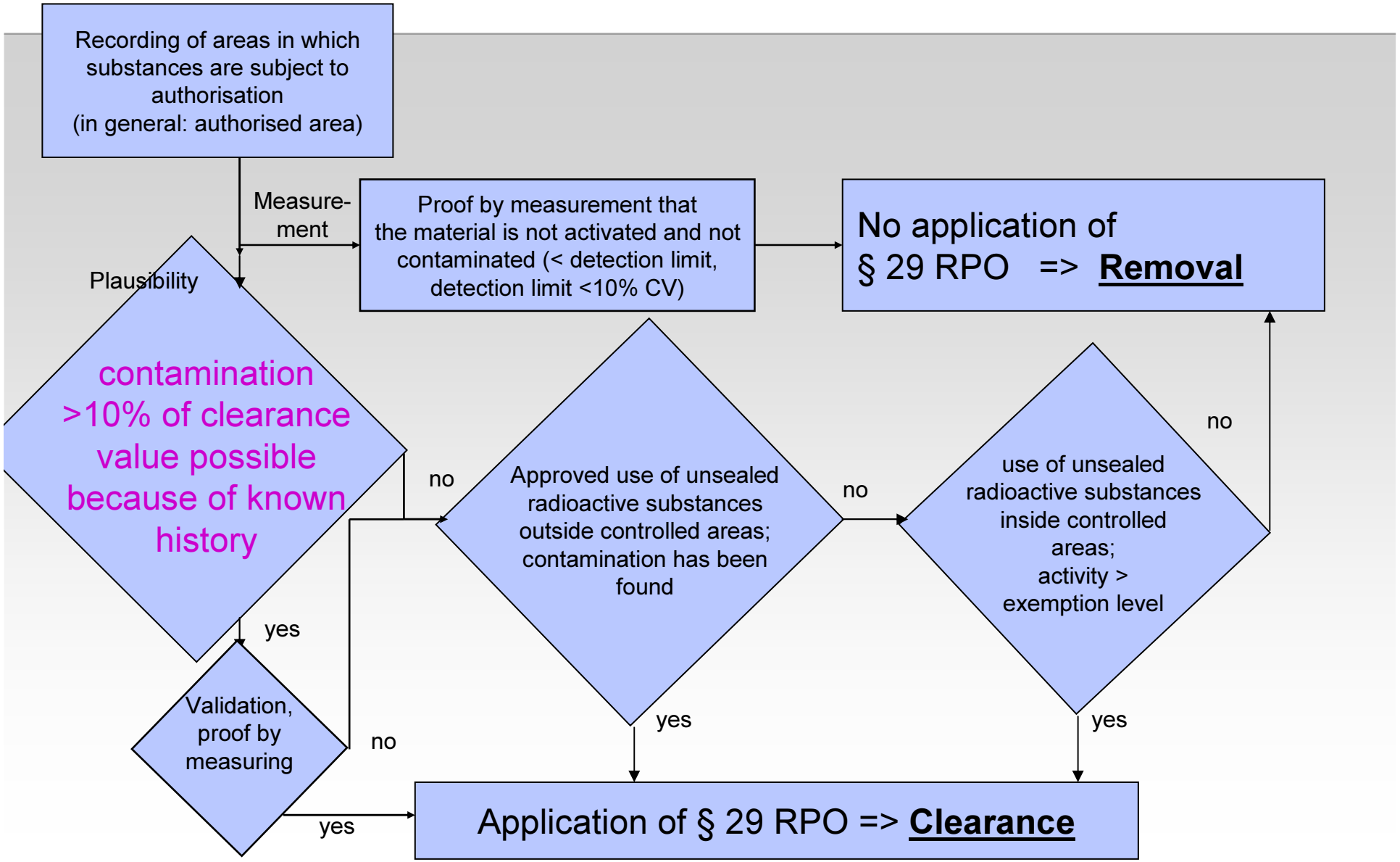

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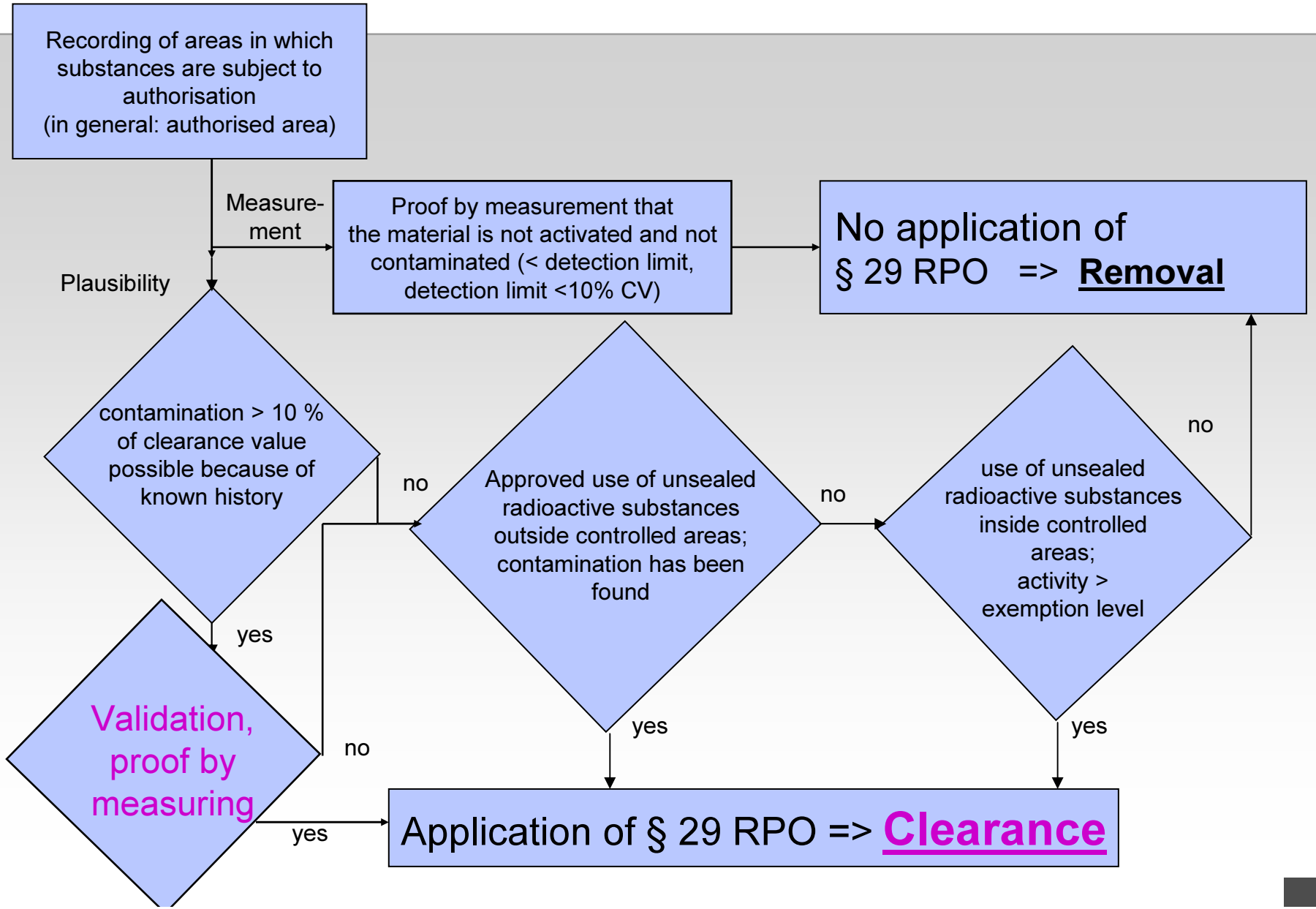

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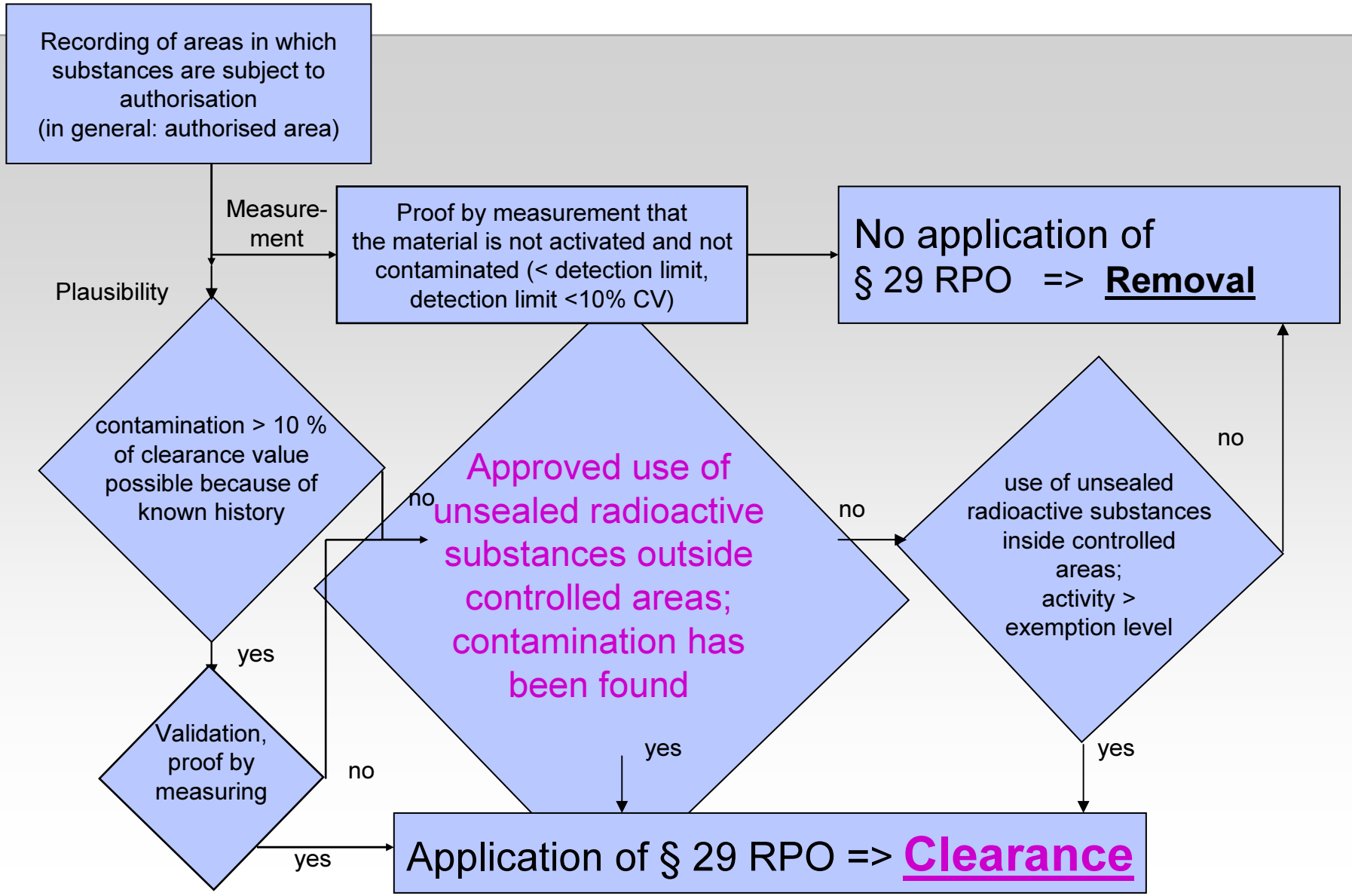

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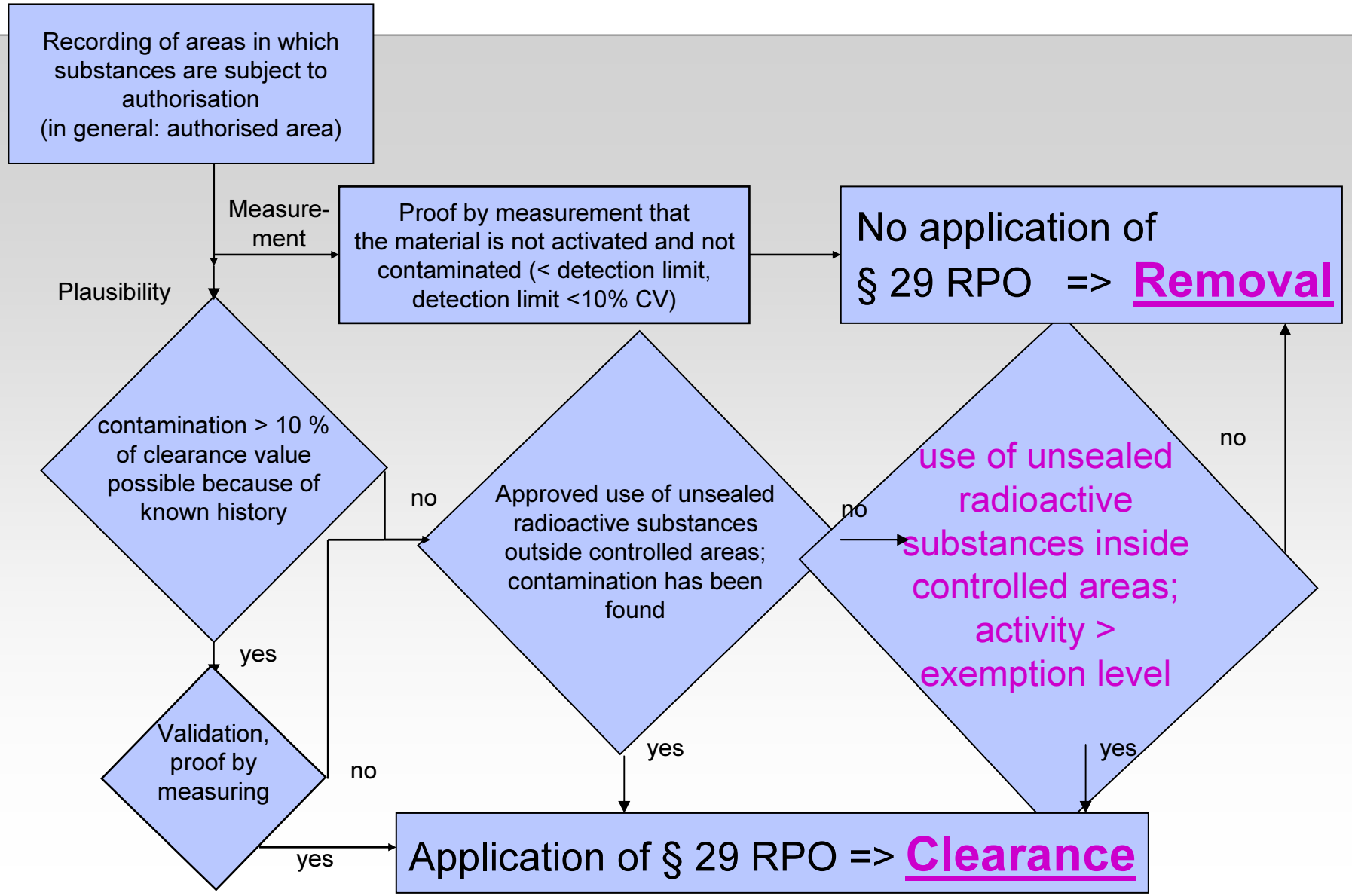

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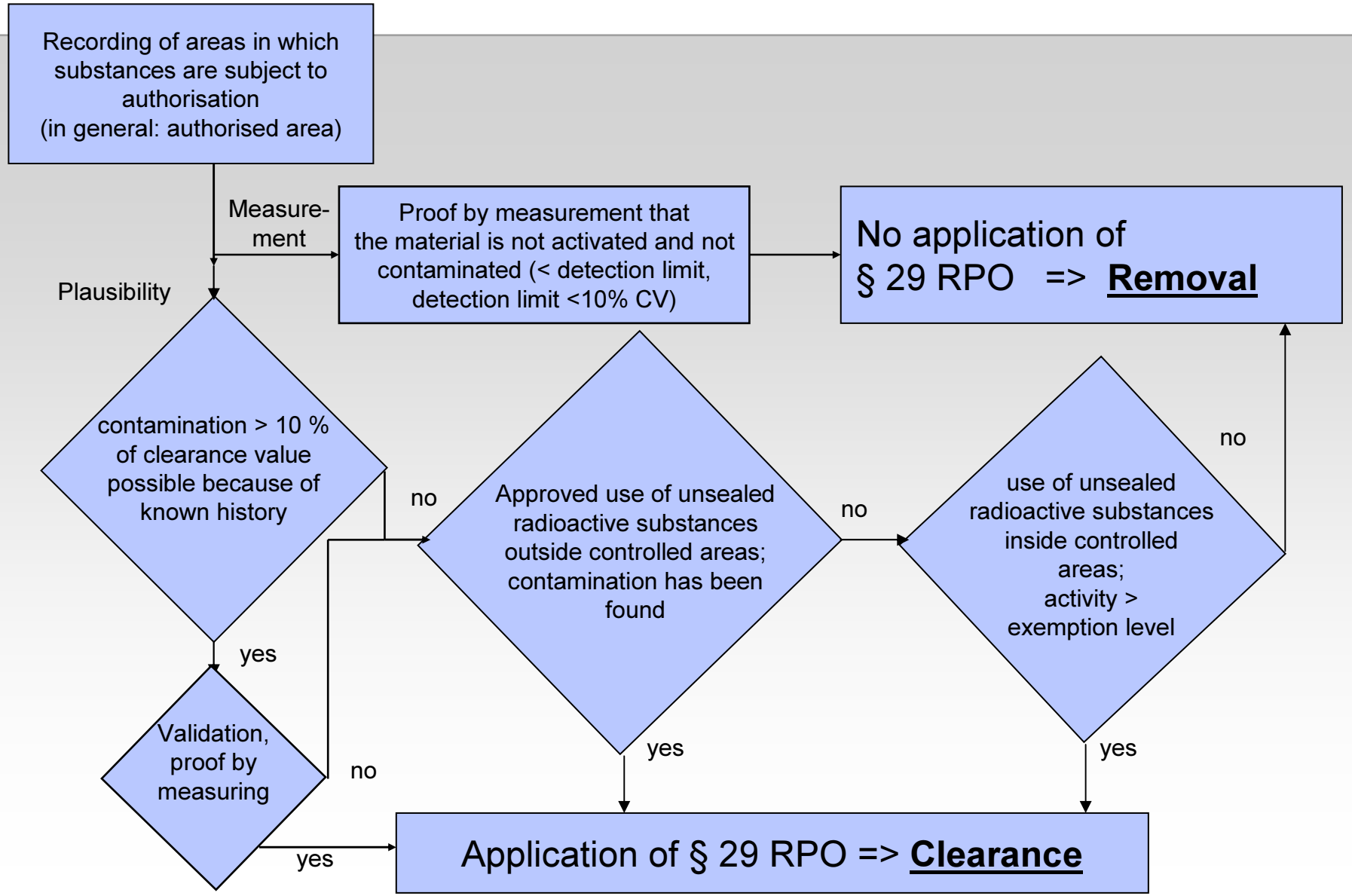


Scope of Application
Contamination Control, Clearance, Removal

- Material not belonging to the scope of the license

  ⇒**Contamination Control**

  ⇒**no approval by the authority**

- Material belonging to the scope of the license, activated or contaminated

  ⇒**Clearance**

  ⇒**approval by the authority necessary**

- Material belonging to the scope of the license, not activated and not contaminated (outside of the controlled area)

  ⇒**Removal**

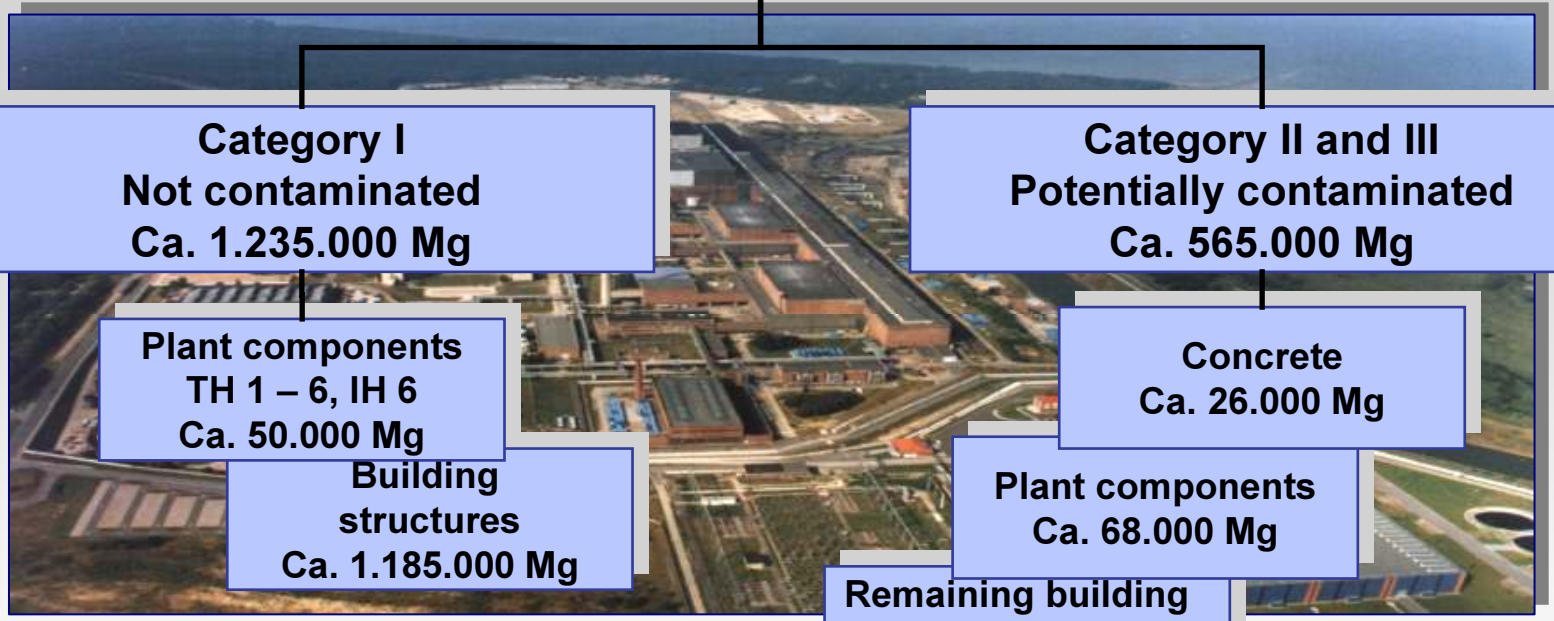
  ⇒**no approval by the authority**

Removal Procedure for Dismantling of a Component

1. Assessment of the process technique:
   - The component is not part of the controlled area,
   - has no contact with radioactive media,
   - has no contamination.
2. Assessment of the operational history
   - There was no leakage of radioactive pipes in the same room,
   - no cross contamination,
   - a concentration of small amounts of radioactivity is not possible.
3. Additional measurements by
   - direct measurement of β/γ-emitters or
   - in-situ gammaspectrometry or
   - nuclide specific measurement of scratch samples
   - at places with high probability for contamination
   - and detection limit < cut off criterion.

This concept is close to the French Zoning Concept!

Application of Removal



Removal 2/3

Clearance 1/3

Clearance of Materials - Future Developments

Exemption and Clearance – Two different procedures?

IAEA Safety Guide RS-G-1.7
Application of the Concepts of Exclusion, Exemption and Clearance

- Only one system of limits for clearance, exemption and exclusion on the basis of the de minimis concept,

- but not for foodstuffs, drinking water and any material intended for use in food or animal feed, radon, potassium-40.

IAEA Safety Guide RS-G-1.7
Application of the Concepts of Exclusion, Exemption and Clearance

- Advantages:
  - an easier understanding and therefore a better acceptance by the users,
  - easier to control,
  - a good basis for an international harmonisation. Int. BSS=>Eur. BSS=>Nat. Rad.Prot.Ord.

Where to go? Outlook towards new international regulations Revision of the International Basic Safety Standards for Radiation Protection by IAEA

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TABLE I-2. LEVELS FOR CLEARANCE AND FOR EXEMPTION OF BULK AMOUNTS OF MATERIAL WITHOUT FURTHER CONSIDERATION: ACTIVITY CONCENTRATIONS OF RADIONUCLIDES OF ARTIFICIAL ORIGIN *(see footnote42)*

Radionuclide	Activity concentration (Bq/g)	Radionuclide	Activity concentration (Bq/g)	Radionuclide	Activity concentration (Bq/g)
H-3	100	Co-58m	10 000	Zr-95[a]	1
Be-7	10	Co-60	0.1	Zr-97[a]	10
C-14	1	Co-60m	1000	Nb-93m	10
F-18	10	Co-61	100	Nb-94	0.1
Na-22	0.1	Co-62m	10	Nb-95	1

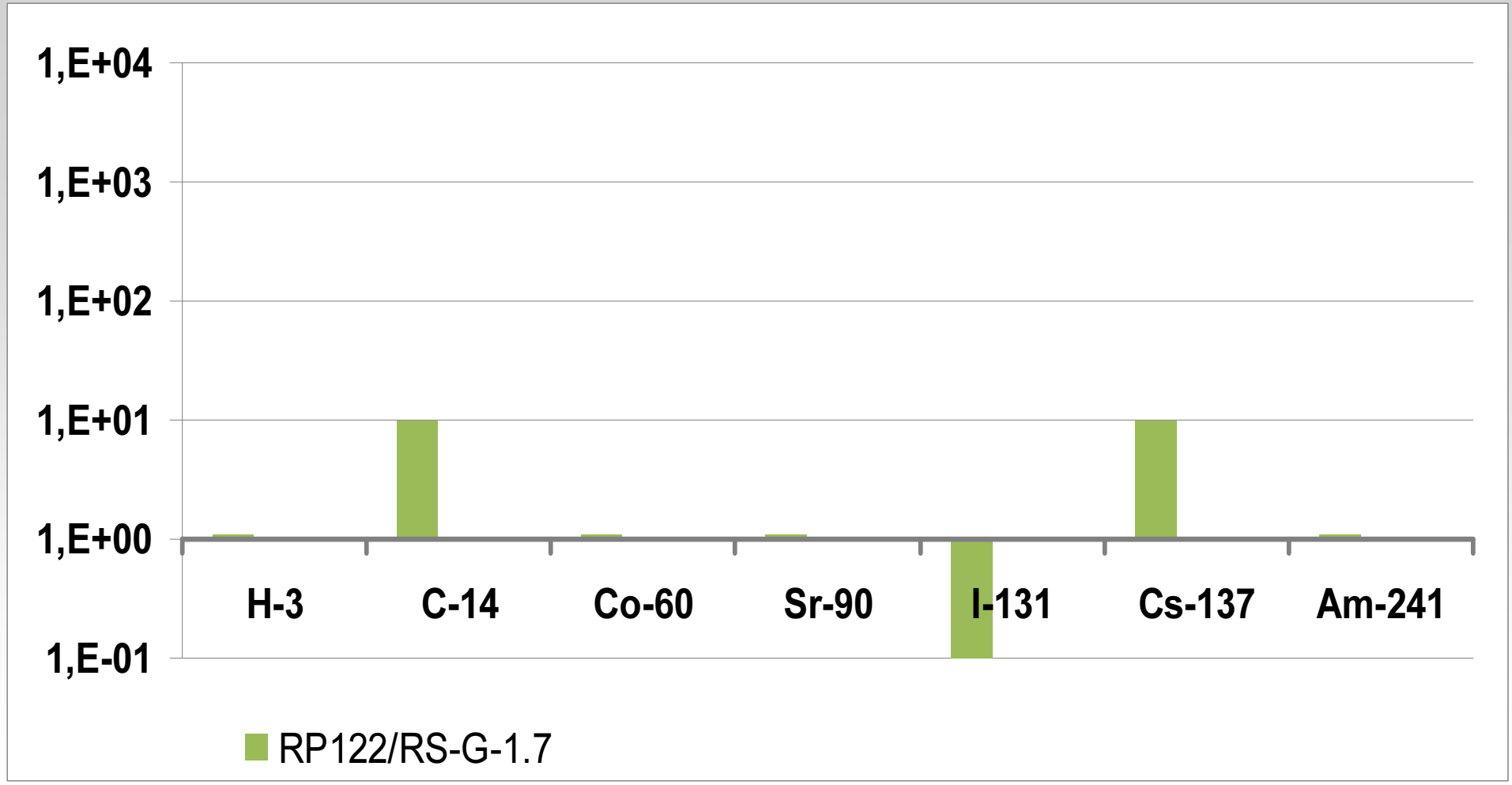
EC wants to have only one set of exemption values for the specific activity (table I-2).

Disadvantages (only from the view of clearance):

- For most of the nuclides the IAEA values are corresponding with the European values of the unrestricted clearance acc. RP 122.
  This may lead to a prohibition of clearance pathways (for disposal etc.) with higher values.

- For some nuclides the IAEA values are evident higher or lower than the German values for unrestricted release.

Comparison of European Clearance values with IAEA RS-G-1.7 values



general clearance

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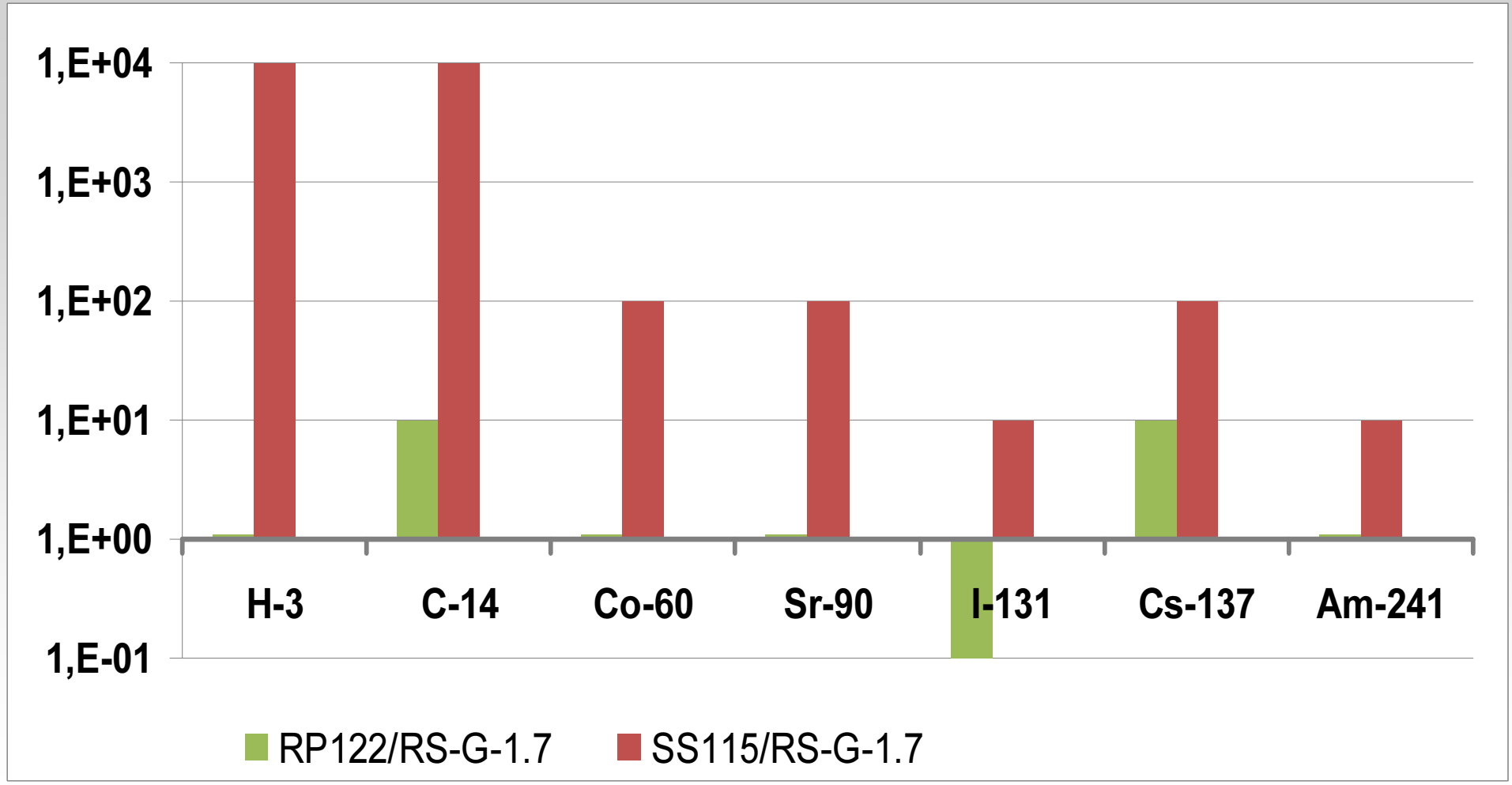

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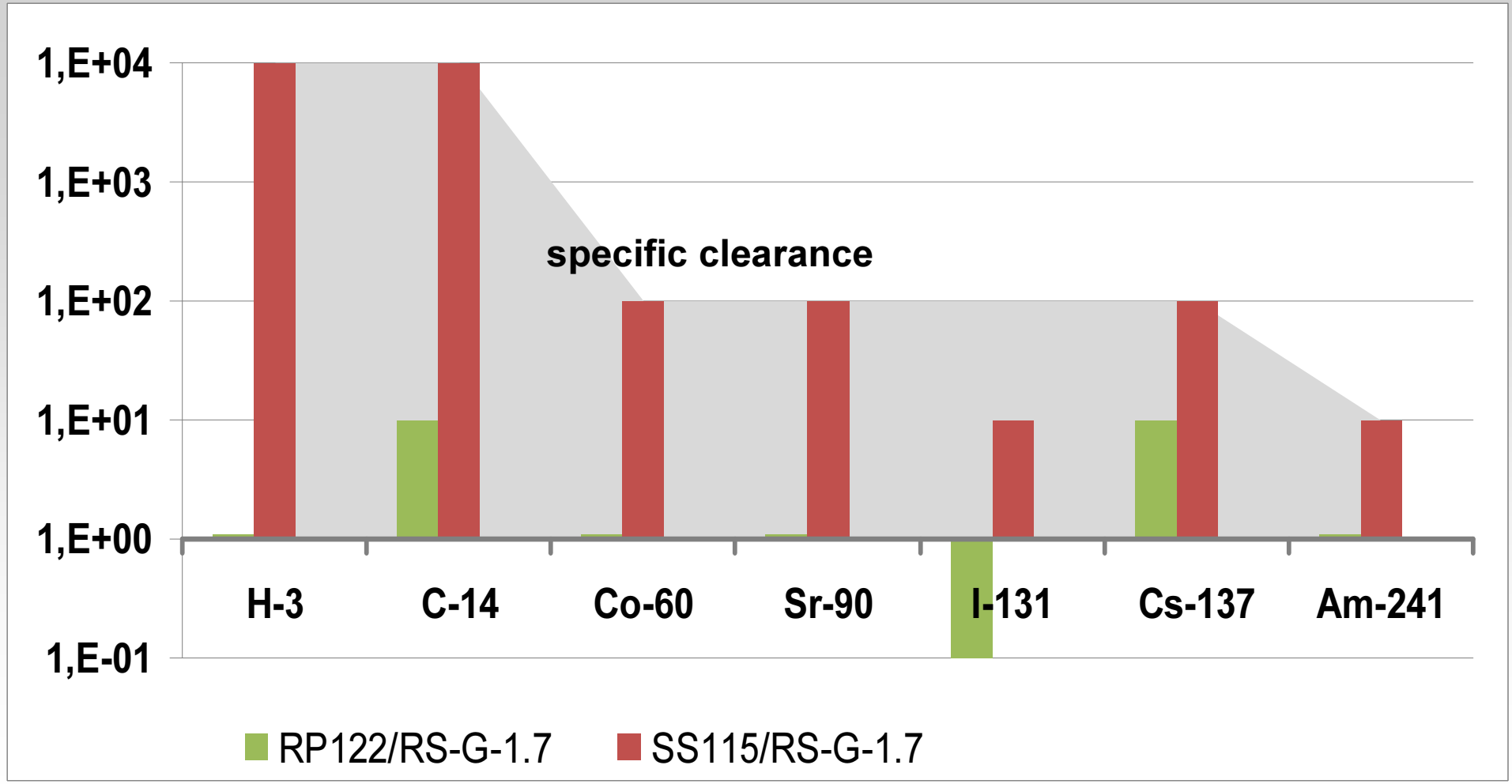
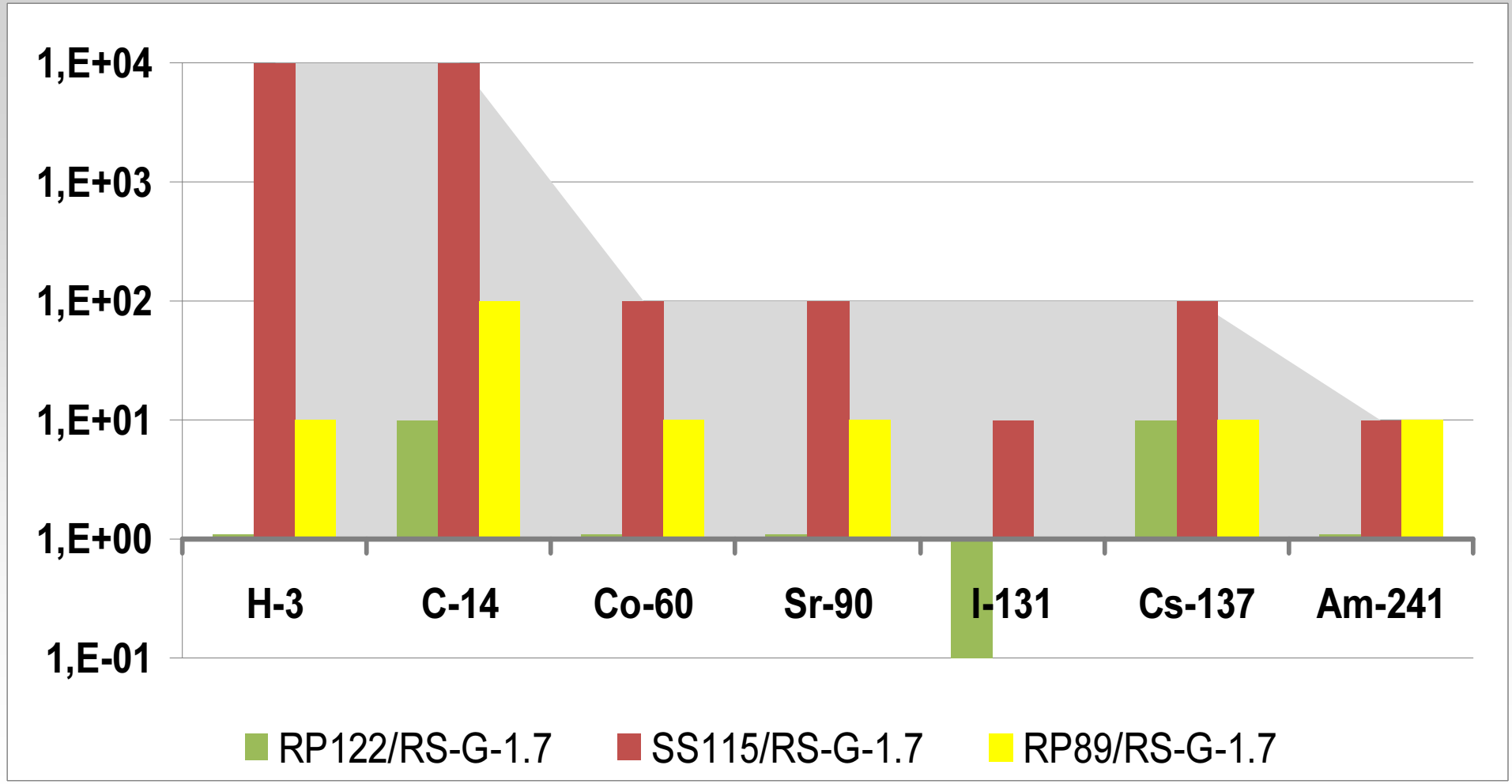


Comparison of European Clearance values with IAEA RS-G-1.7 values

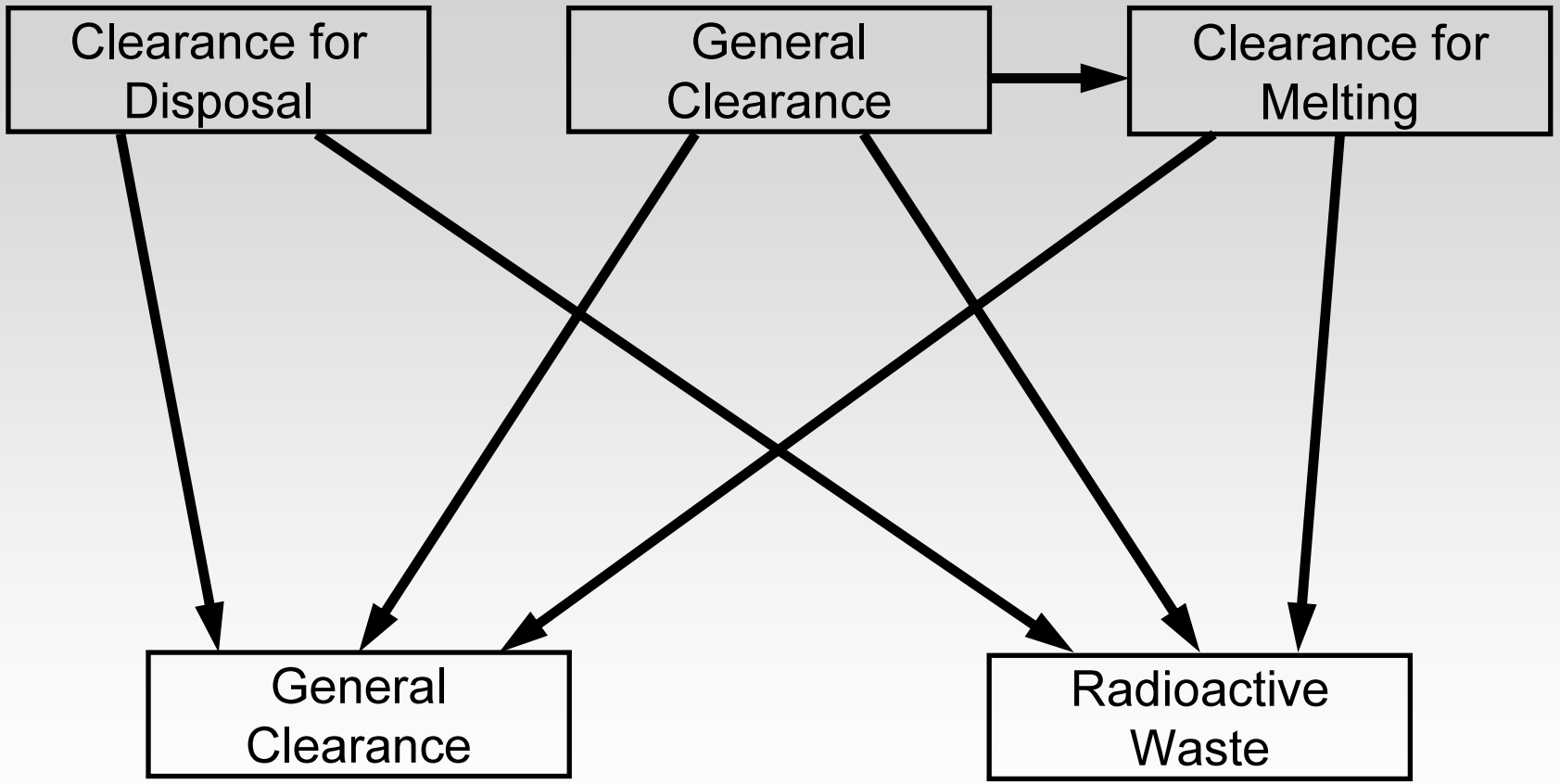


recycling of metal scrap

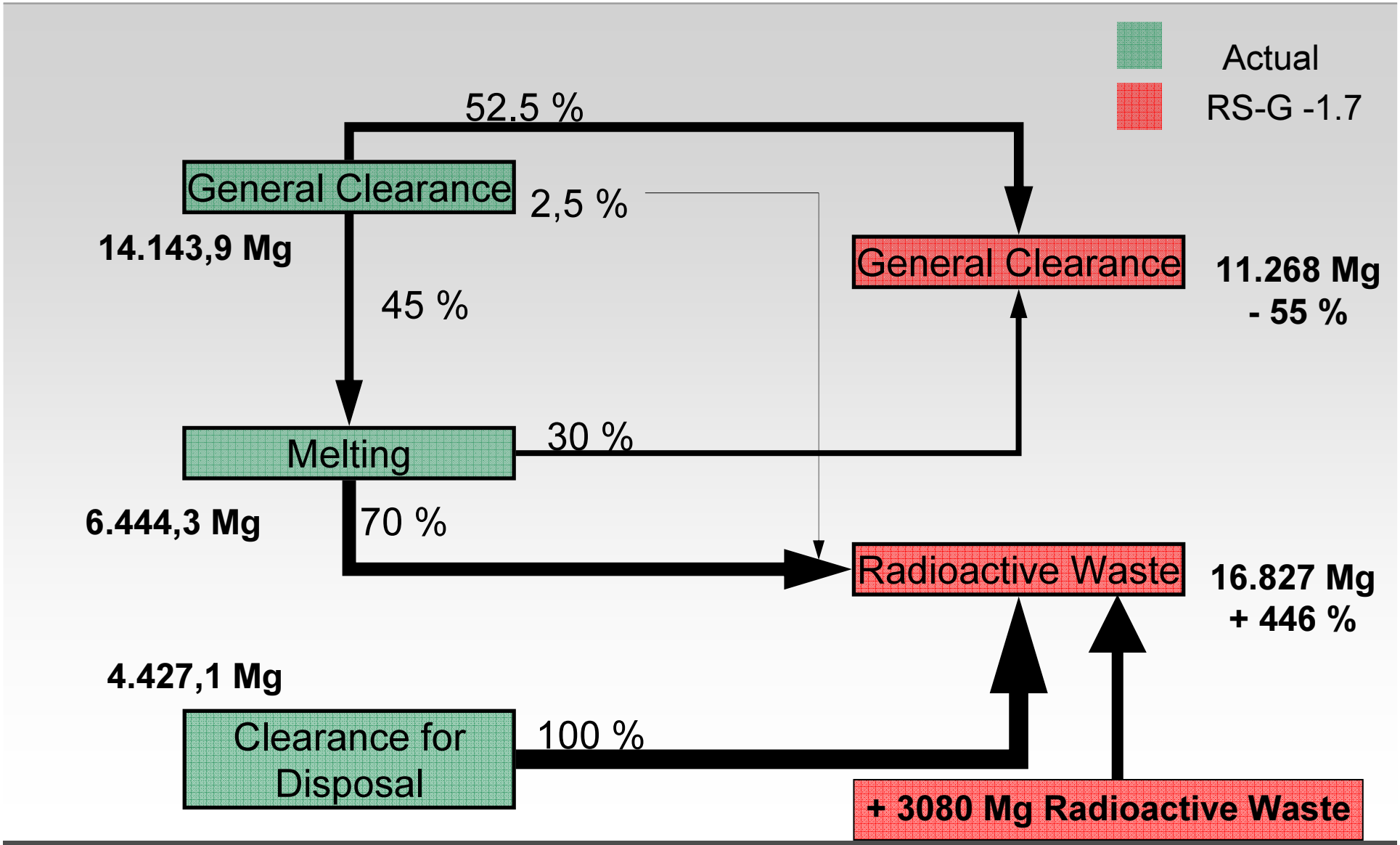
Mass balance for decommissioning projects

plant	Mass/Mg	General clearance	Recycling, reuse	Disposal, demolition	Radioactive waste
KKS actual total mass	11.734 Mg 100% 101.353 Mg	3.763 Mg 32%	2.852 Mg 24,3%	2.830 Mg 24,1%	2.289 Mg 19,6%
KWW actual	25.867 Mg	15.230 Mg 58,9%	5.250 Mg 20,3%	1.840 Mg 7,1%	3.547 Mg 13,7%
EWN total actual	565.000 Mg 172.647 Mg	27.770 Mg 16%	13.472 Mg 8%	126.273 Mg 73%	5.131 Mg 3%

Approach – Option I without decay storage (by EON)



Results for NPP KWW in Germany (without decay storage)



Waste Volume and Costs (without decay storage)

- **Volume**
- Increase of waste for E.ON NPP (without decay storage):
- **approx. 75.000 Mg**

⇒for all NPP in Germany (without research reactors):

⇒ **approx. 210.000 Mg or 180.000 m³**

⇒**Costs**

⇒For conditioning approx. 6.000 €/Mg => approx. 1,26 Bill. €

⇒repository approx. 12.000 €/m³ => approx. 2,16 Bill. €

⇒new interim storage capacities on site (10 Mio € per site)
=> approx. 0,15 Bill. €

⇒additional costs for transport and casks (approx. 18.000 container, approx. 25.000 €/Cont.) => approx. 0,45 Bill. €

⇒**Sum approx. 4 Bill. €**

⇒**Costs for research reactors and industrial plants ?**

TÜV NORD

Where to go? Outlook towards new international regulations

IAEA: “In the revisions of the BSS of IAEA and EC consideration should be given to further simplification by having only a single table of values (RS-G-1.7) instead of two tables (for exemption and for clearance). This proposal is to be considered by the groups responsible for the revision of the EC BSS. If such a change were to be made it is important, for the sake of maintaining international uniformity, for it also to be made in the IAEA BSS. The advantages and disadvantages of this approach were discussed during this conference.”

EC: ”There is no consensus on abandoning the old exemption values. Many countries have built a regulatory system, for instance the classification of sources, on the basis of these exemption values; I explained that Member States could keep this system if it complied with the general exemption criteria as part of the graded approach. Unfortunately, this commitment does not yet provide sufficient reassurance”.

Release of Sites

Release of Sites

EC Member States

- Buildings (RP 122)
- Land area (German RPO)

accord. de minimis concept

IAEA:

- Buildings + land area = site

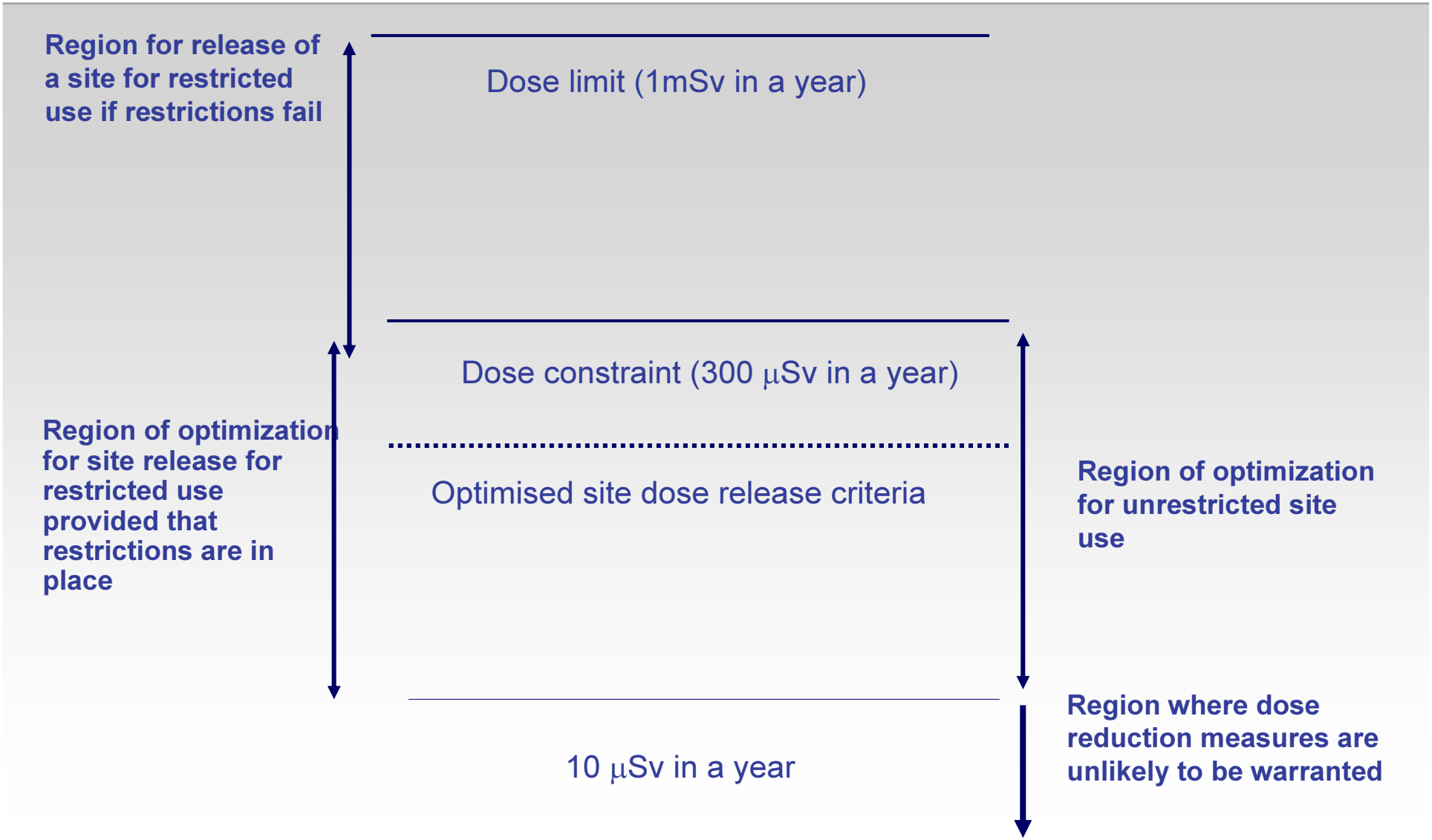
Criteria for Site Release

- Clearance of material
  - Effective dose to a member of a critical group below the order of 10 µSv in a year
  - Multiple scenarios
  - Enter trade
- Release of the site
  - Effective dose to a member of a critical group below 300 µSv in a year
  - Less scenarios
  - Constant location
- New practices on a released site

Criteria for Site Release

- Release of Site
  - End of decommissioning
  - Part of practice
  - Basic Safety Standards apply
    - Dose limit – 1mSv in a year
    - Dose constraint – 0.3 mSv in a year
    - Optimization below the order of 10 μSv in a year may not be warranted
  - Unrestricted use
    - Below 0.3 mSv in a year
  - Restricted use
    - Below 0.3 mSv in a year with restrictions
    - Less than 1 mSv in a year if restrictions fail

Criteria for Site Release



Restrictions for Release of Sites

Some examples for restricted use:

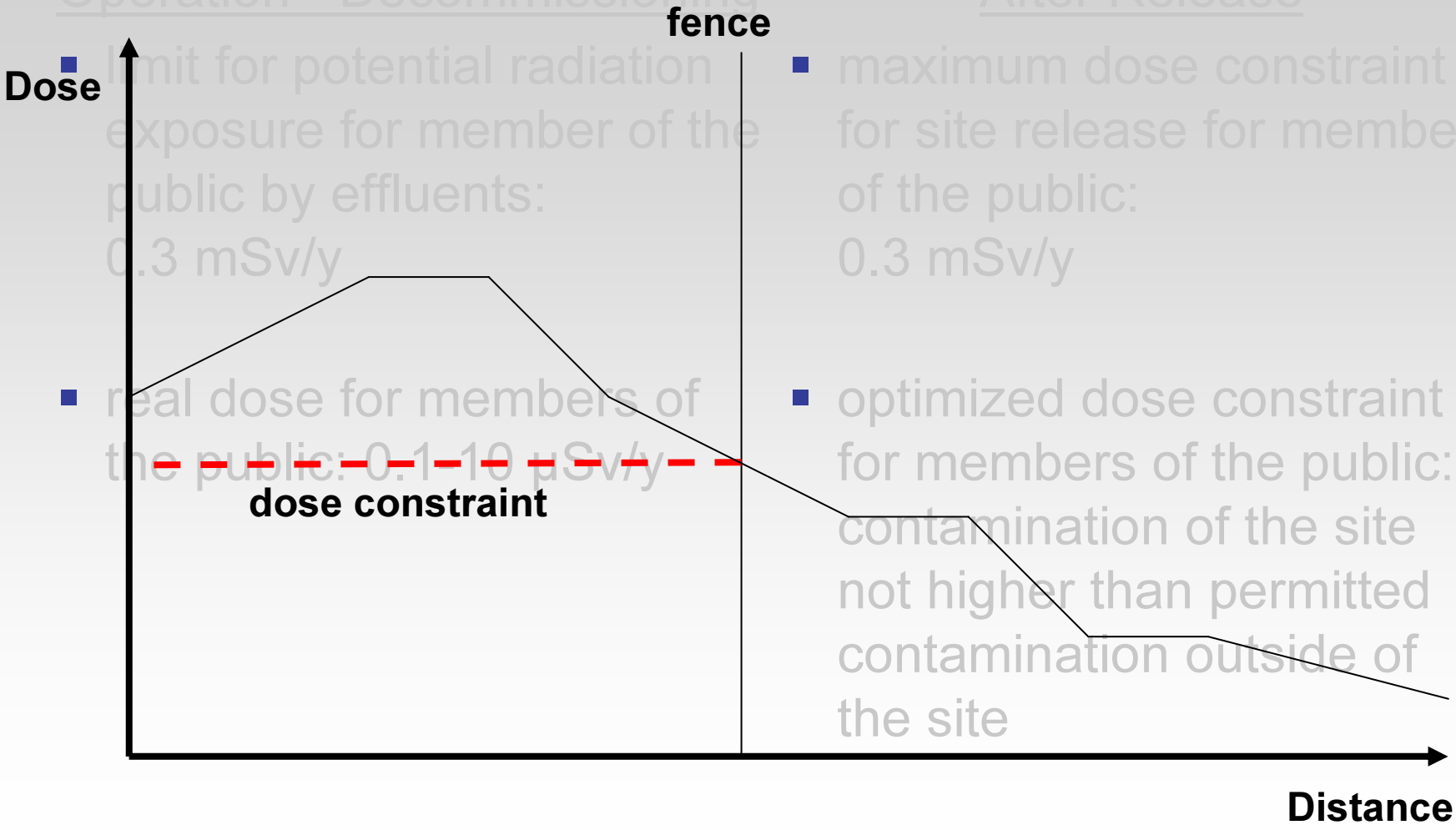
- industrial use of turbine hall
  (fabrication of ship segments at KGR)
- restricted use of the site located in nature conservation area (KKR)
- site remains in monitored area of a research center (FZJ, FZK)

Release of Sites

TÜV NORD

Operation - Decommissioning	After Release
▪ limit for potential radiation exposure for member of the public by effluents: 0.3 mSv/y	▪ maximum dose constraint for site release for member of the public: 0.3 mSv/y
▪ real dose for members of the public: 0.1-10 µSv/y	▪ optimized dose constraint for members of the public: contamination of the site not higher than permitted contamination outside of the site

Release of Sites



Operation - Decommissioning

- limit for potential radiation exposure for member of the public by effluents: 0.3 mSv/y
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After Release

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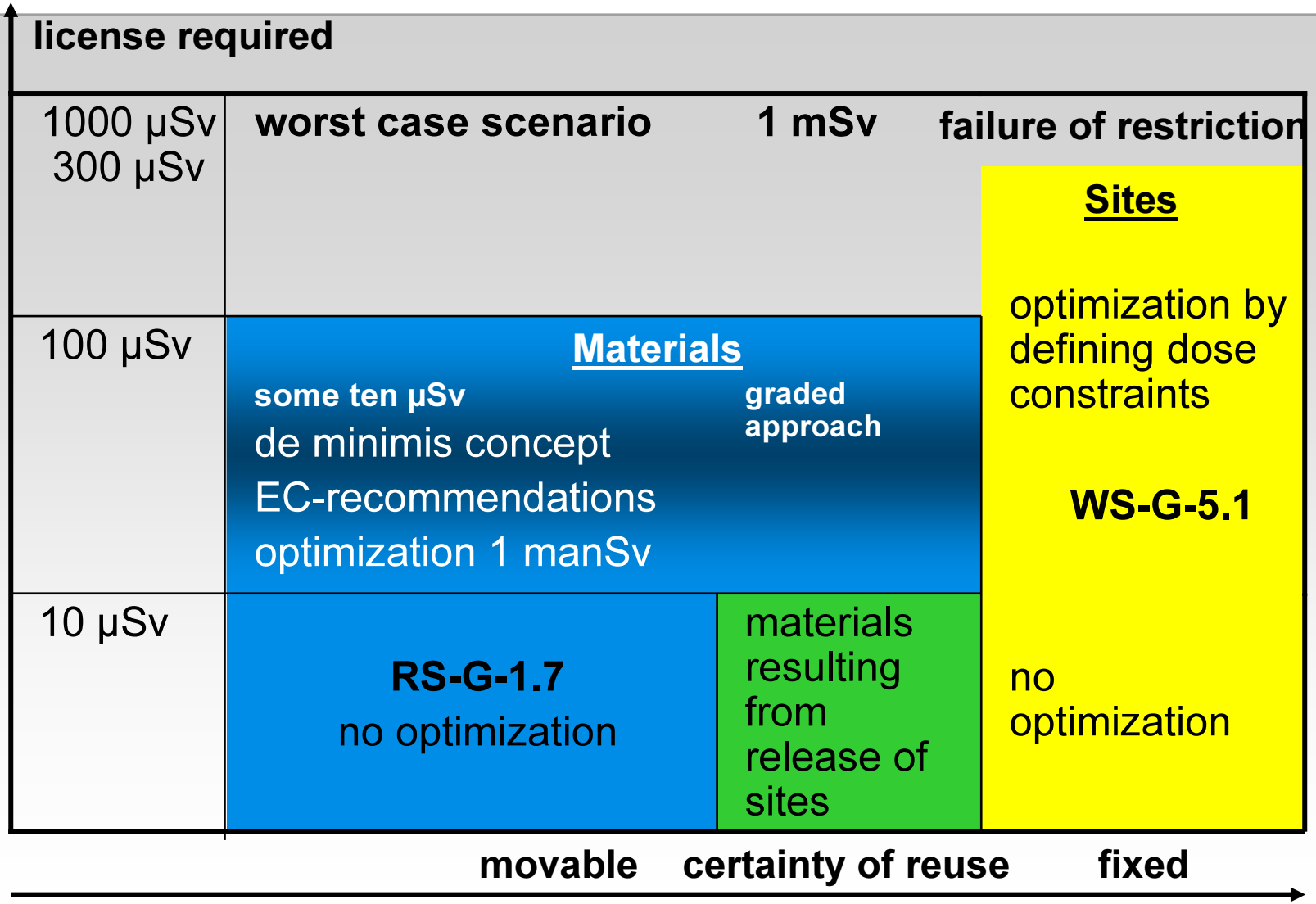
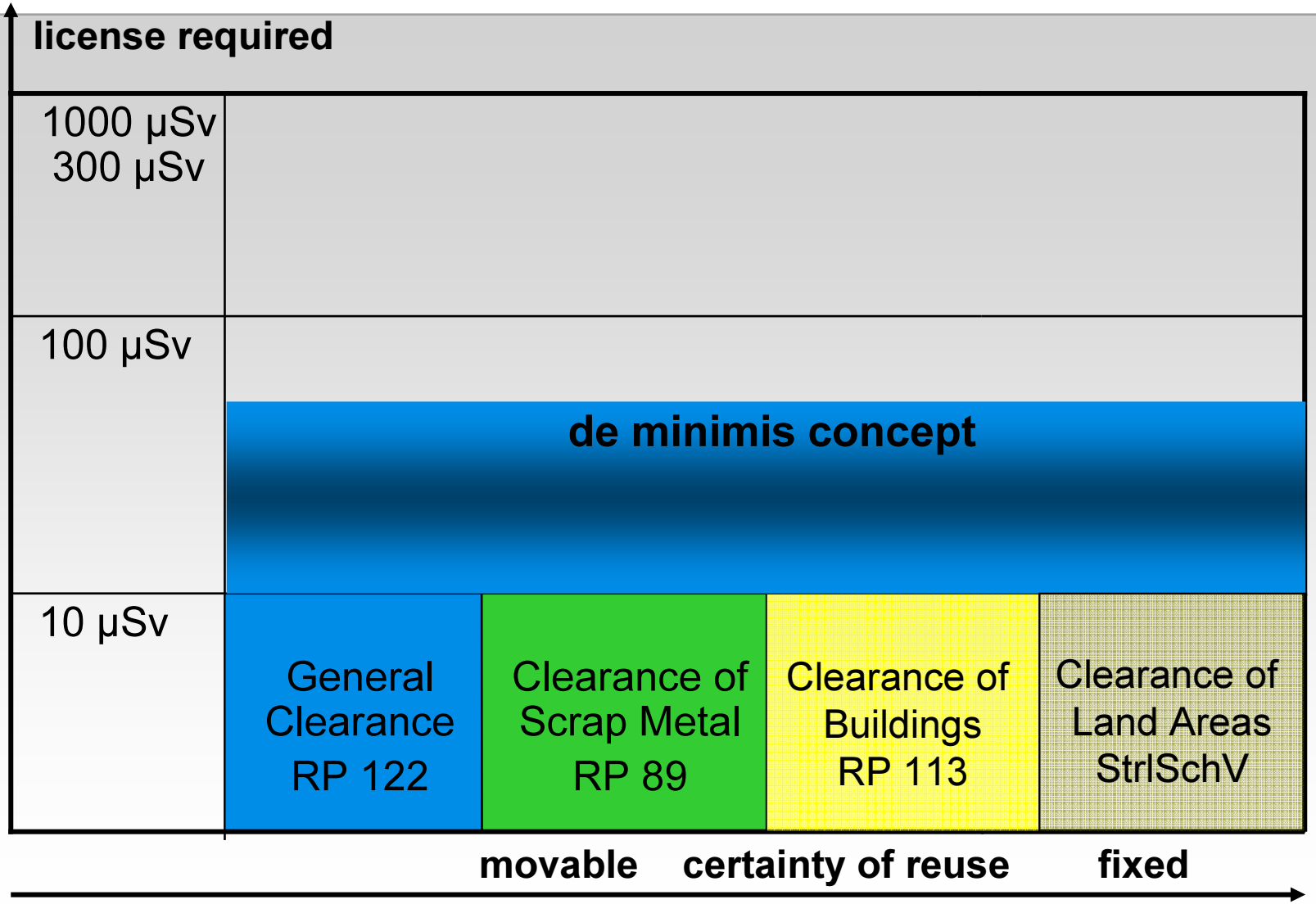
- optimized dose constraint for members of the public: contamination of the site not higher than permitted contamination outside of the site

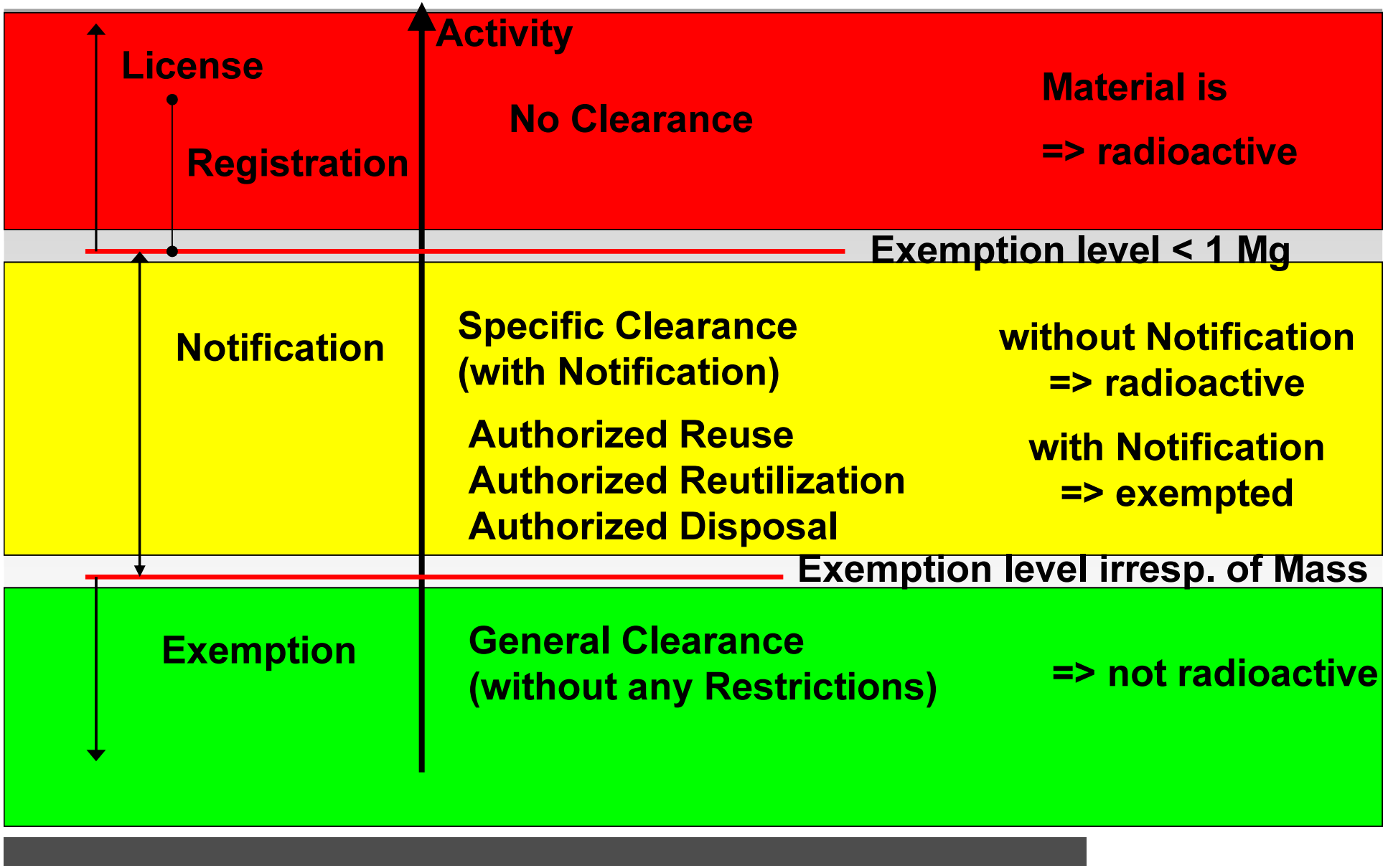
Concept of Clearance by IAEA



Concept of Clearance by EC/Germany



A Model for
Graded Approach – Clearance of Materials – Discovery



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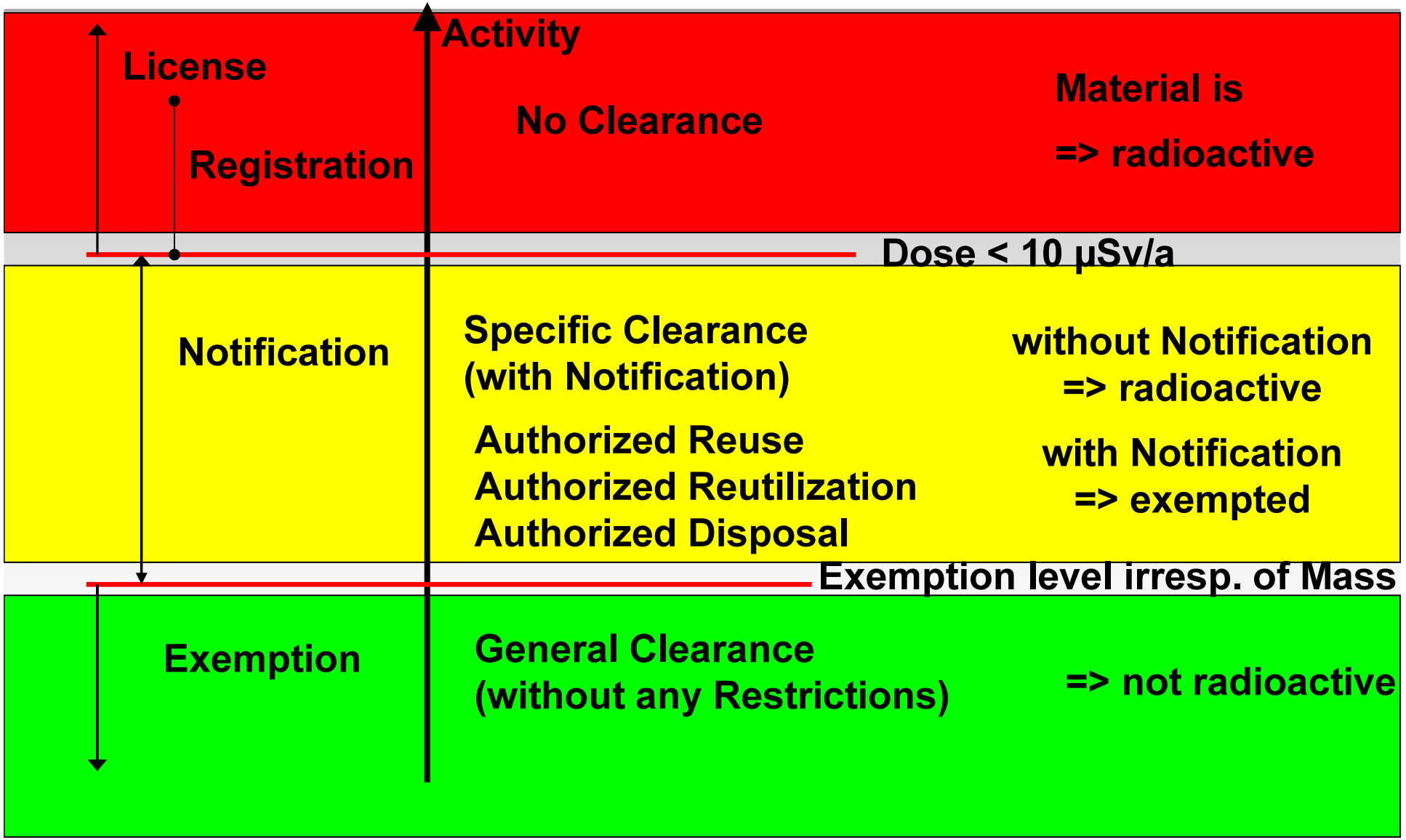
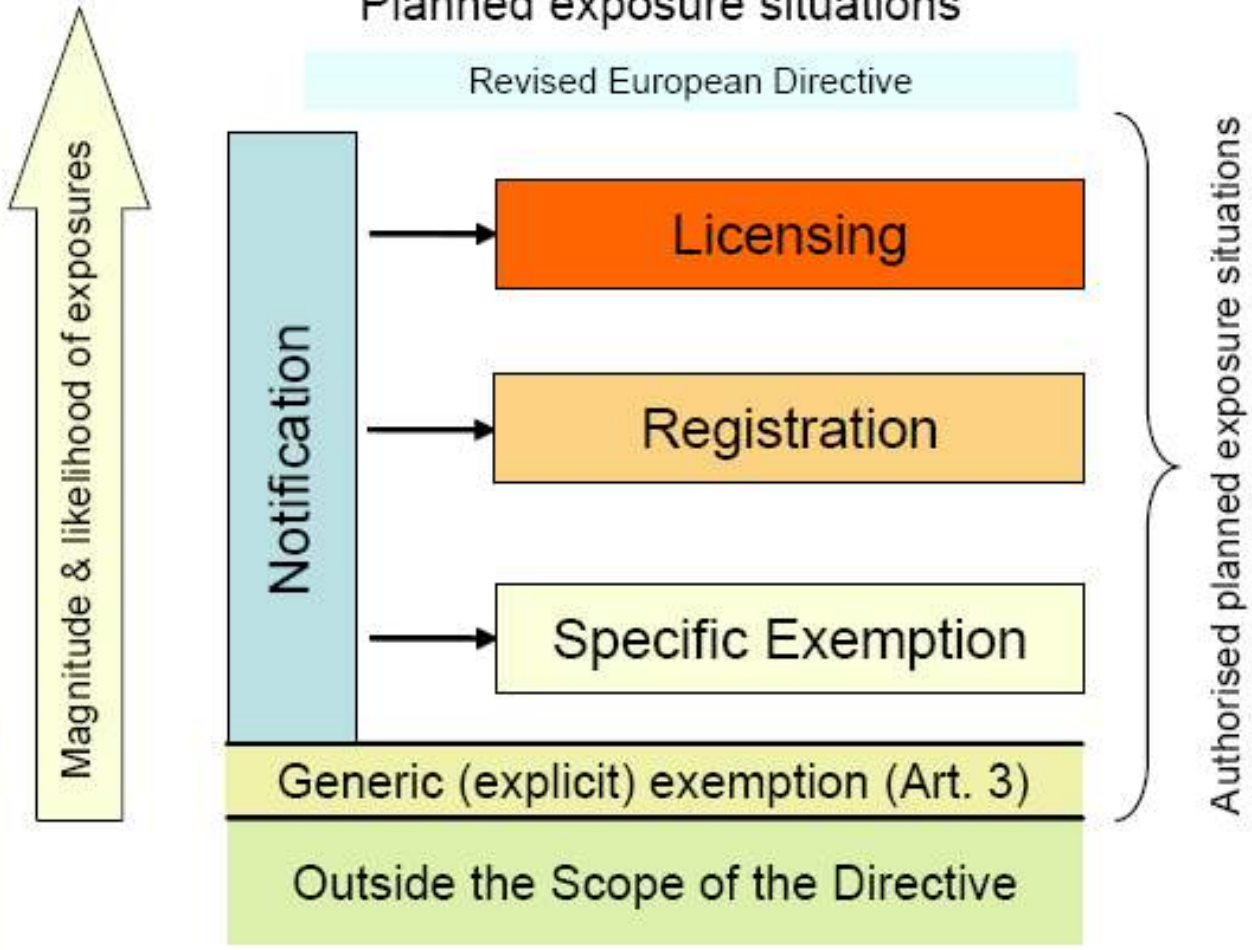


Consequences

- The exemption levels less 1 Mg or the dose of 10 µSv/a are the upper limit for clearance processes.
- Specific clearance needs a notification.
- The notification must accompany the further process of the material to avoid a later classification as radioactive material. An international transport should be avoided as boundary controls may recognize this material as radioactive.
- The notification must be terminated until the material reaches the exemption levels irresp. of mass during the authorized process (e.g. melting, incineration) or the material is disposed of properly in compliance with the de minimis concept.
- In any case the disposal and reutilization will not be easier, as the whole process gets a „bad marker“ of radioactivity by the notification.
- On the other hand the whole process is retraceable.

Regulatory Control of Planned exposure situations



Directorate-General for Energy and Transport

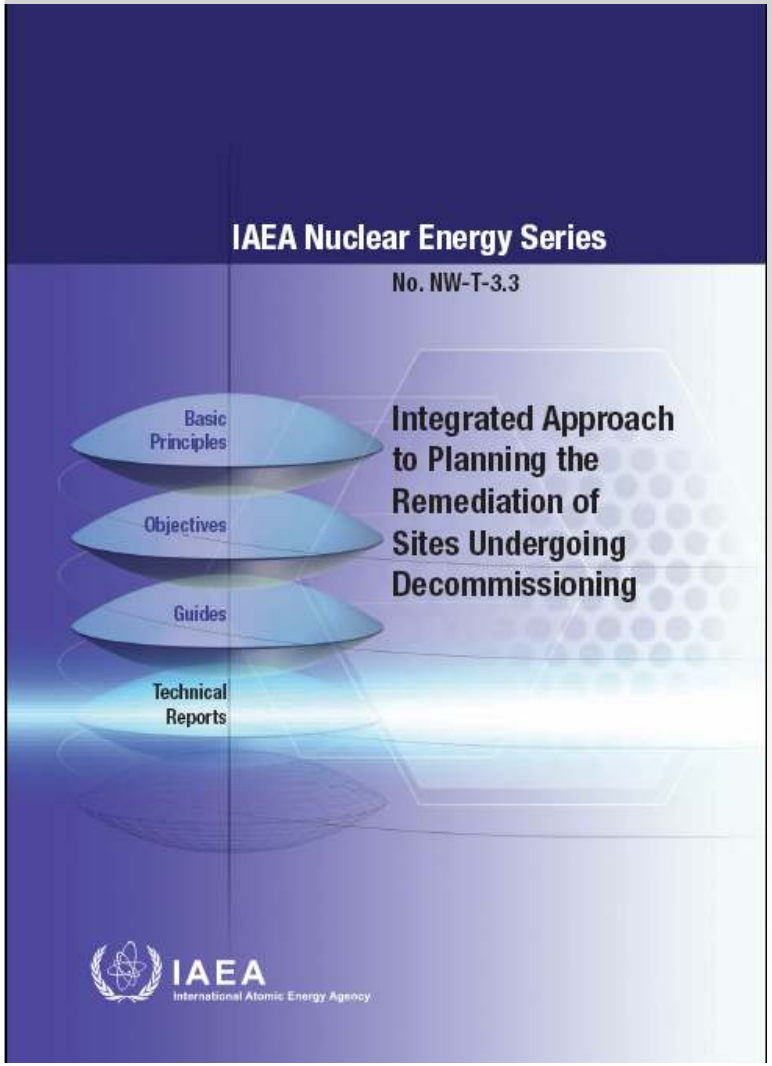
Our aims, our way

- Simplicity — simple rules are well accepted
  but it is a tool, not an aim!
- Harmonization — necessary in our global world with cross border traffic, but not necessary for every specific solution (esp. national ones)
- Appropriateness — you may have a simple and well harmonized solution, but if it is not appropriate, no one will use it.

Our aims, our way

1. RS-G-1.7 values as general clearance values are widely accepted.
2. Exemption=Clearance offers a great chance for simplification, but then the simple rule *Above exemption needs a license* is no longer true.
3. We need a clear definition of the rules for using solutions a) for specific clearance or b) above the new exemption values. That should not be written between the lines.
4. Many countries offer a national guideline for their users. This is very helpful, but brings us to the next challenge “Harmonization of procedures for compliance of international clearance values”
   => We need an international guideline!

Release of Sites/Remediation and Decommissioning of Nuclear Facilities

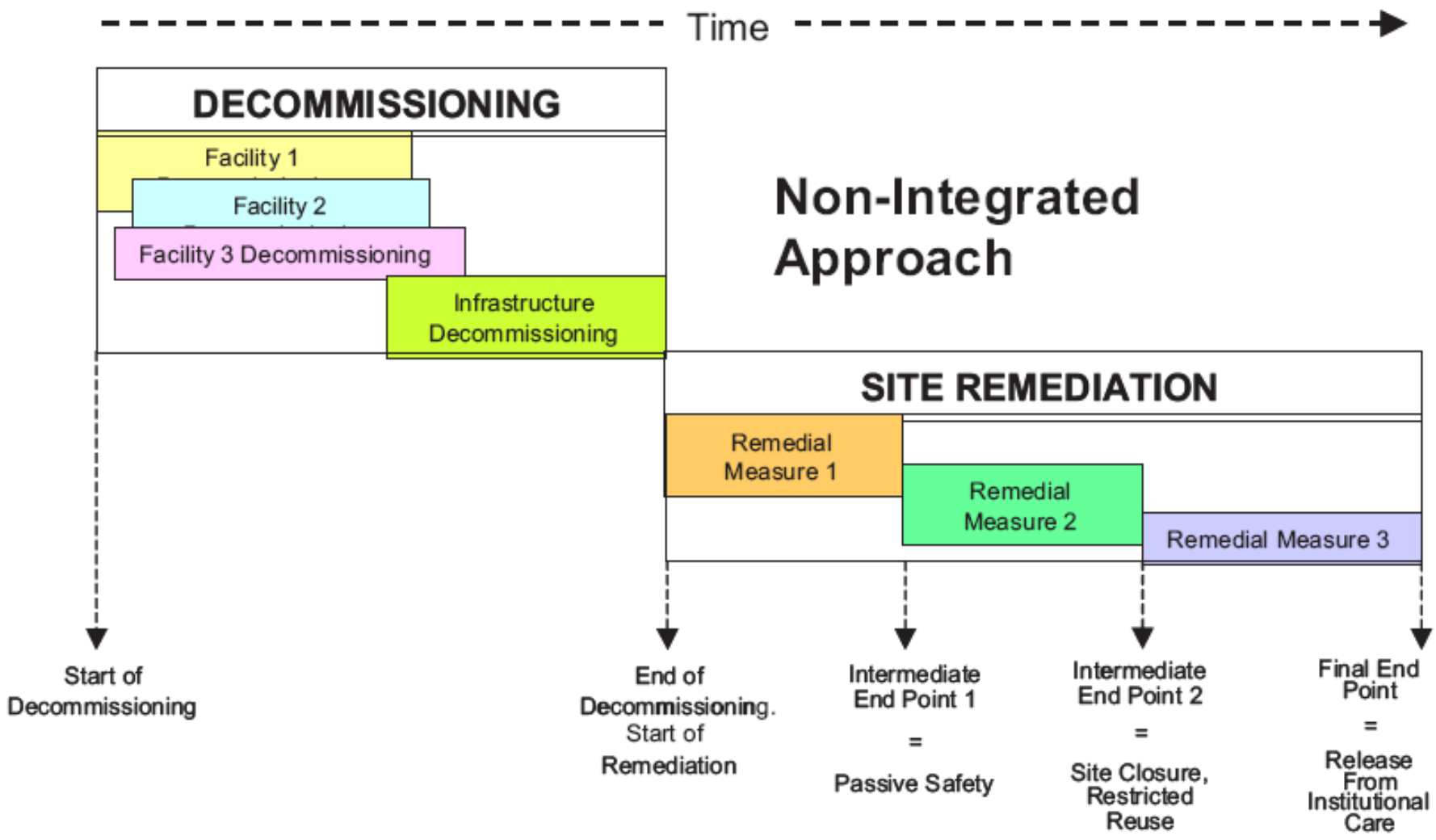


Careful identification of opportunities for synergies between remediation and decommissioning => optimized use of available resources

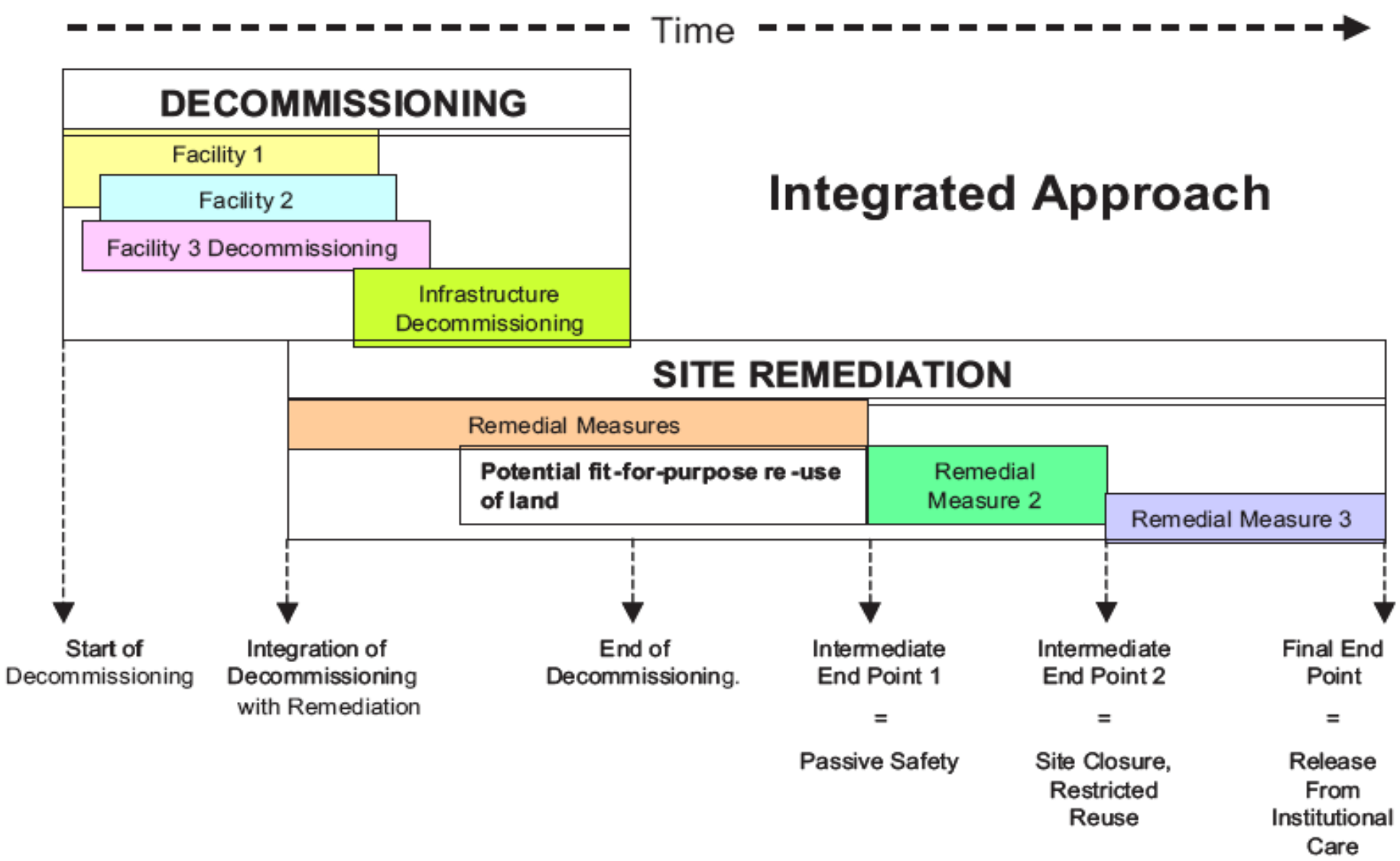
Integration of decommissioning activities with site remediation in order to realize the potential of early `fit-for-purpose´reuse of land.

Remediation and decommissioning not as independent activities => optimization of effort, cost, impacts and risk reductions

Release of Sites/Remediation and Decommissioning of Nuclear Facilities



Release of Sites/Remediation and Decommissioning of Nuclear Facilities



Advantages

- (a) Remediate surface and sub-surface contamination while the decommissioning workforce is still mobilized and project management infrastructure is in place;
- (b) Use existing site infrastructure that is required to support remedial actions (liquid and solid waste processing facilities and other ‘enabling’ facilities);
- (c) Realize potential revenues from re-using parts of the site early by remediation to a ‘fit-for-purpose’ end point at the time a particular facility is decommissioned, as opposed to waiting for all facilities to be decommissioned before the site can be re-used.

⇒Goals of decommissioning and remediation activities are aligned, no conflict with each other,

⇒costs are minimized,

⇒safety, security and environmental benefits are maximized!

Thank you for your attention and good luck for your projects!