International Conference on Control and Management of Inadvertent Radioactive Material in Scrap Metal

Spanish Nuclear Safety Council; Tarragona, Spain; 23-27 Feb. 2009

Exclusion, Exemption and Clearance in the frame of the control and management of inadvertent radioactive material in scrap metal

(Exclusión, exención y desclasificación en el marco del control y la gestión de material radiactivo inadvertidamente presente en la chatarra)

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International Conference on Control and Management of Inadvertent Radioactive Material in Scrap Metal

Tarragona, Spain
23-27 February 2009

Organized by the

CSN

In cooperation with the

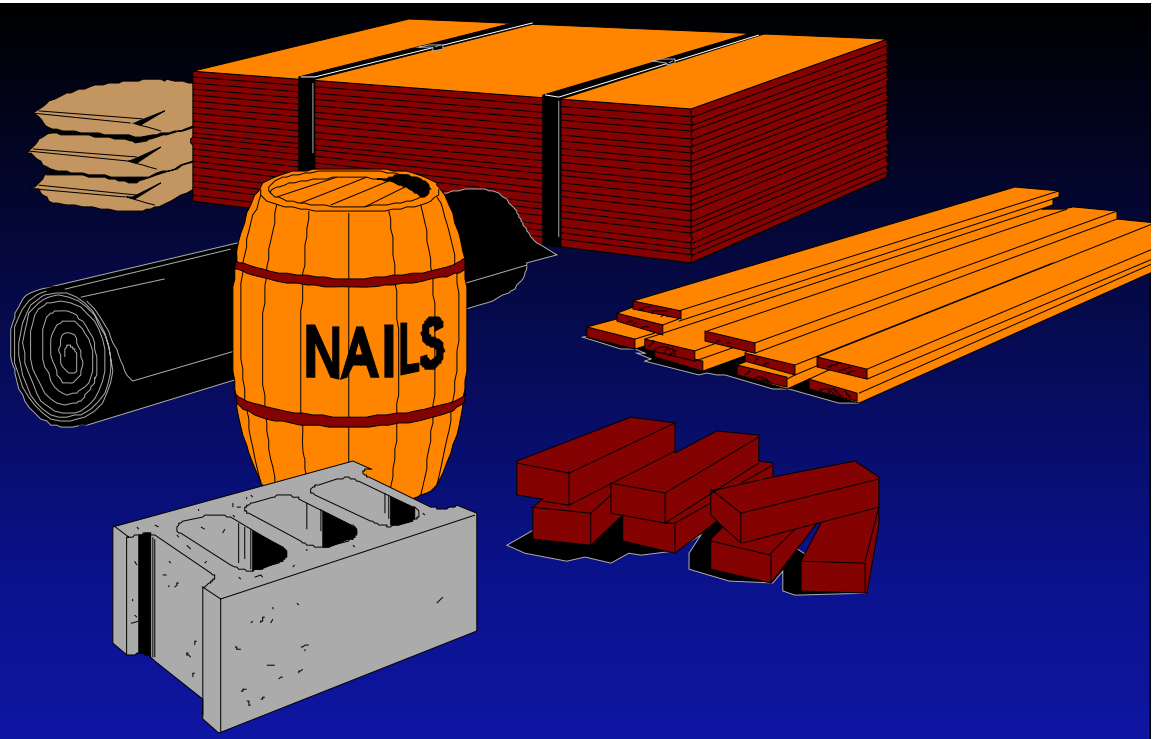
IAEA

Co-sponsored by the

- NEA / OCDE
- Ministerio de Industria, Turismo y Comercio
- Federación Española de la Recuperación
- Unión de Empresas Siderúrgicas
- Empresa Nacional de Residuos Radiactivos S.A.
- Diputació de Tarragona
- Ajuntament de Tarragona
- Universitat Rovira i Virgili

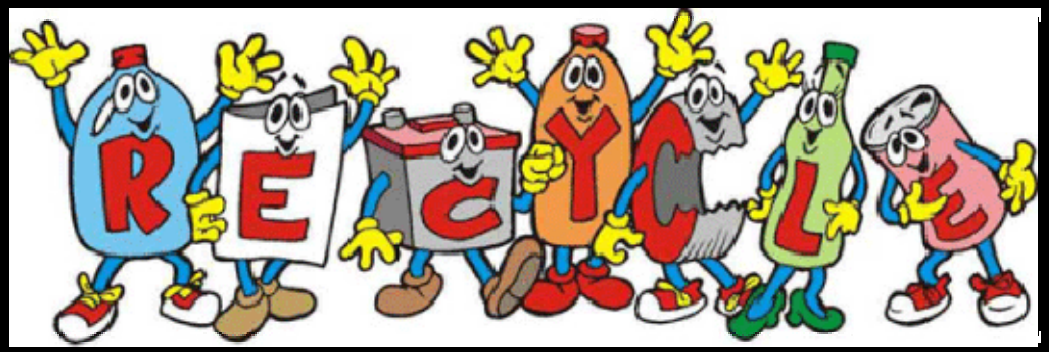
What is the problem?

…radioactive substances are incorporated into materials, goods, merchandises, products…




…and in scrap…..

…and, as scrap would



into new produce,

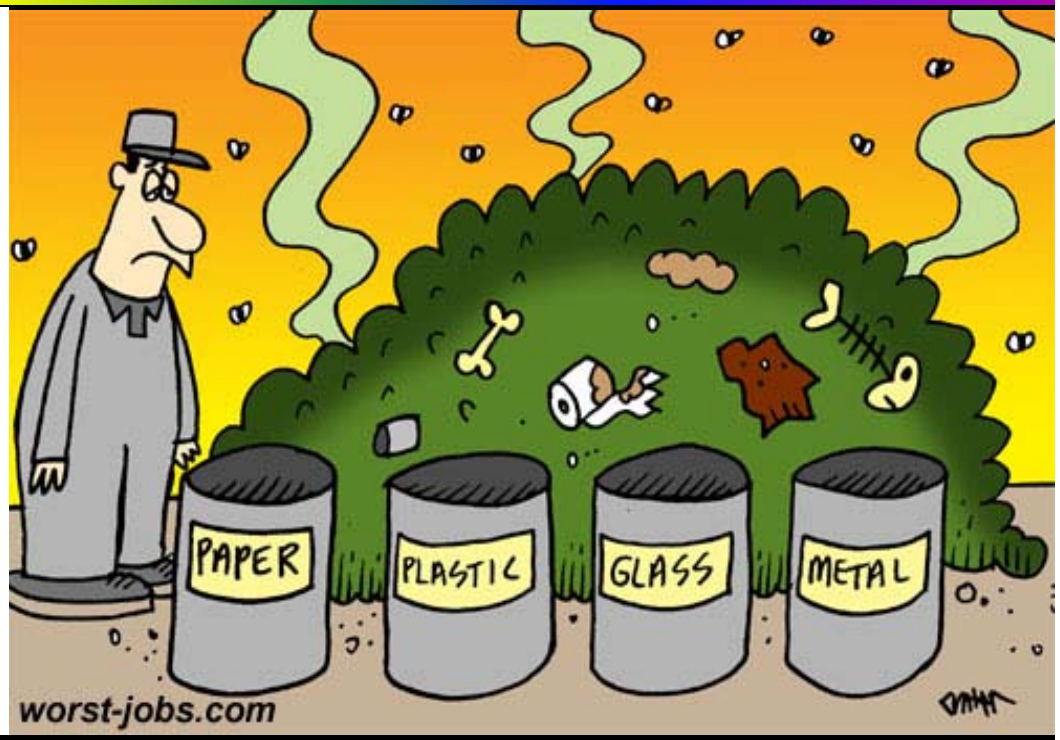
the process of introduction

of radioactive susbtanaces

into commodities will

continue

(even if you do not believe in recycling!)



Theses

- The situation is unstoppable and requires straightforward solutions.
- The problem is global and therefore the solution (s) should be global.
- A clear intergovernmental agreement is needed establishing to what extent commodities should be regulated.

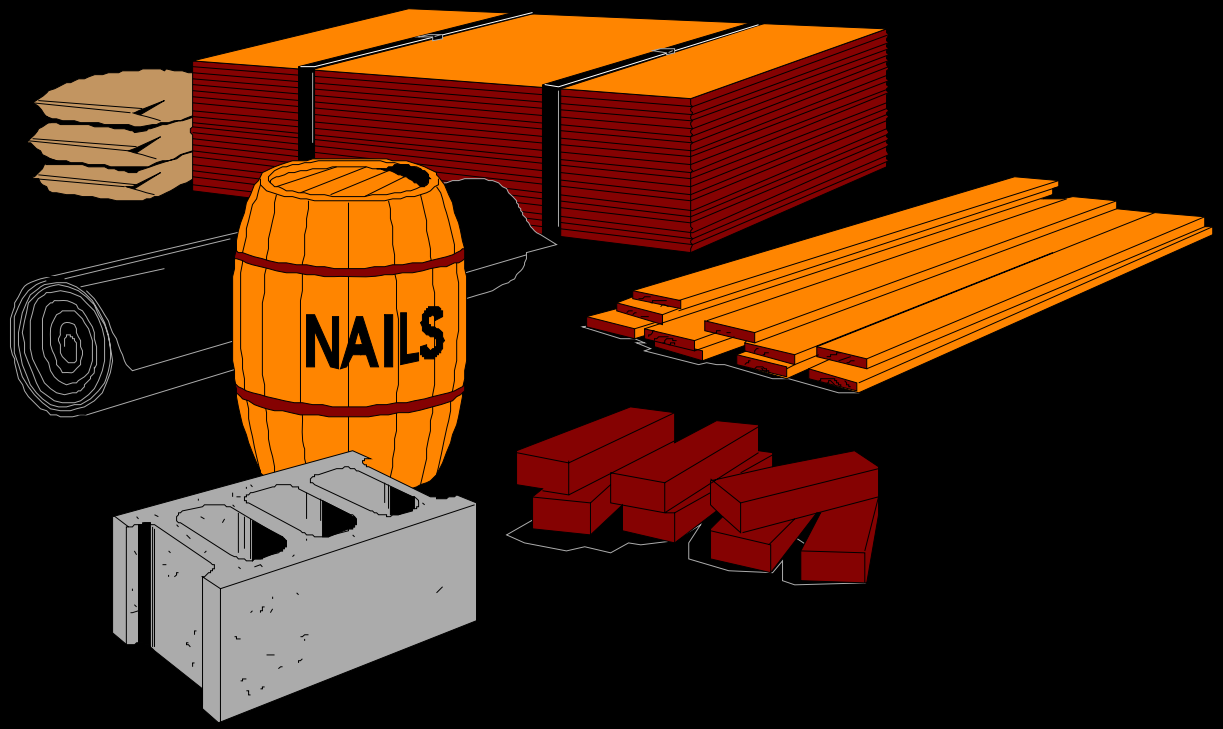
Not surprisingly,

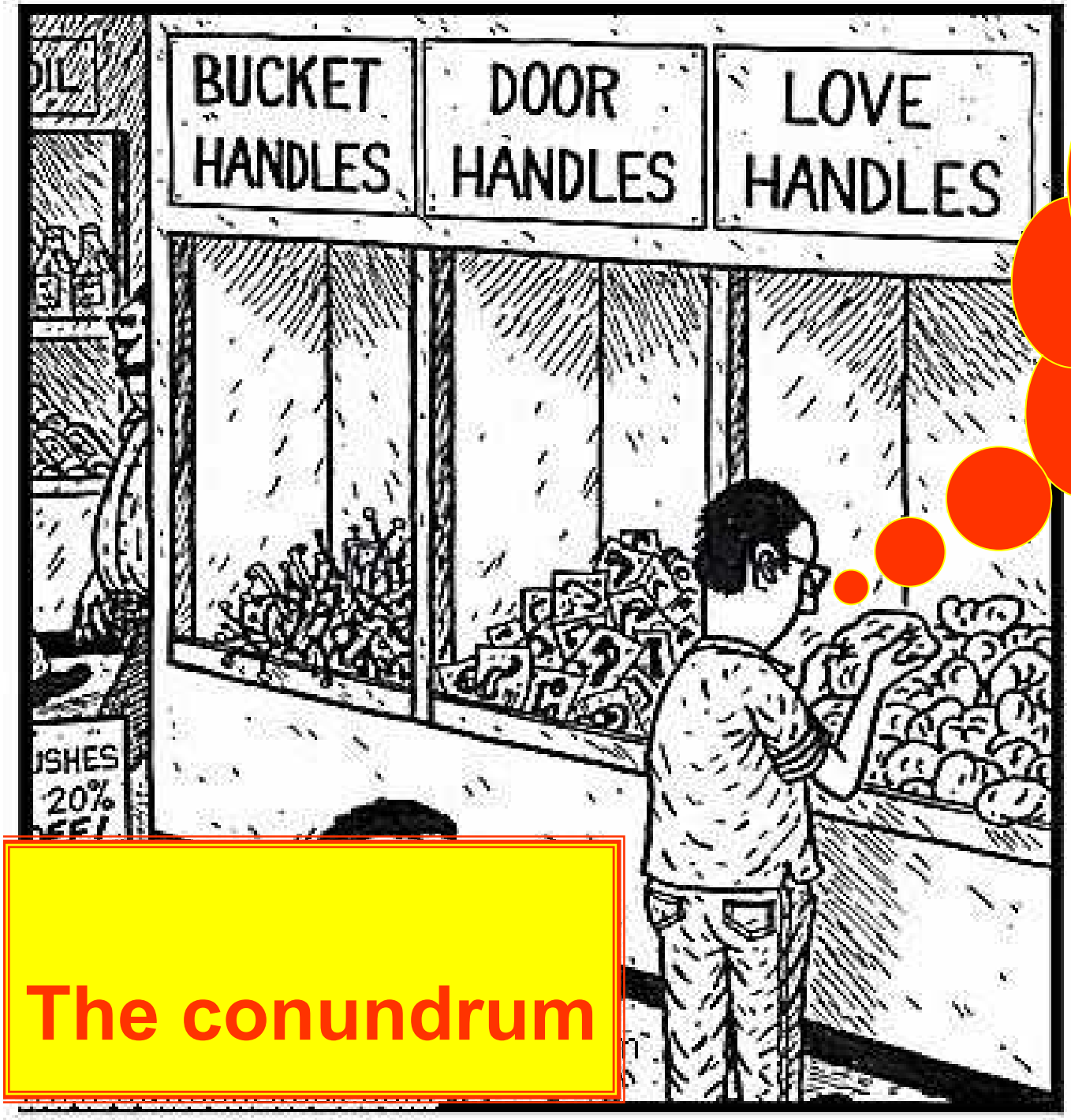
people (and their representatives)

have been asking a simple basic question to the

radiation protection community:

What is the amount of radioactivity in commodities above which radiation protection control is required?





Should this stuff be controlled by CSN?

The conundrum

The challenge for the RP community

- to provide a rational, logical and sustainable answer to this simple question:

What is the safe level of radioactivity in products of public use

Otherwise people will be convinced that scrap metal = death

(An apparently obvious reflection)

Scrap metal (and recycled produce)

may contain

becquerels (or curies)

but NOT

sieverts (or rems)

Therefore, criteria should be set in terms of activity

rather than in terms of hypothetical doses!

(Another apparently obvious reflection)

Scrap metal is an international commodity

Therefore, criteria should be internationally agreed!

HISTORY

(…at the beginning there was light!)

IVLIA VICTRIX VRBS TRIVMPHALIS

TARRACO

Roman Law (B.C.)

- DE MINIMIS NON CVRAT LEX

(**Cause** of no-concern for the **law**;

excluded from the law)

- DE MINIMIS NON CVRAT PRÆTOR

(**Cause** of no-concern for the **regulator**;

exempted by the regulator)

These simple basic principles are at the basis of civil organization

(except for radiation protection)

Regulation of transportation in my village in the Argentine pampas

De minimis not curat lex

excluded

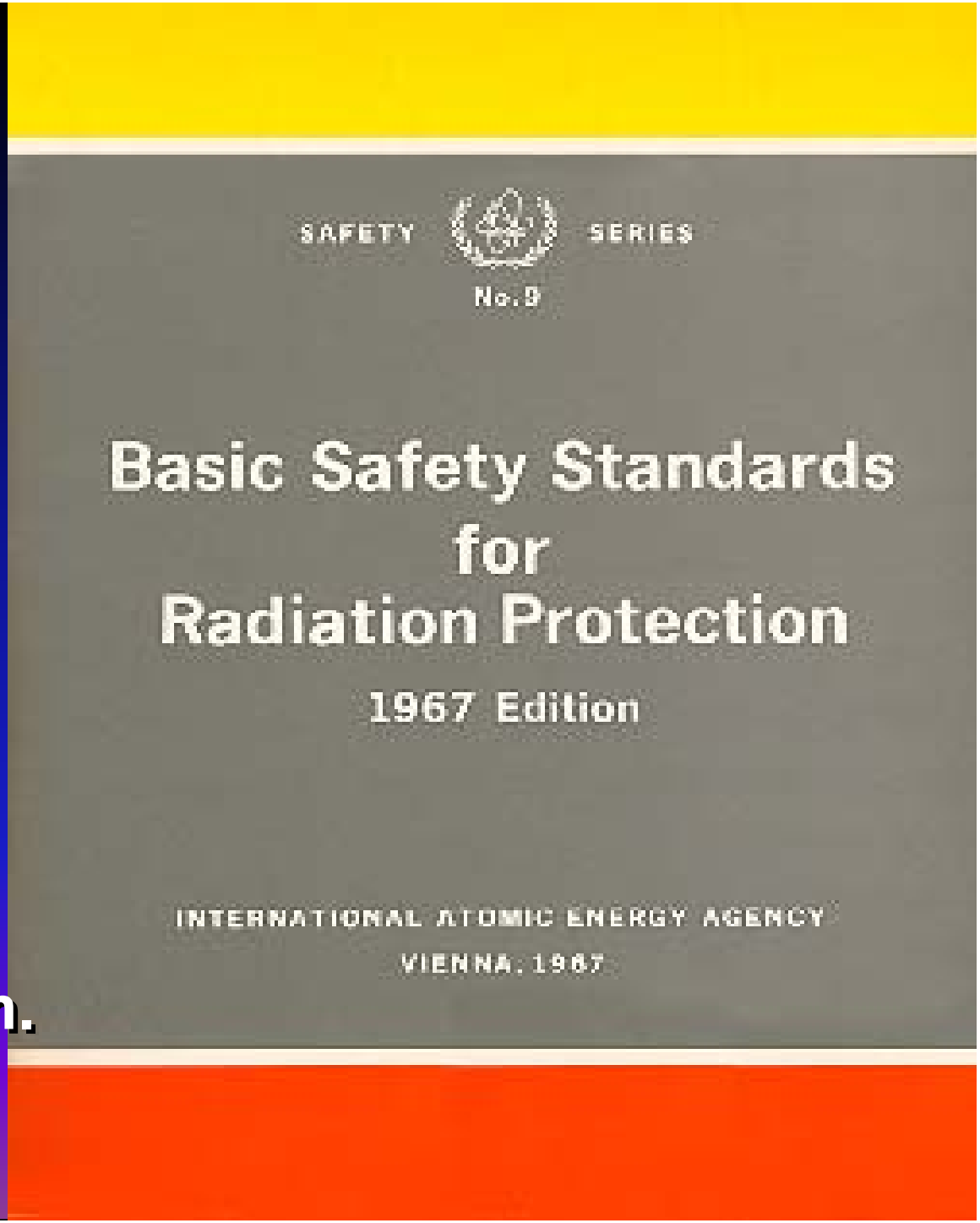
De minimis not curat praetor

exempted

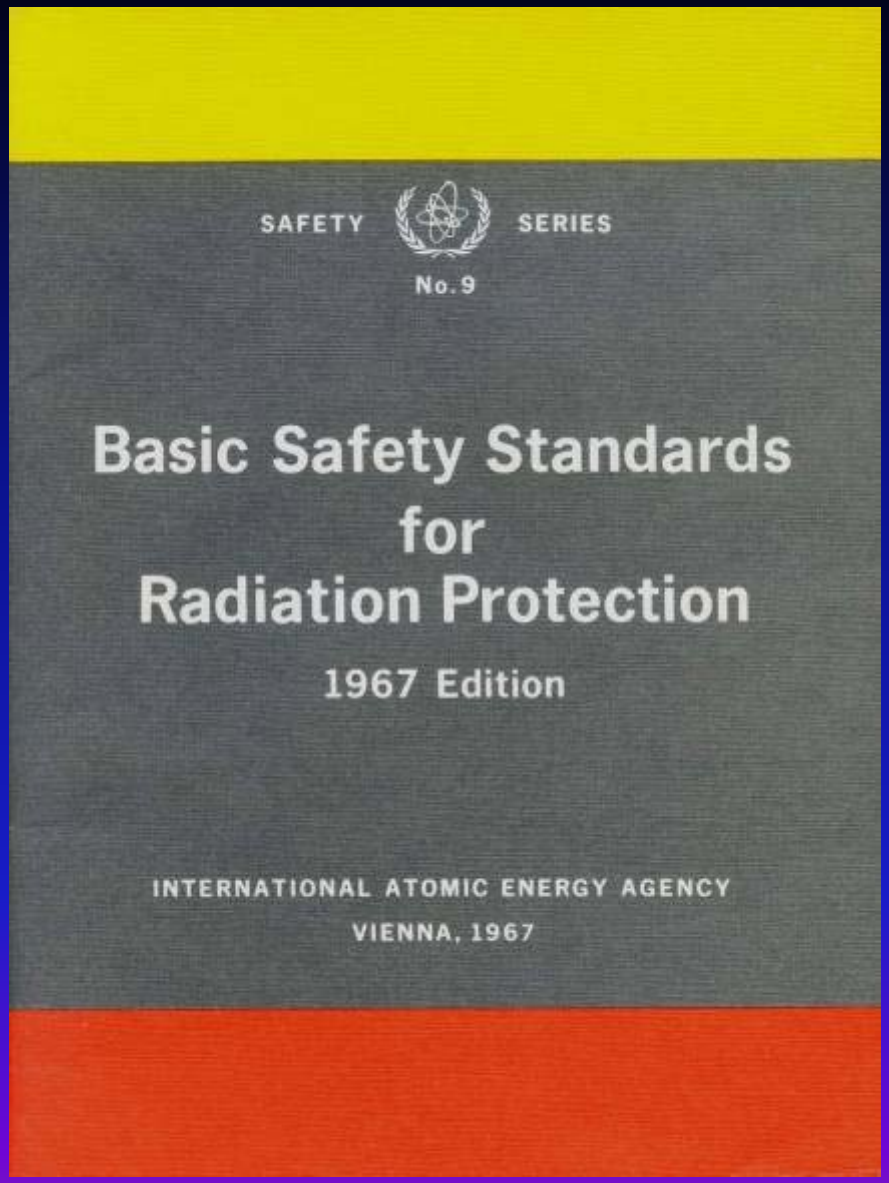
regulated

These simple concepts were surprisingly absent from radiation protection criteria.

In 1967, there was an attempt to introduce them.



The 1967 BSS *'…apply to operations which do not involve the use of radioactive substances at concentrations exceeding 0.002 μCi/g (74 Bq/g) or solid natural radioactive substances at concentrations exceeding 0.01 μCi/g (370 Bq/g).'*



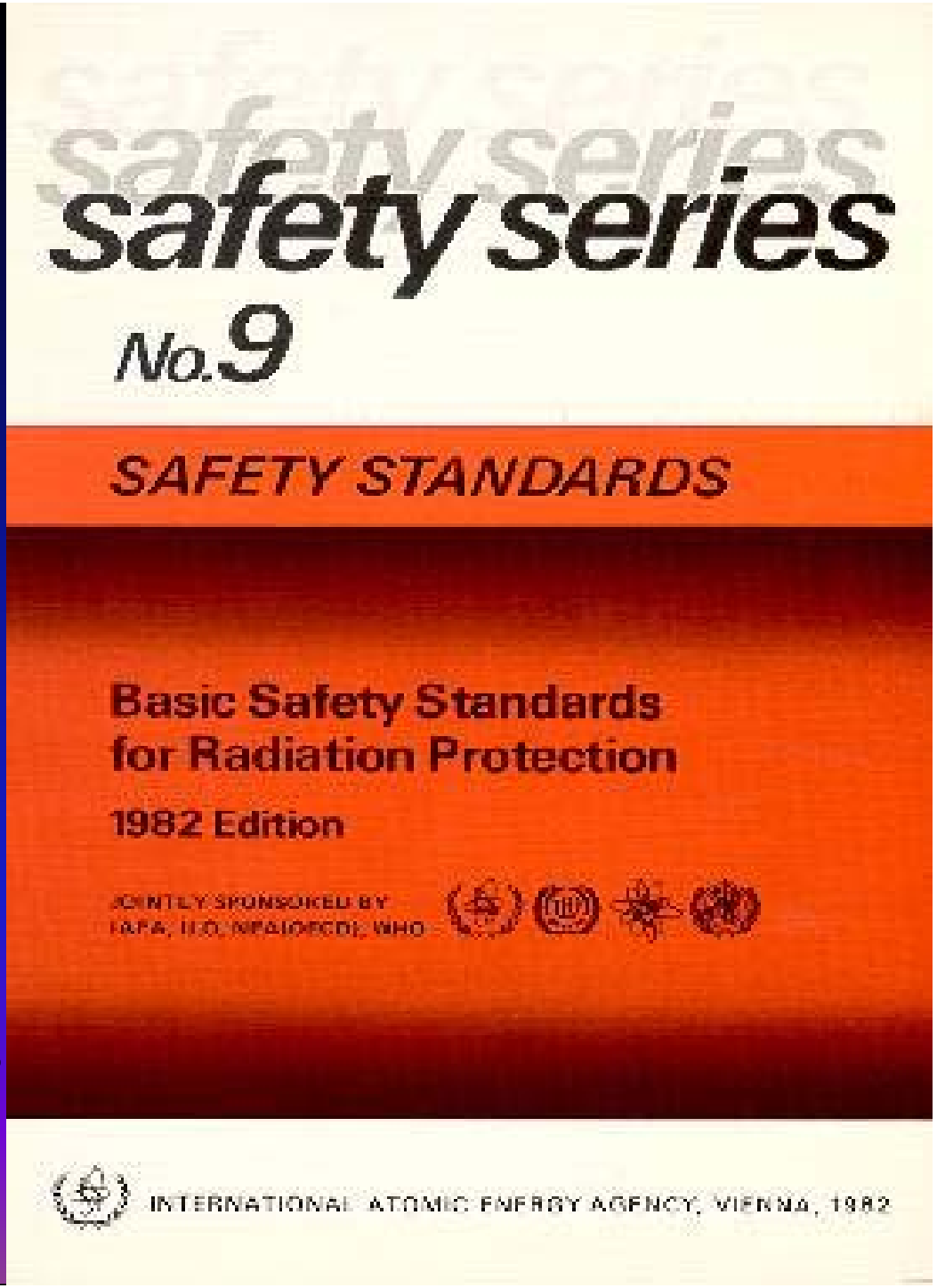
I.e., the 1967 BSS *de facto* excluded operations involving

radioactive substances at concentrations below

several 10's of Bq/g!

. . . then, the 80's shown a reverse in policy: . . .

. . . the era of purism. . .



...the 1982 BSS required that *everything be regulated*...

…at the time, a serious

grammatical mistake

was made by lawyers…

de minimis non curat lex

and

de minimis non curat prætor,

which are both *ablative* grammatical cases,

were converted into

‘*de minimis* dose’

i.e., the adjective de minimis qualifying the substantive dose

This mistake created a tremendous confusion…

…which still permeates into our discussions today

The '*de-minimis* dose' confusion

1. Equates *not curat lex* and *not curat prætor*

   (i.e., equates legislator and regulator).

2. Equates *cause* and *qualification.*

3. Contradicts basic radiation protection principle:

   …all doses…however small….(etc).

4. Moves focus from activity to doses

non curat law and *not curat prætor*

Totally different legal concepts:

- ***Non curat lex***

  Control is unfeasible or unamenable

  (for this reason it may be excluded from the law)

- ***Non curat prætor***

  Some control may be unwarranted or unnecessary

  (for this reason it may be exempted by the regulator)

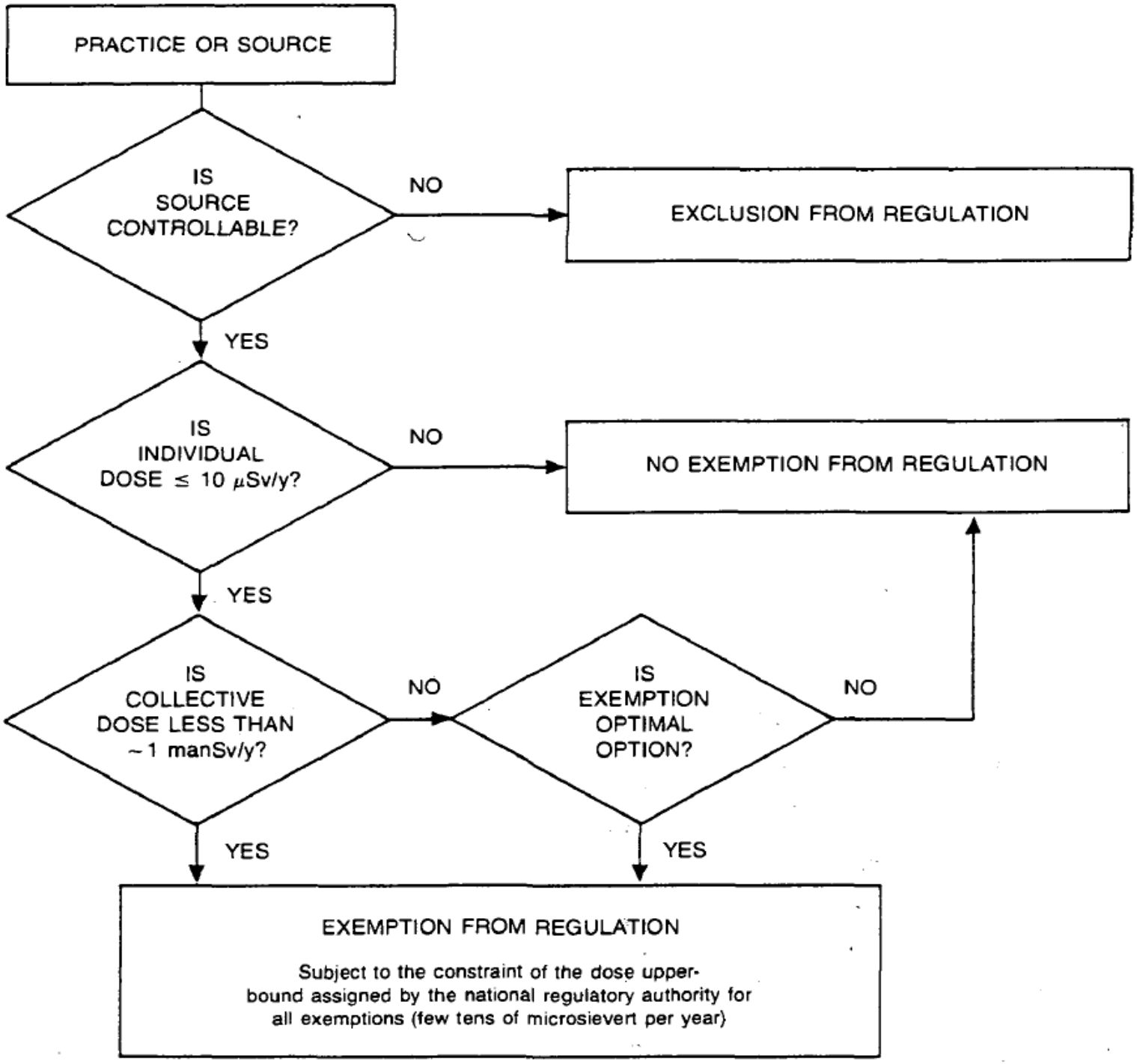
Exemption from regulatory control: An international consensus

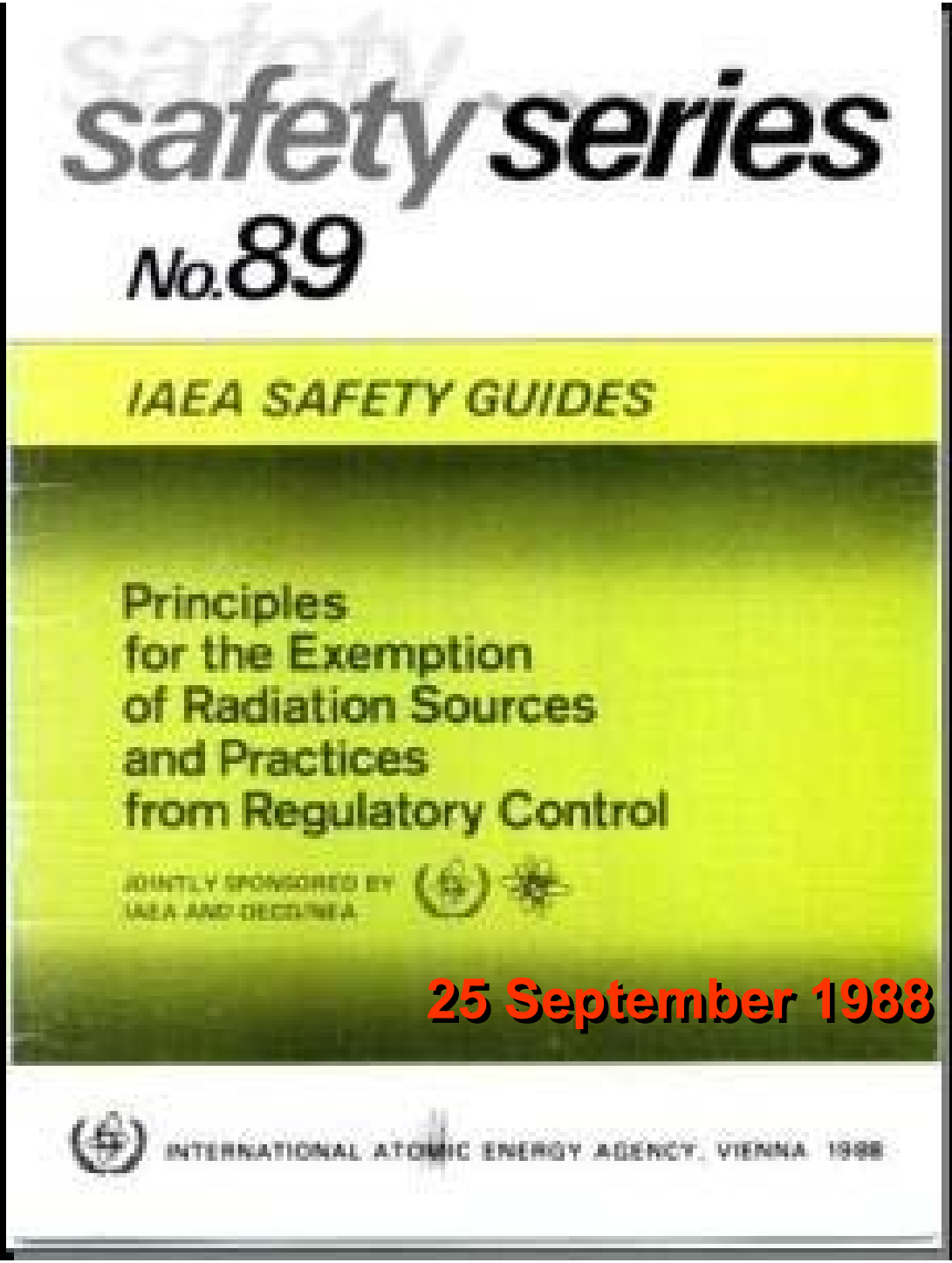
A summary of essential features and concepts

by G.S. Linsley and A.J. González

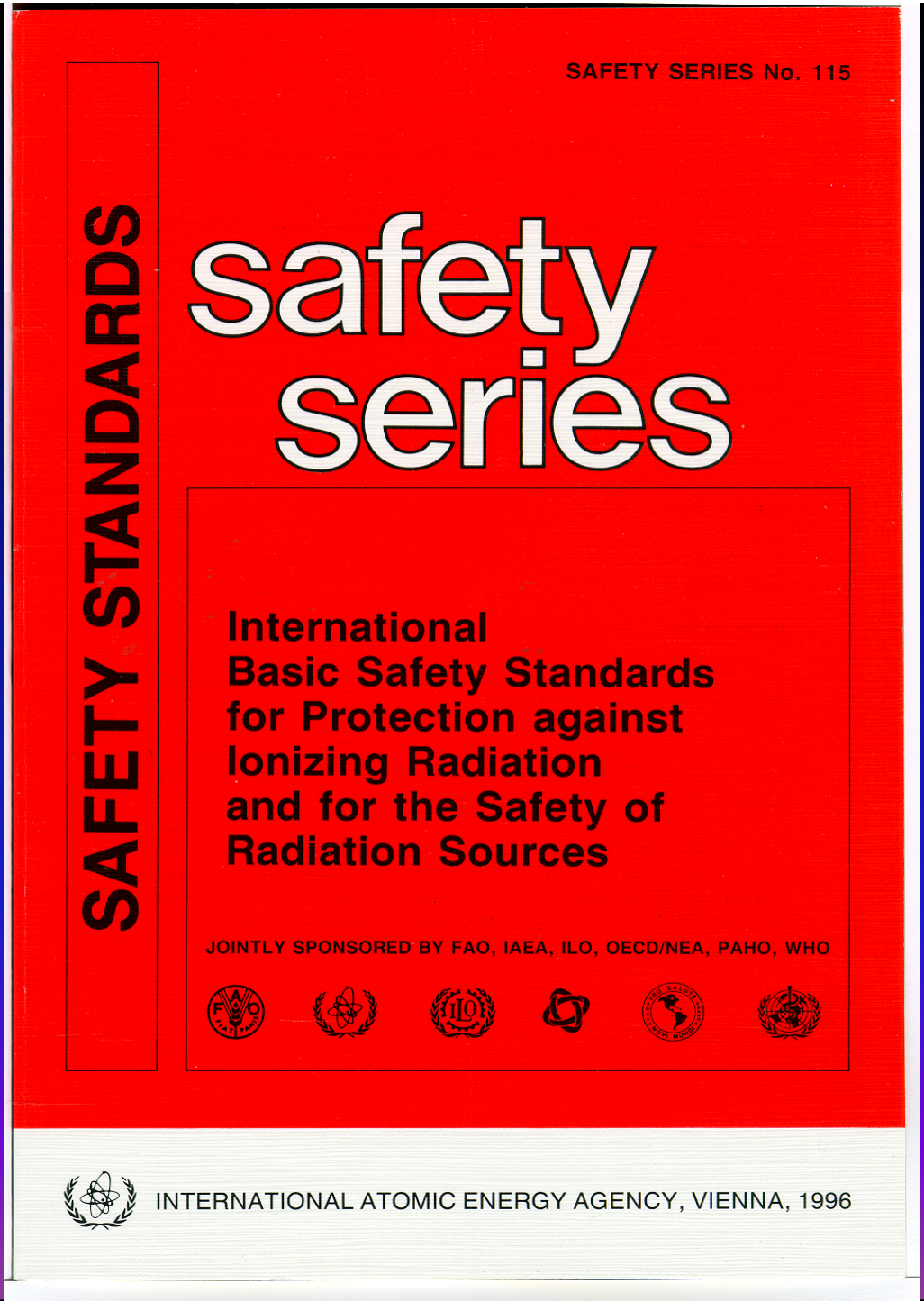
IAEA BULLETIN, 3/1988

http://www.iaea.org/Publications/Magazines/Bulletin/Bull303/30302342730.pdf


PRACTICE OR SOURCE
IS SOURCE CONTROLLABLE?
NO
EXCLUSION FROM REGULATION
YES
IS INDIVIDUAL DOSE ≤ 10 μSv/y?
NO
NO EXEMPTION FROM REGULATION
YES
IS COLLECTIVE DOSE LESS THAN ~1 manSv/y?
NO
IS EXEMPTION OPTIMAL OPTION?
NO
YES
YES
EXEMPTION FROM REGULATION
Subject to the constraint of the dose upper-bound assigned by the national regulatory authority for all exemptions (few tens of microsievert per year)


safety series
No. 89
IAEA SAFETY GUIDES
Principles
for the Exemption
of Radiation Sources
and Practices
from Regulatory Control
JOINTLY SPONSORED BY
IAEA AND OECD/NEA
25 September 1988
INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA 1988

. . . in 1996, this saga concluded with the BSS.



IAEA-TECDOC-855

Clearance levels for radionuclides in solid materials

Application of exemption principles

Interim report for comment

INTERNATIONAL ATOMIC ENERGY AGENCY IAEA

5 February 1996

IAEA-TECDOC-1068

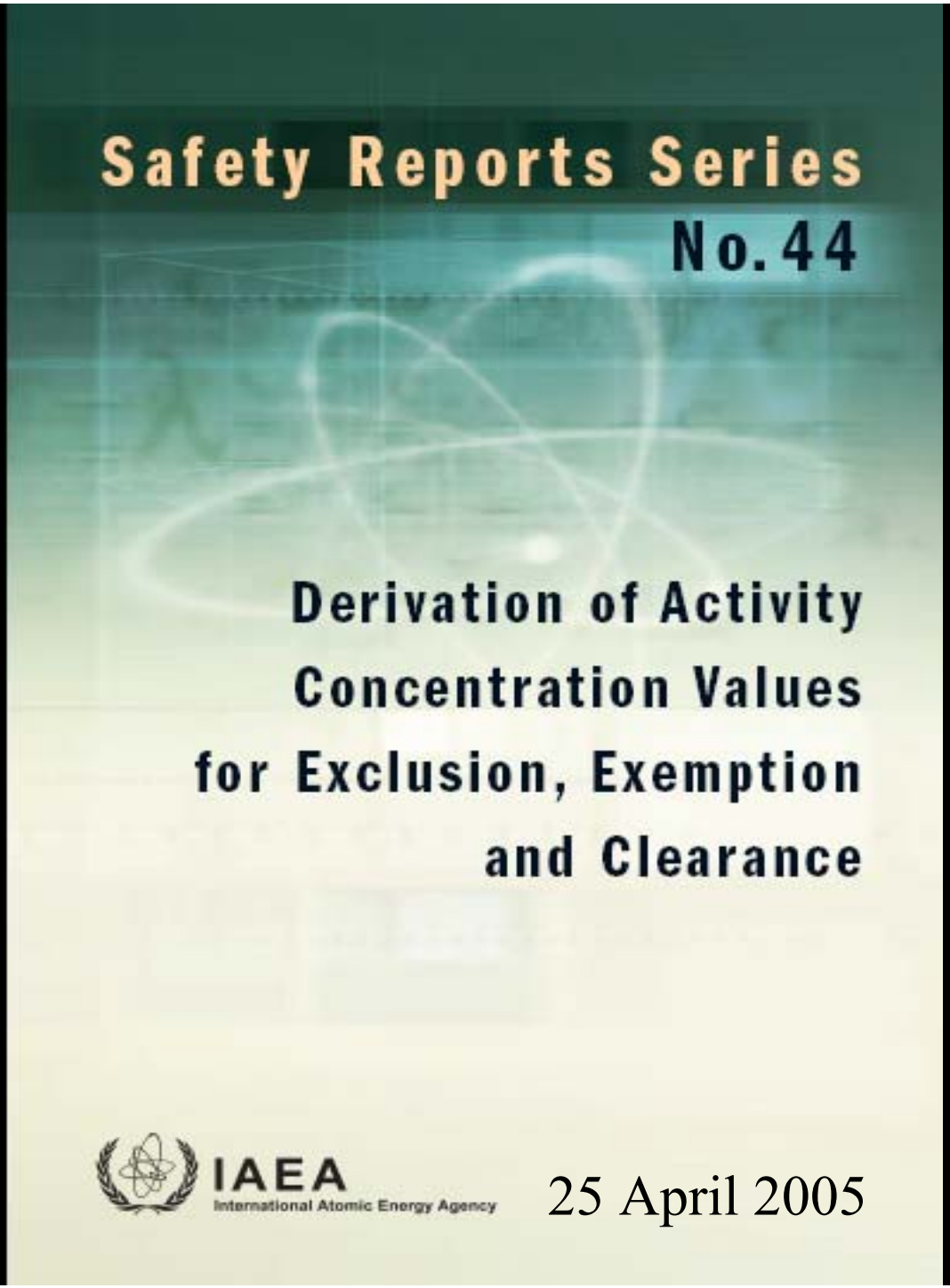
Application of radiological exclusion and exemption principles to sea disposal

The concept of 'de minimis' for radioactive substances under the London Convention 1972

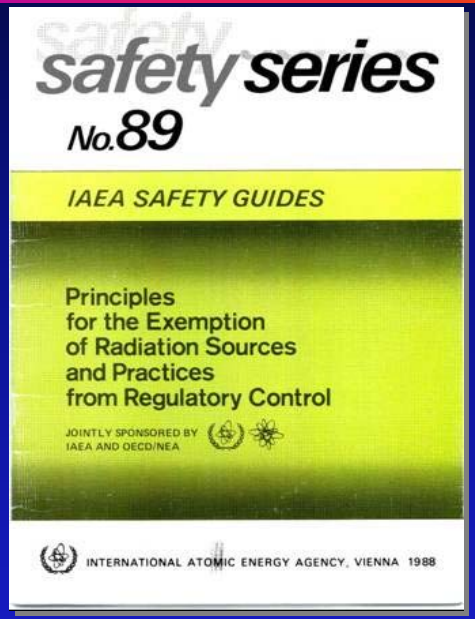
INTERNATIONAL ATOMIC ENERGY AGENCY IAEA

March 1999

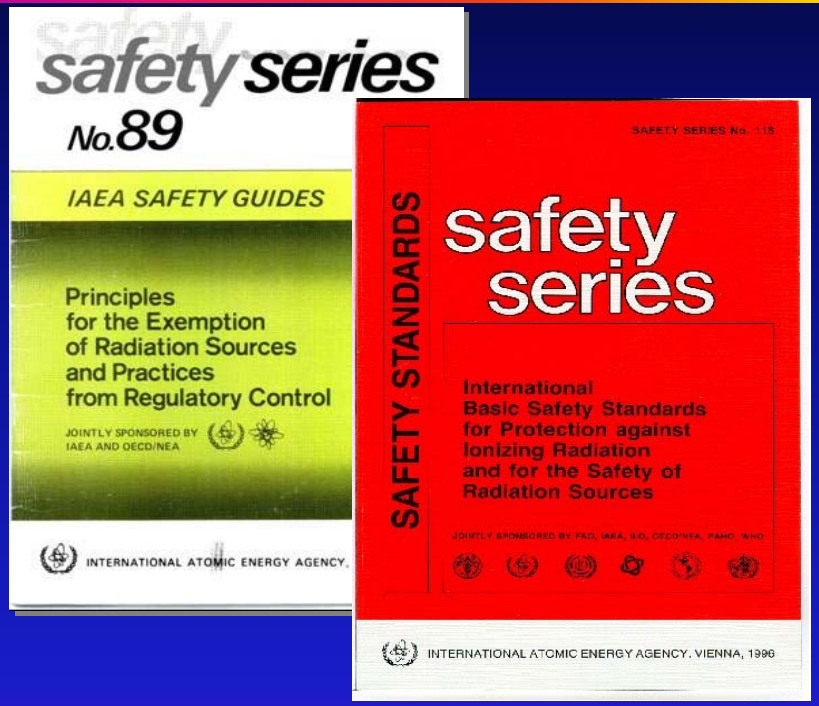
5 March 1999


Safety Reports Series
No. 44
Derivation of Activity
Concentration Values
for Exclusion, Exemption
and Clearance
IAEA
International Atomic Energy Agency
25 April 2005

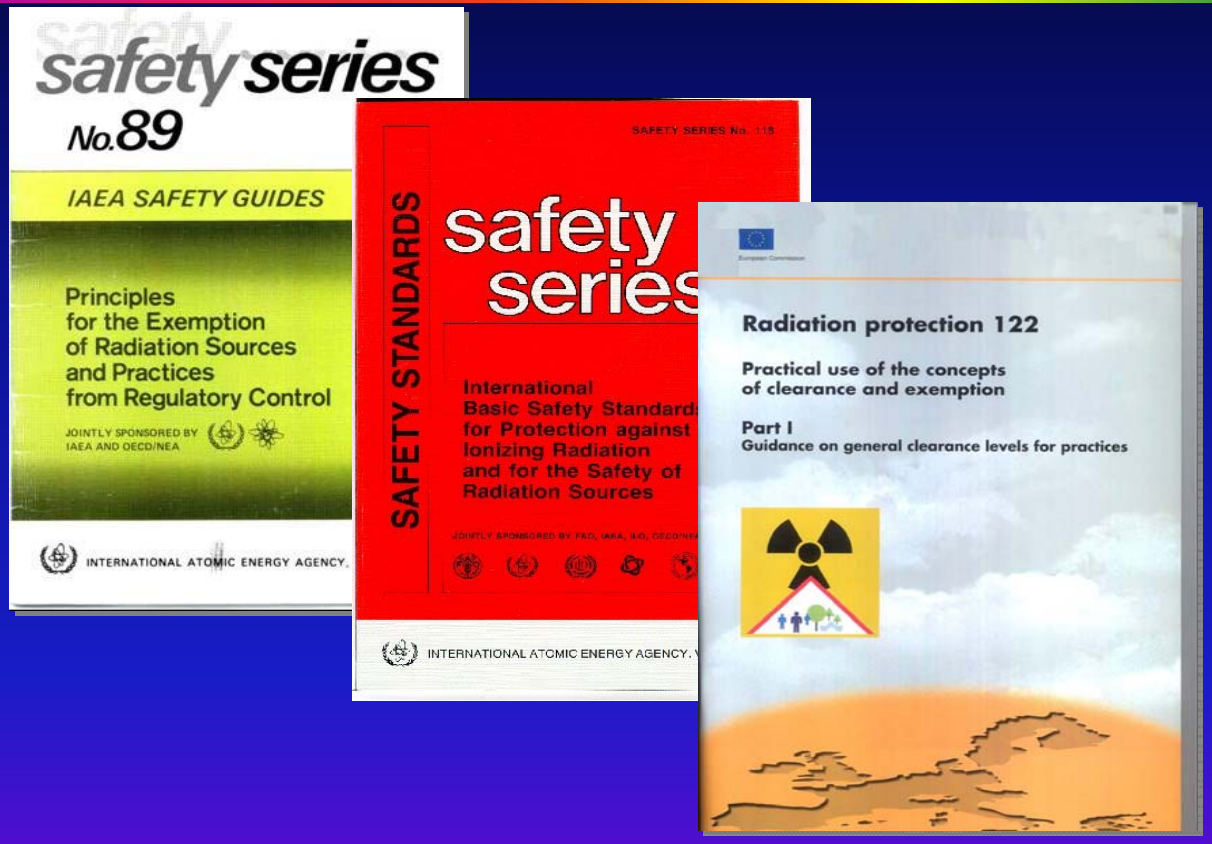
Exemption and Clearance 1988 to 1998



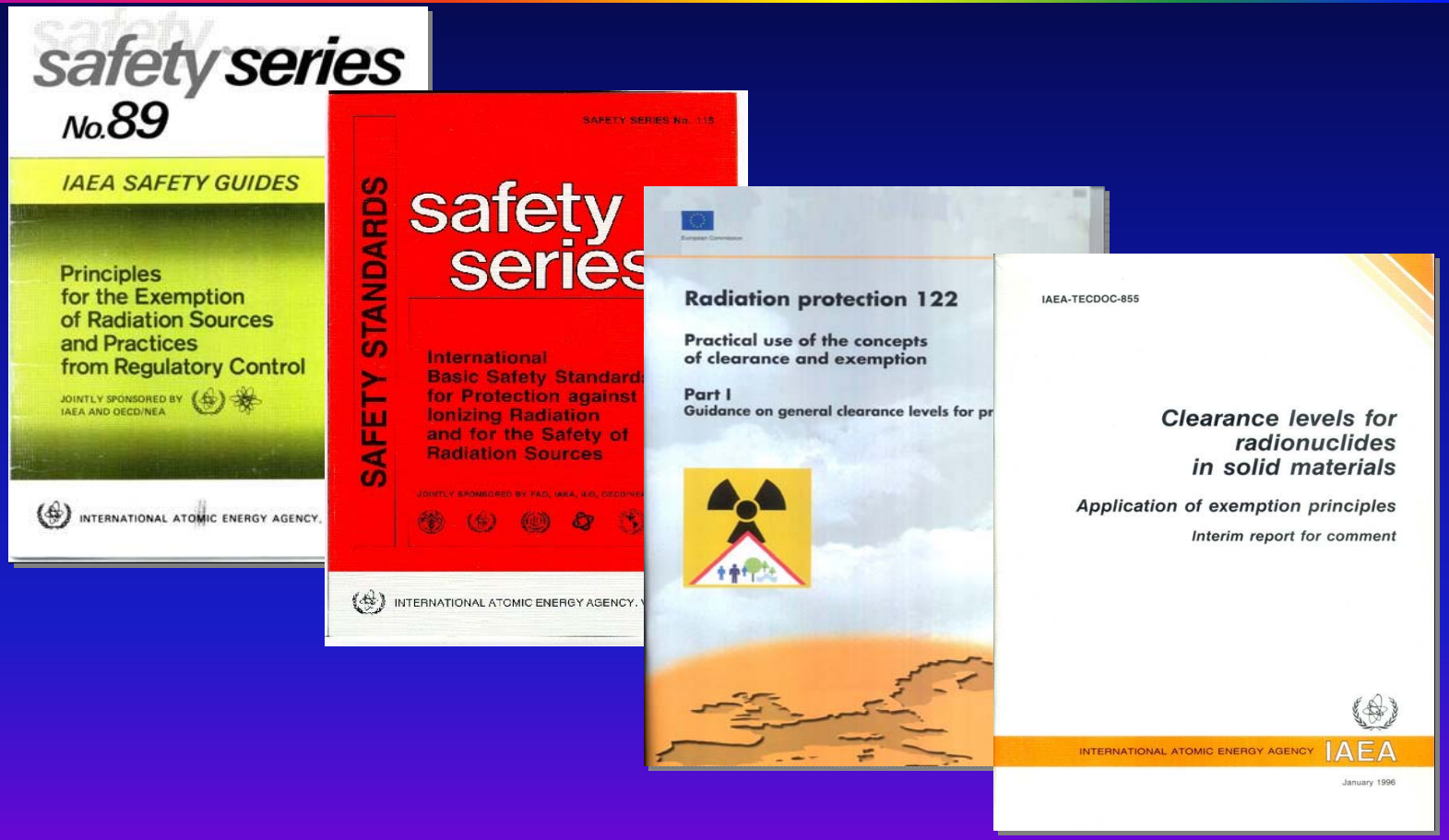
Exemption and Clearance 1988 to 1998



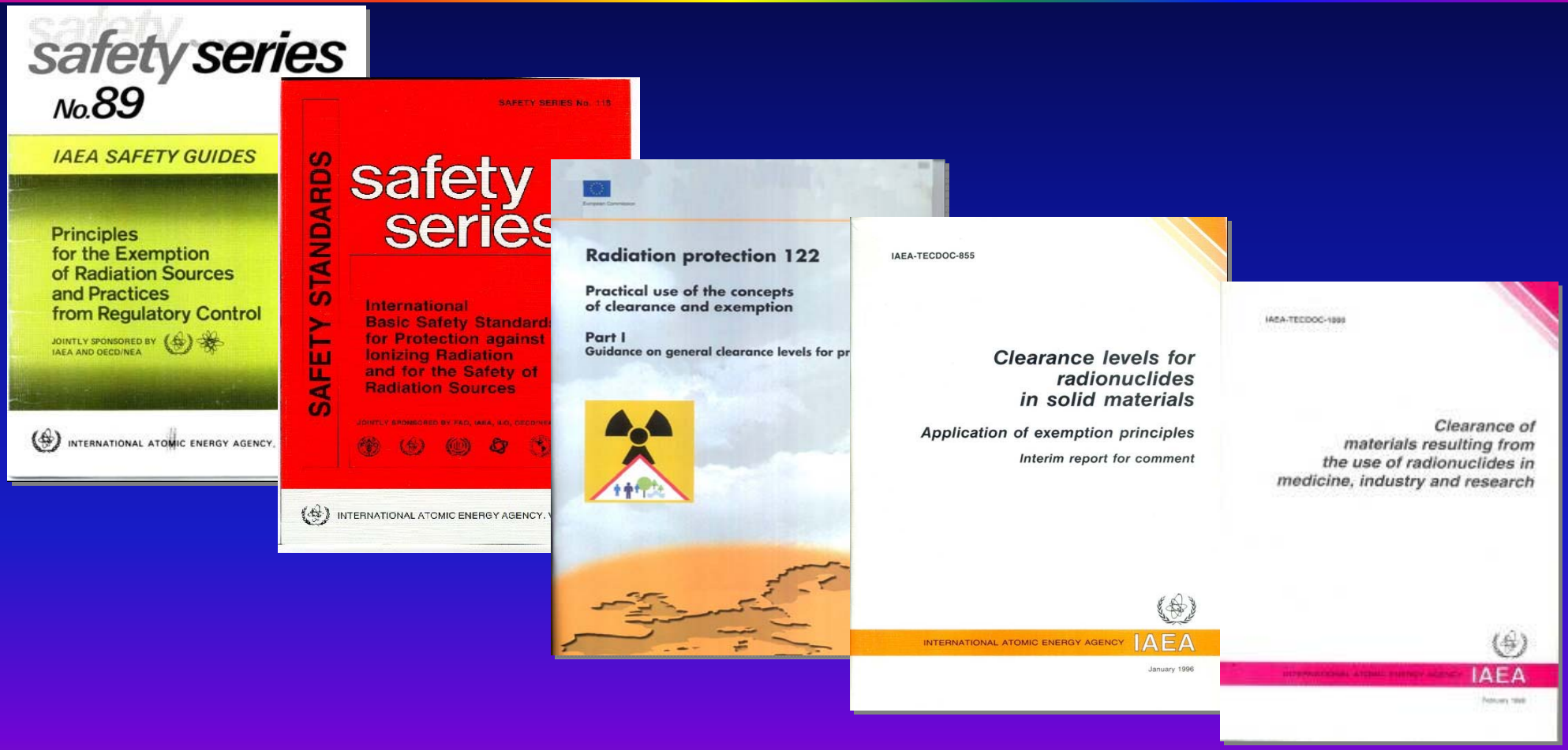
Exemption and Clearance 1988 to 1998



Exemption and Clearance 1988 to 1998



Exemption and Clearance 1988 to 1998

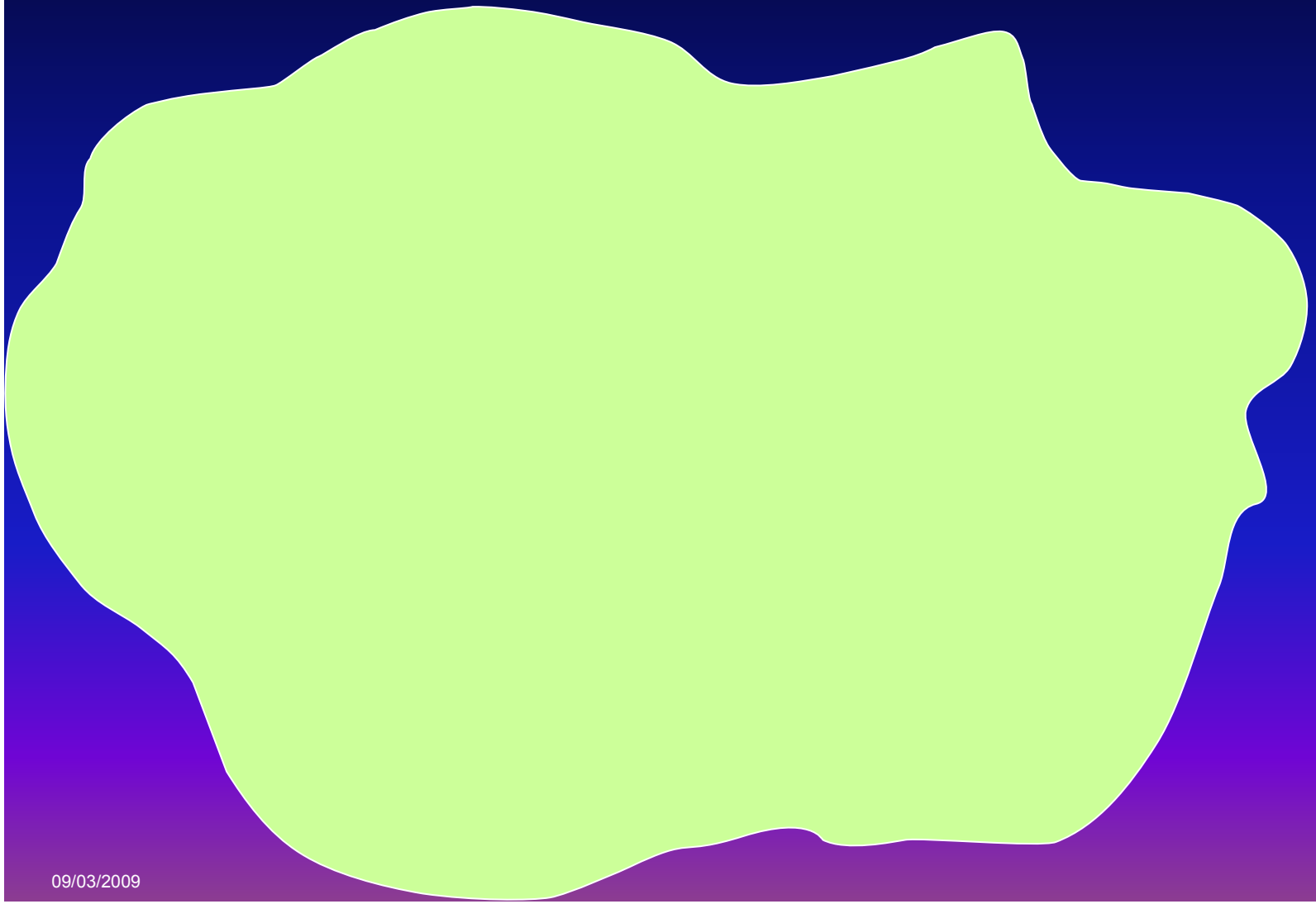


Summing up the basic concepts

EXCLUSION

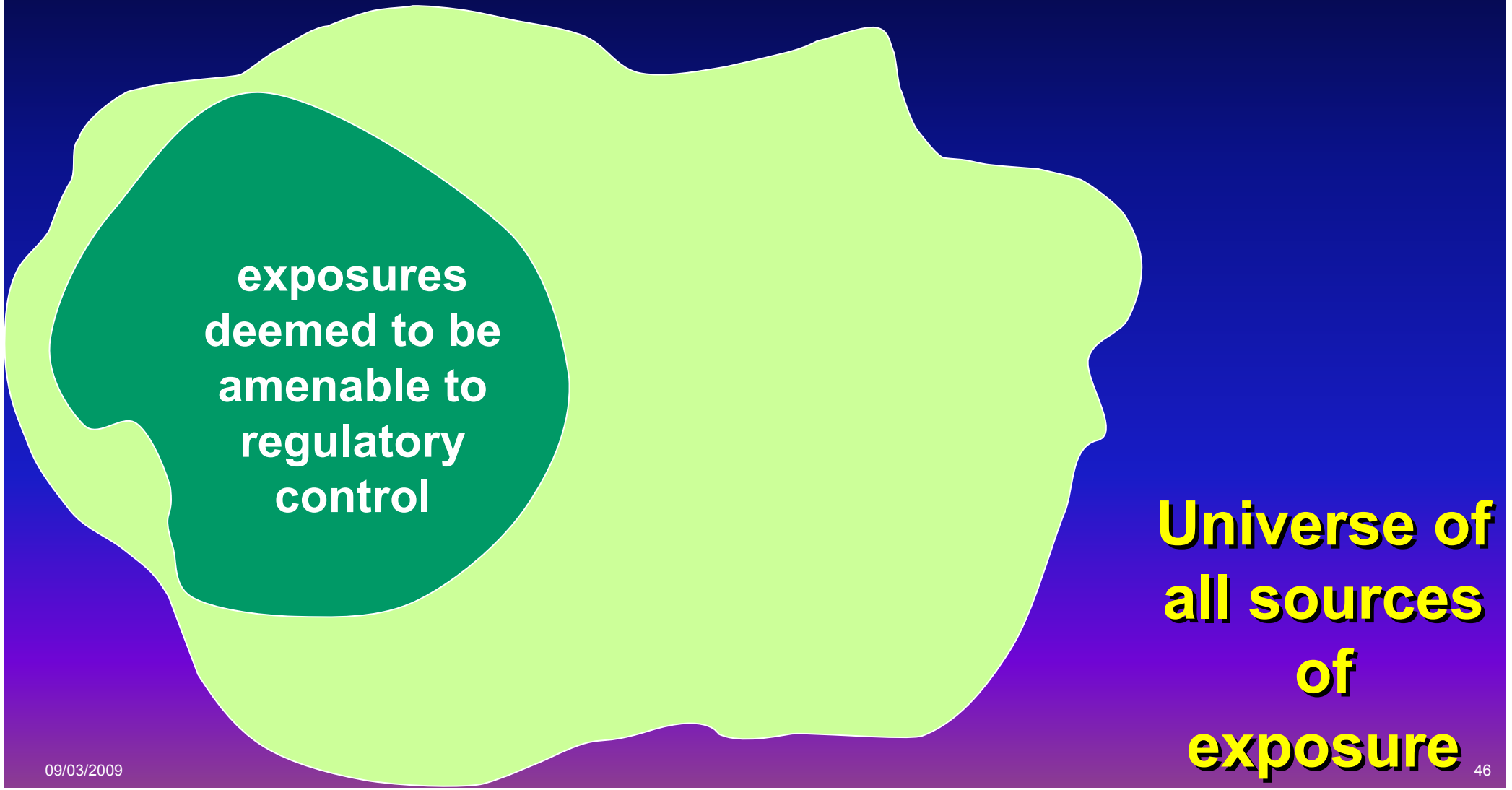
(de minimis non curat lex)

Exclusion



Universe of all sources of exposure

Exclusion


exposures deemed to be amenable to regulatory control
Universe of all sources of exposure

Exclusion


exposures deemed to be amenable to regulatory control
Excluded exposures
Universe of all sources of exposure

Exclusion

Basic Safety Standards:

"Any exposure whose magnitude or likelihood is essentially unamenable to control through the requirements of the Standards is deemed to be excluded from the Standards"

"unamenable" **can be taken to mean that regulatory control is**

- **impossible**
- **unfeasible**
- **generically unwarranted**

EXCLUSION

The BSS provide examples of:

- **impossibility of control**

  (potassium-40 in the body)

- **unfeasibility of control**

  (cosmic ray exposure at the earth's surface)

- **generically unwarranted control**

  (unmodified concentrations of radionuclides in most raw materials)

SCOPE AND EXCLUSION

- Scope can be specified by stating what is excluded
- However, it can also be specified by defining

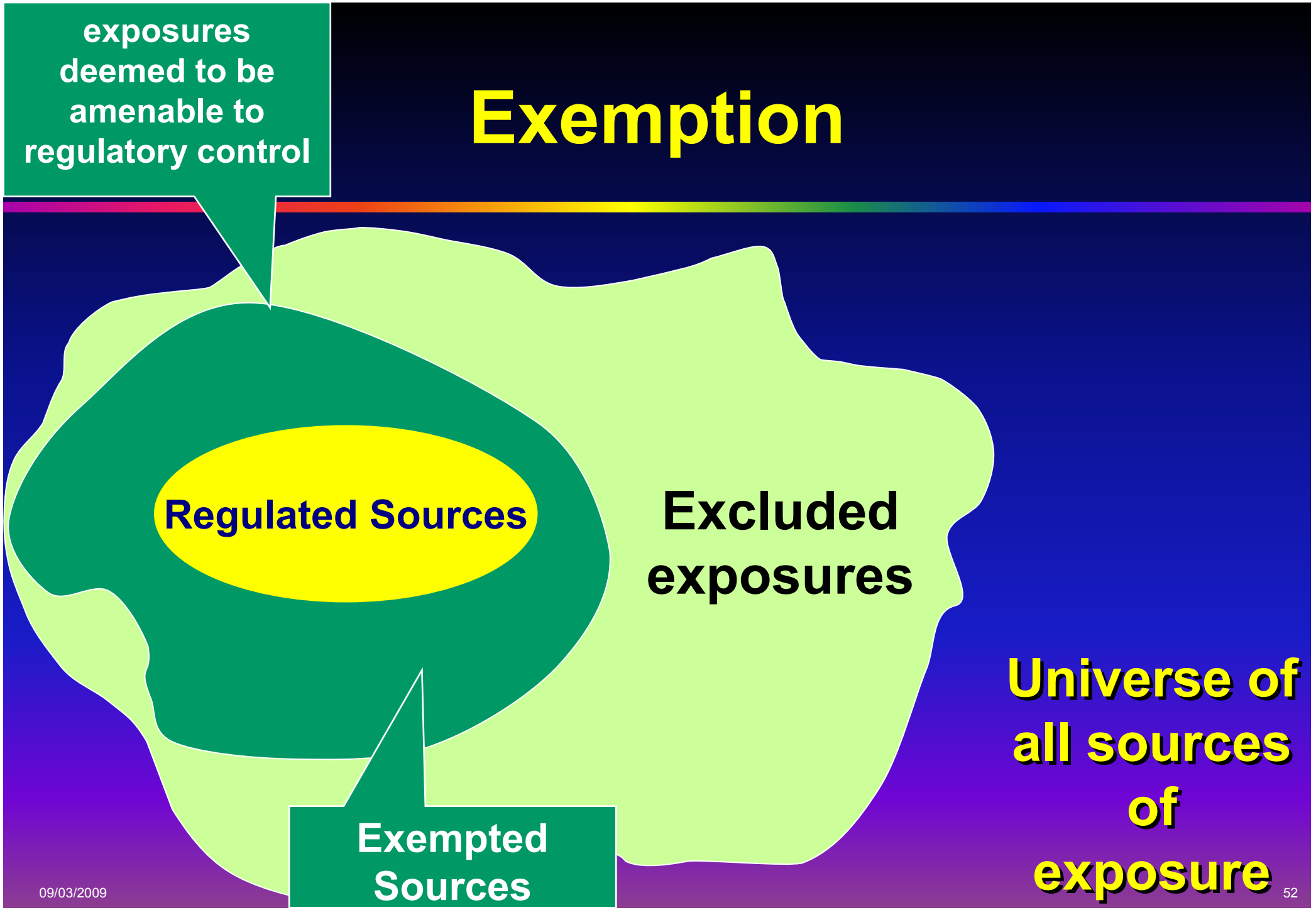
  what is included

  - this may be more pragmatic!

EXEMPTION

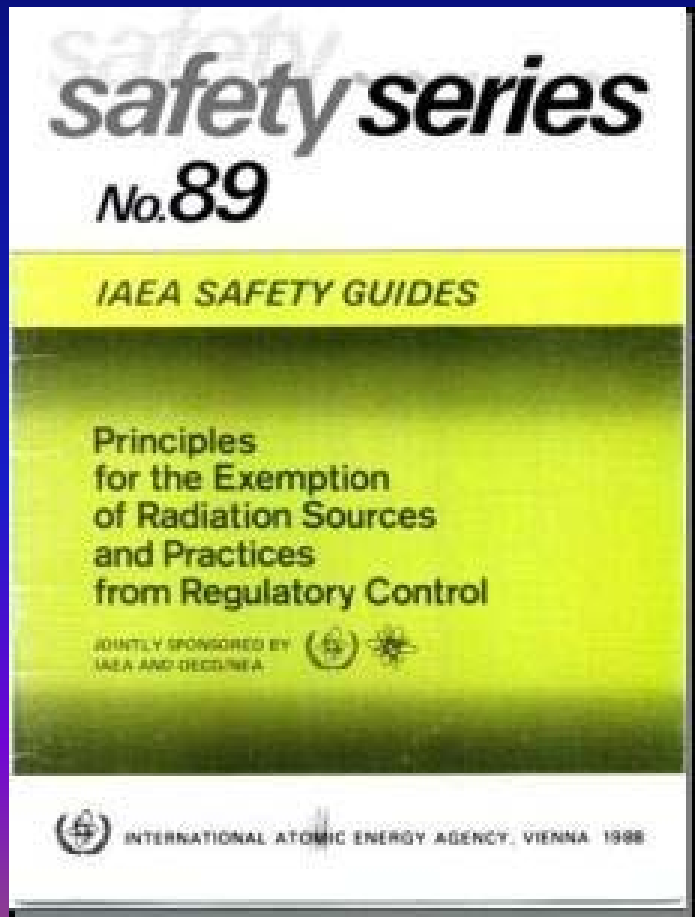
(de minimis non curat prætor)

Exemption


exposures deemed to be amenable to regulatory control
Regulated Sources
Excluded exposures
Exempted Sources
Universe of all sources of exposure

EXEMPTION

- General principles agreed over 20 years ago:
  - the radiation risks to individuals should be sufficiently low as to be of no regulatory concern.
  - the collective should be sufficiently low as unwarranting regulatory control under the prevailing circumstances.
  - inherently safe

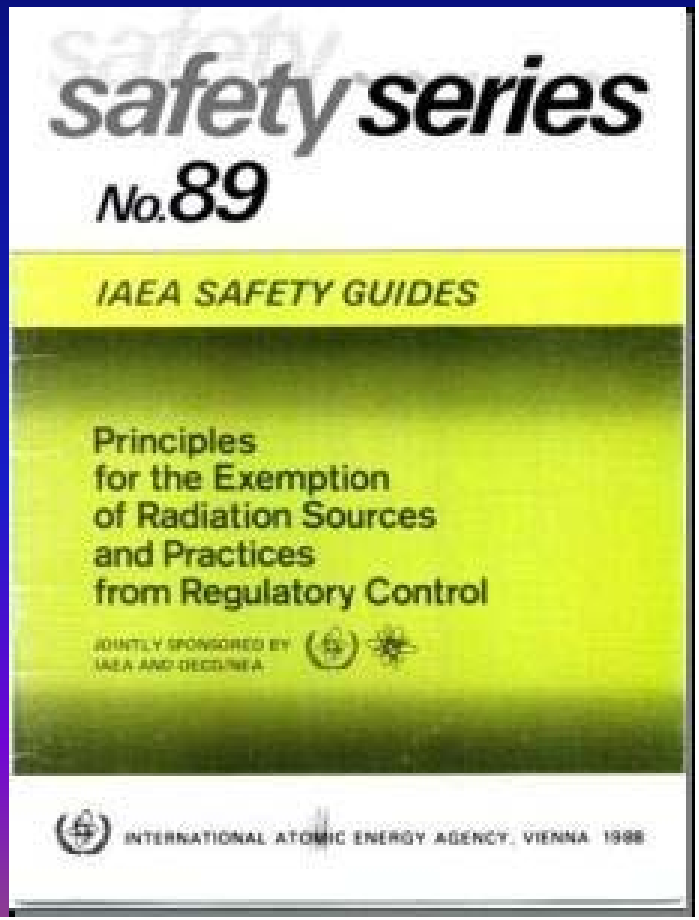


EXEMPTION

- General numerical criteria agreed over 20 years ago:
  - Trivial individual risk

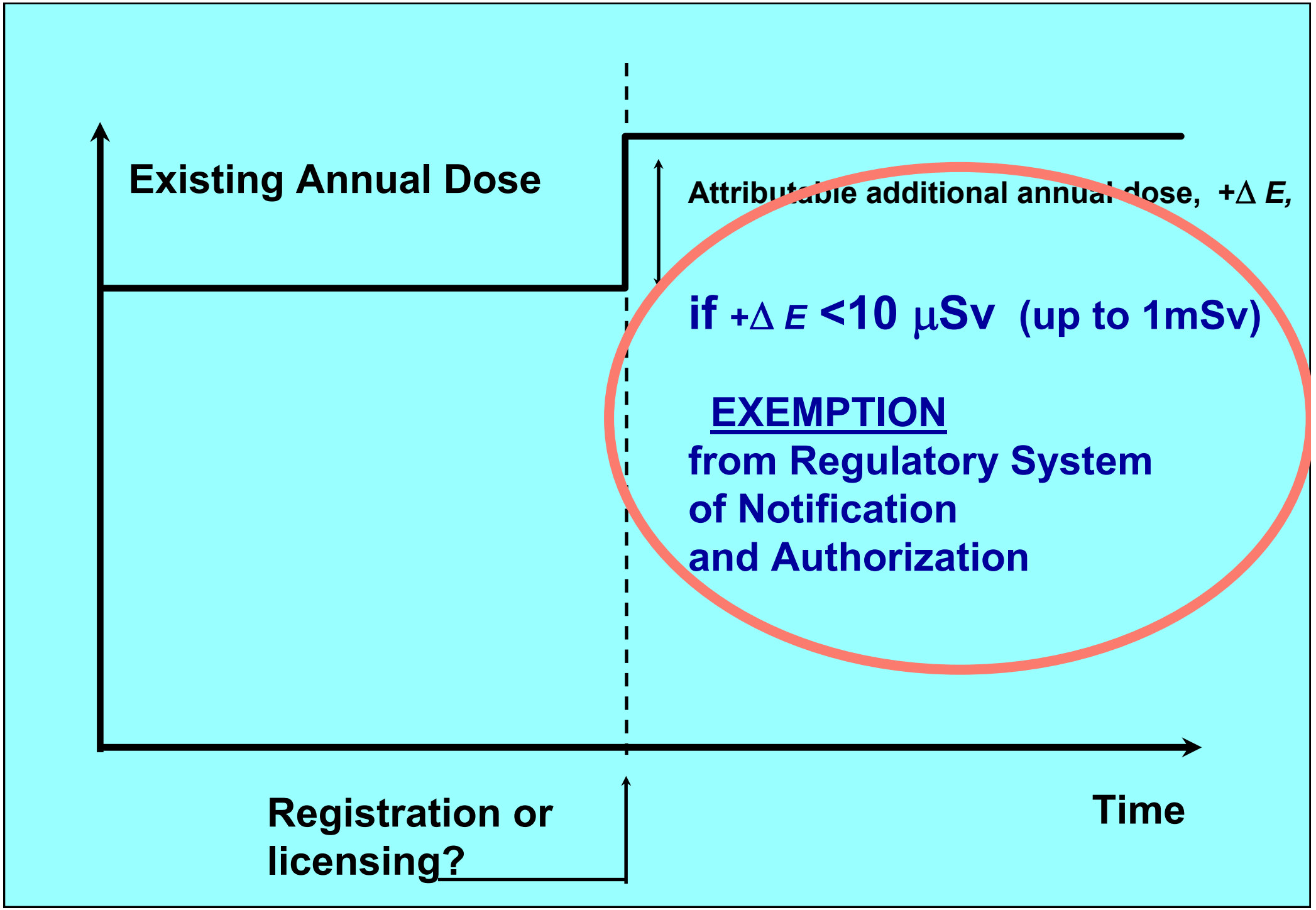
    (10μSv/y →1mSv/y)
  - Optimized radiation protection

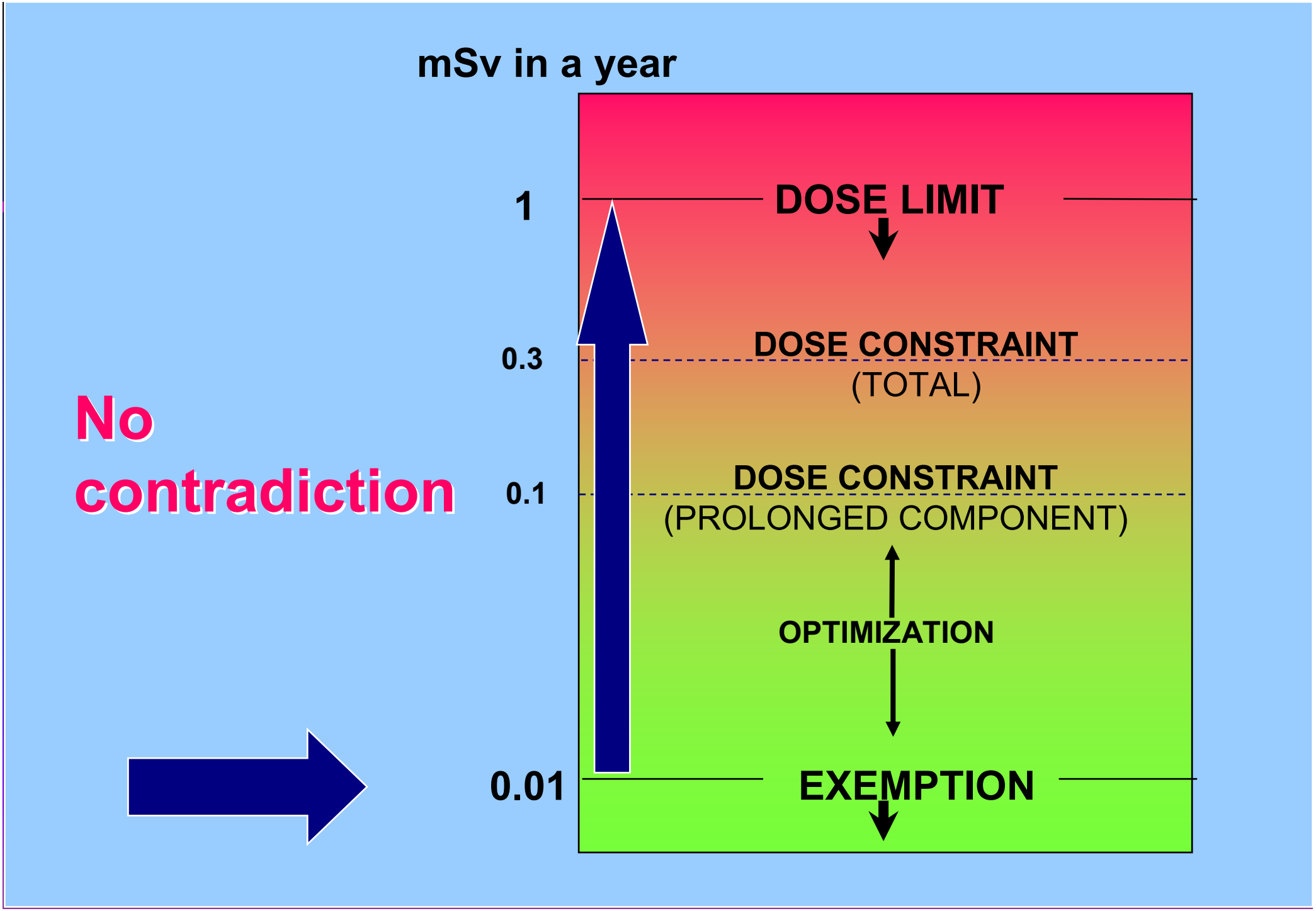
    (around 1 man Sv)



Individual risk basis

- Work of the European Communities:
  - Normal situations: around above 10 μSv/y
  - Pessimistic situations: distribution up to 1 mSv/y

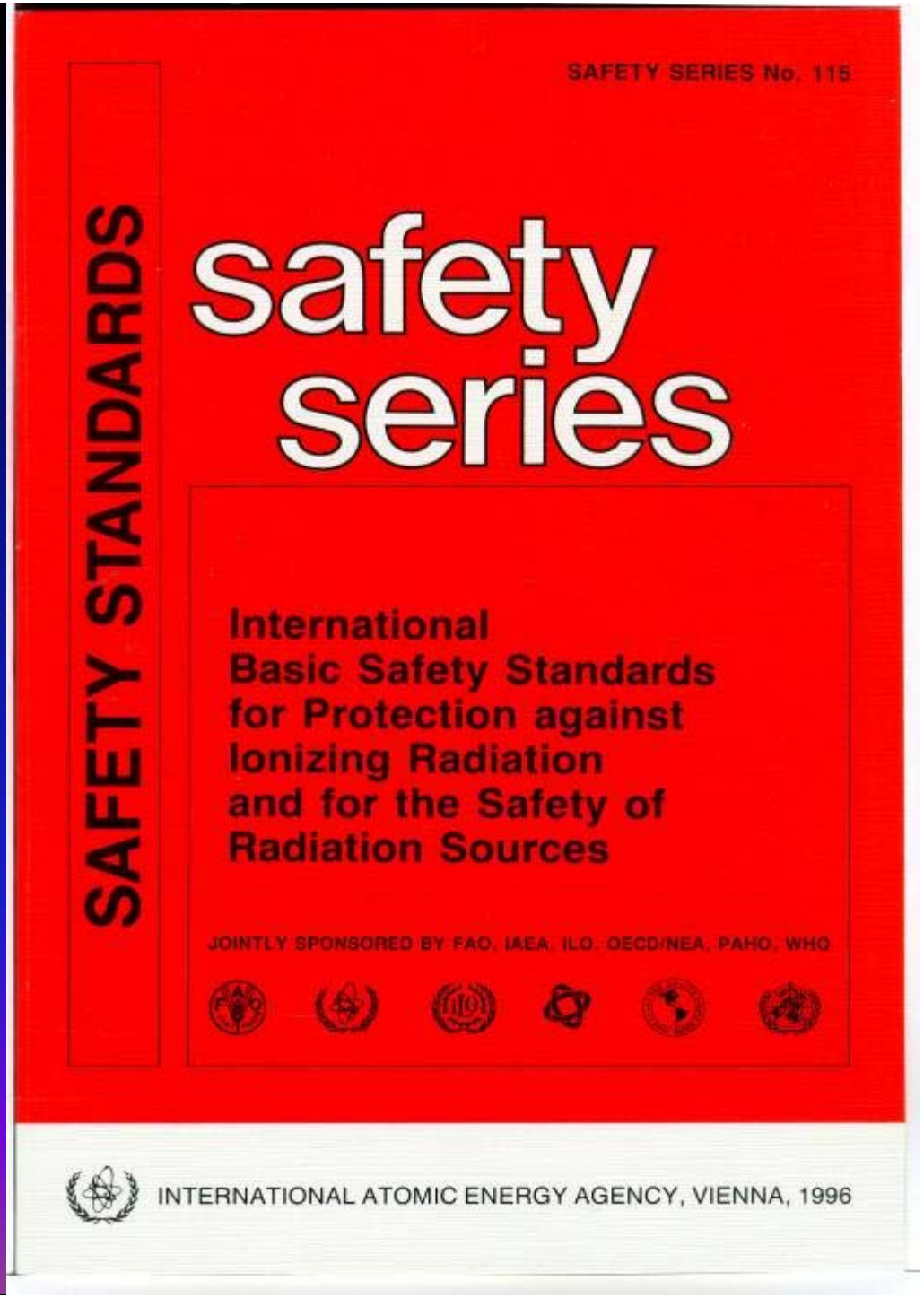

Existing Annual Dose
Attributable additional annual dose, +Δ E,
if +Δ E <10 μSv (up to 1mSv)
EXEMPTION
from Regulatory System
of Notification
and Authorization
Registration or
licensing?
Time


mSv in a year
1
DOSE LIMIT
0.3
DOSE CONSTRAINT
(TOTAL)
0.1
DOSE CONSTRAINT
(PROLONGED COMPONENT)
OPTIMIZATION
0.01
EXEMPTION
No contradiction

International exemption

levels were established in

Schedule 1 of BSS



International exemption levels

- Activity
- Activity concentration (except bulk amounts)
- Energy

  (radiation generators with e < 5keV)
- Dose rate

  (radiation generators delivering

  dose rate < 1μSv h^{-1} at 0.1m)

CLEARANCE:

exit from the system

(the least ‘clear’ concept)

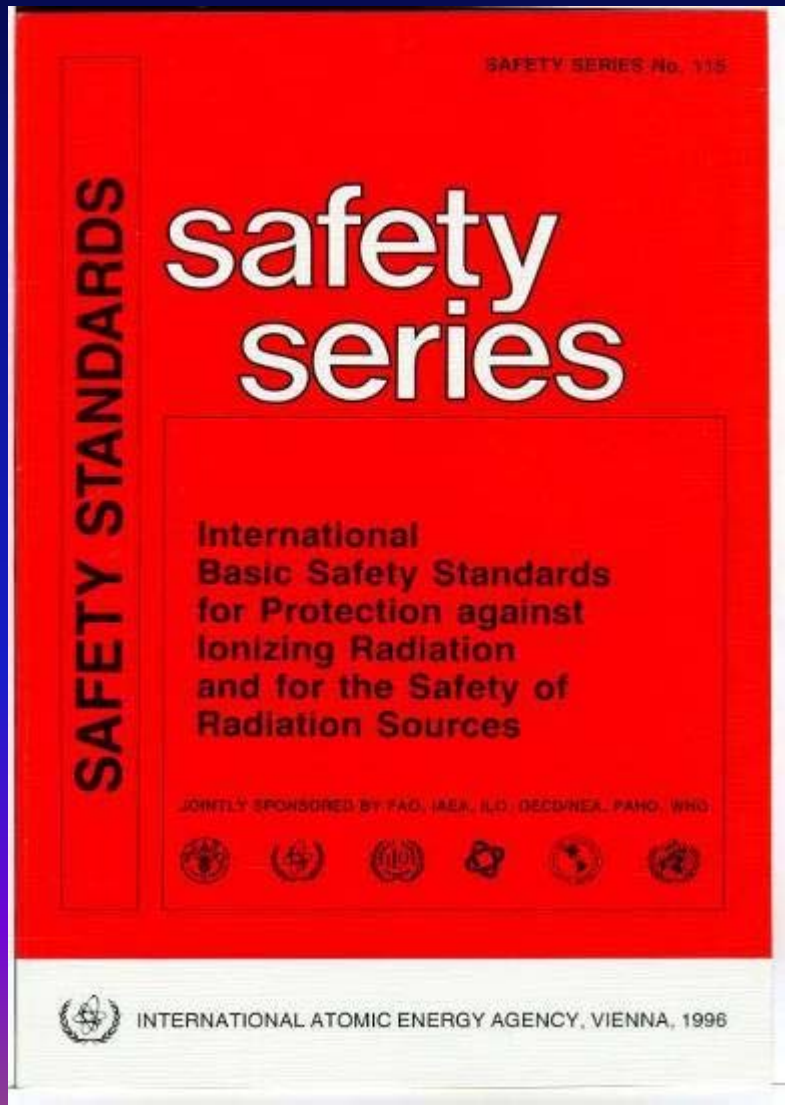
CLEARANCE

- Confusing, untranslatable terminology!
- Word with unclear meaning in English
- Translated into French as *'liberation'*
- Translated into Spanish as *'dispensation'*

(and sometimes as *declassification*)

Clearance

"Sources, including substances, materials and objects, within notified or authorized practices may be released from further requirements of the Standards subject to complying with clearance levels approved by the Regulatory Authority."



CONFUSION

Is ‘clearance’ equivalent to

- an exemption from within?

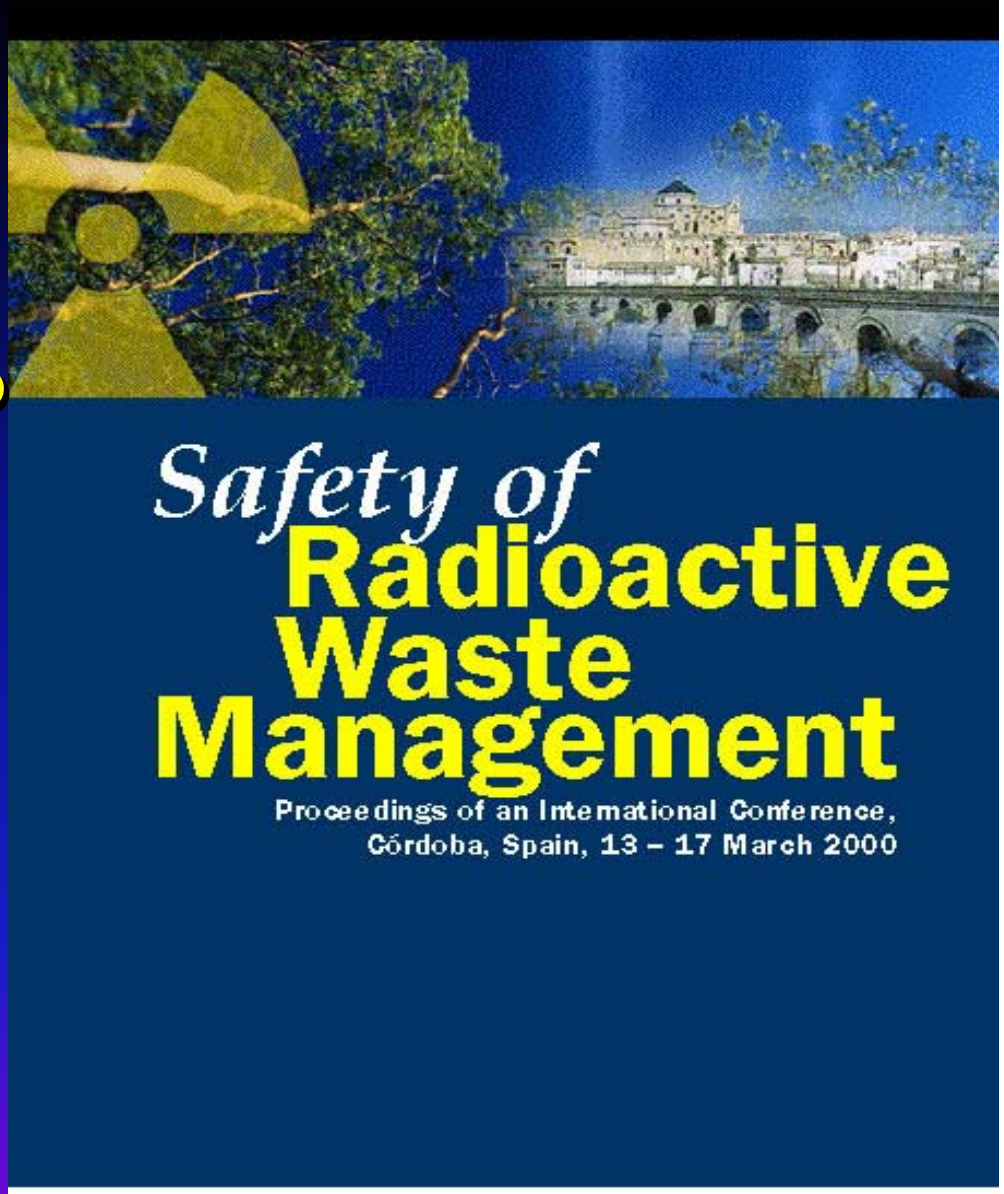
or

- an authorized release?

‘LIBERATION’

authorized level for discharges of radioactive materials into the environment ?

- If the concept is used as 'liberation', i.e., **authorization of release into the environment**, why is needed at all?
- Why the established concept of **authorized release level** is not used?



‘DISPENSATION’ (Dispensa) or Declassification (desclasificación)

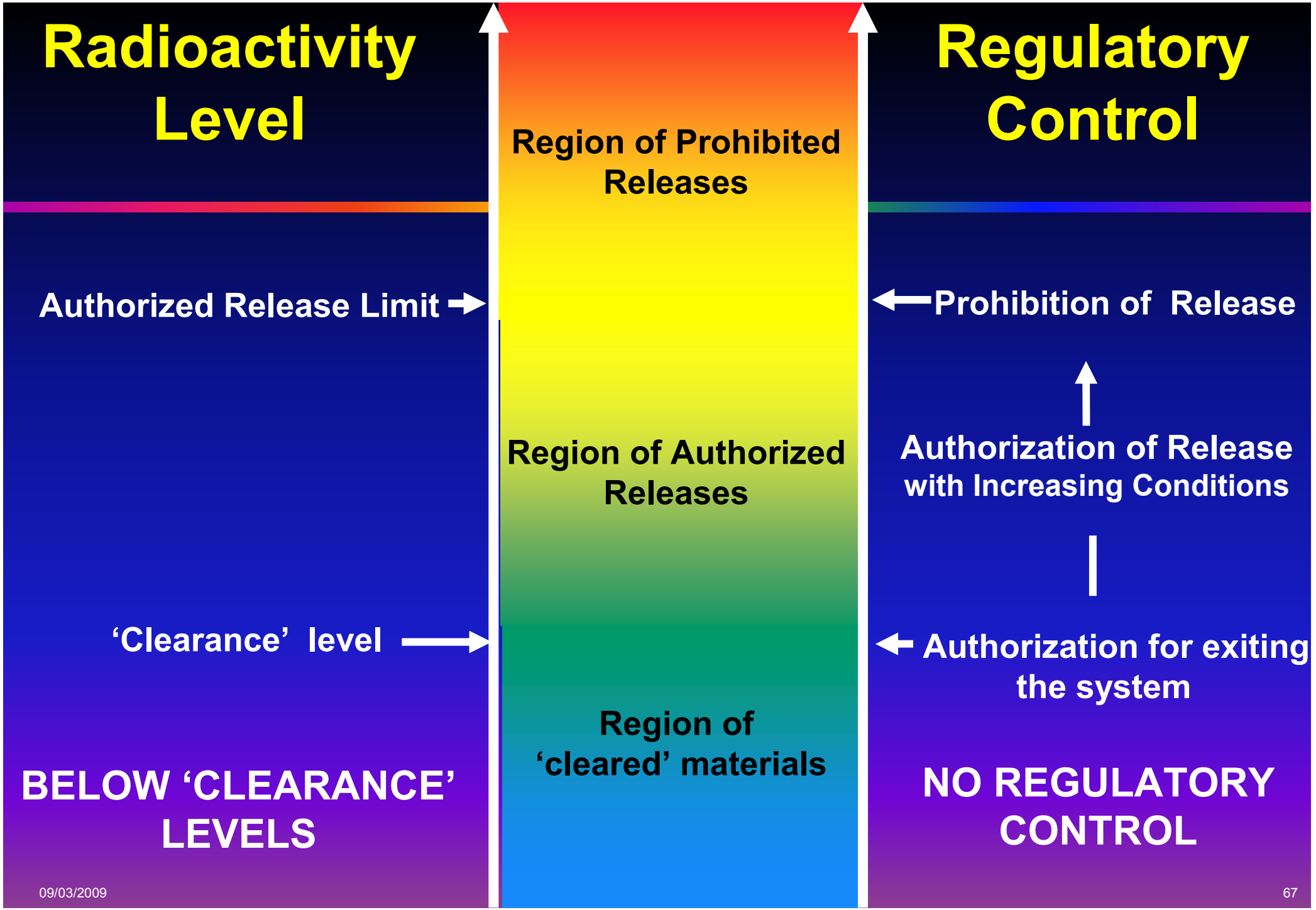
- **Original intention of the BSS drafters:**

  complement to exemption; i.e.:

  ***exemption*: permission not to enter into the system**

  ***clearance*: permission to exit the system) or**

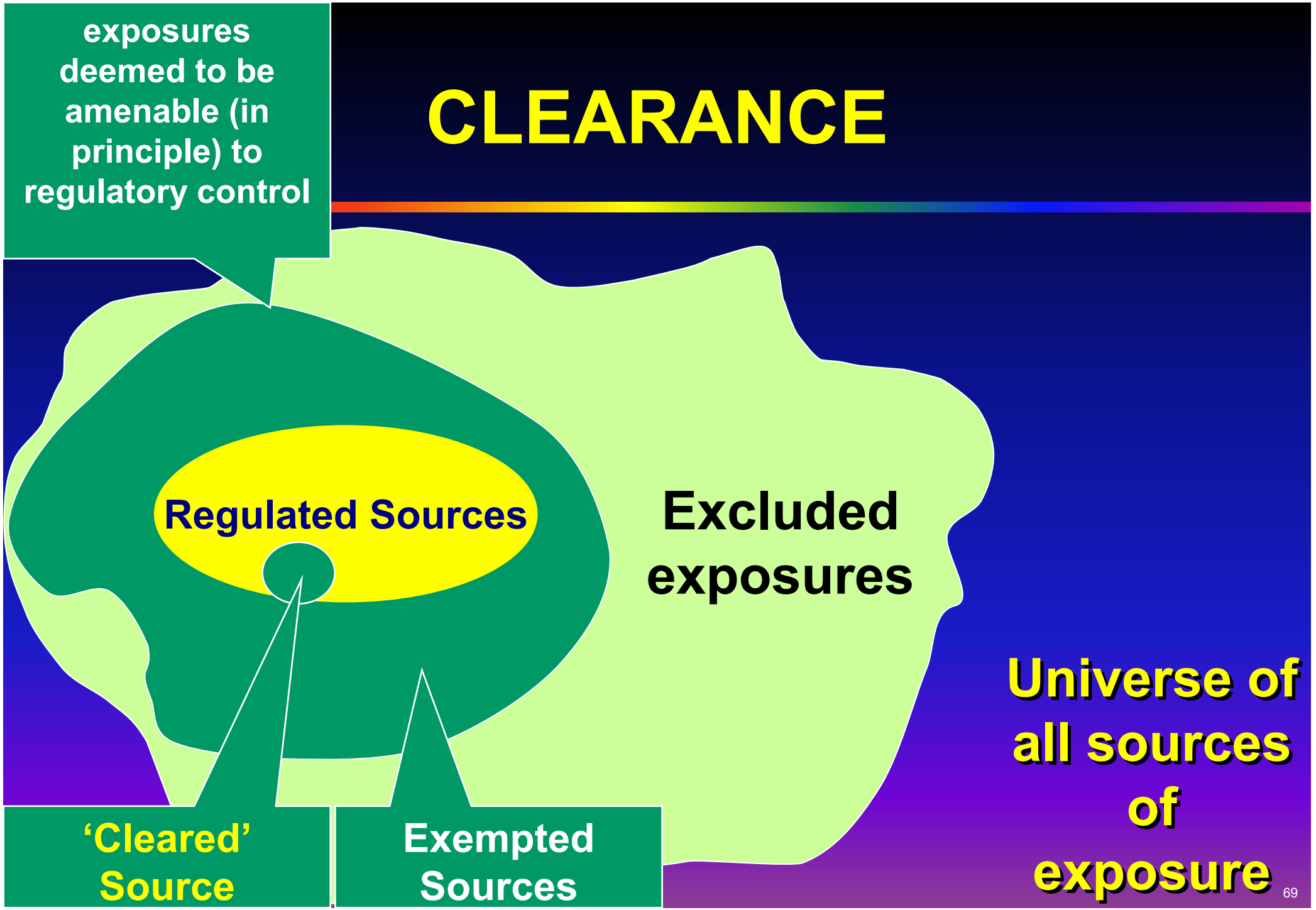
  EXEMPTION FROM WITHIN THE SYSTEM


Radioactivity Level
Regulatory Control
Region of Prohibited Releases
Region of Authorized Releases
Region of 'cleared' materials
Authorized Release Limit
'Clearance' level
Prohibition of Release
Authorization of Release with Increasing Conditions
Authorization for exiting the system
BELOW 'CLEARANCE' LEVELS
NO REGULATORY CONTROL

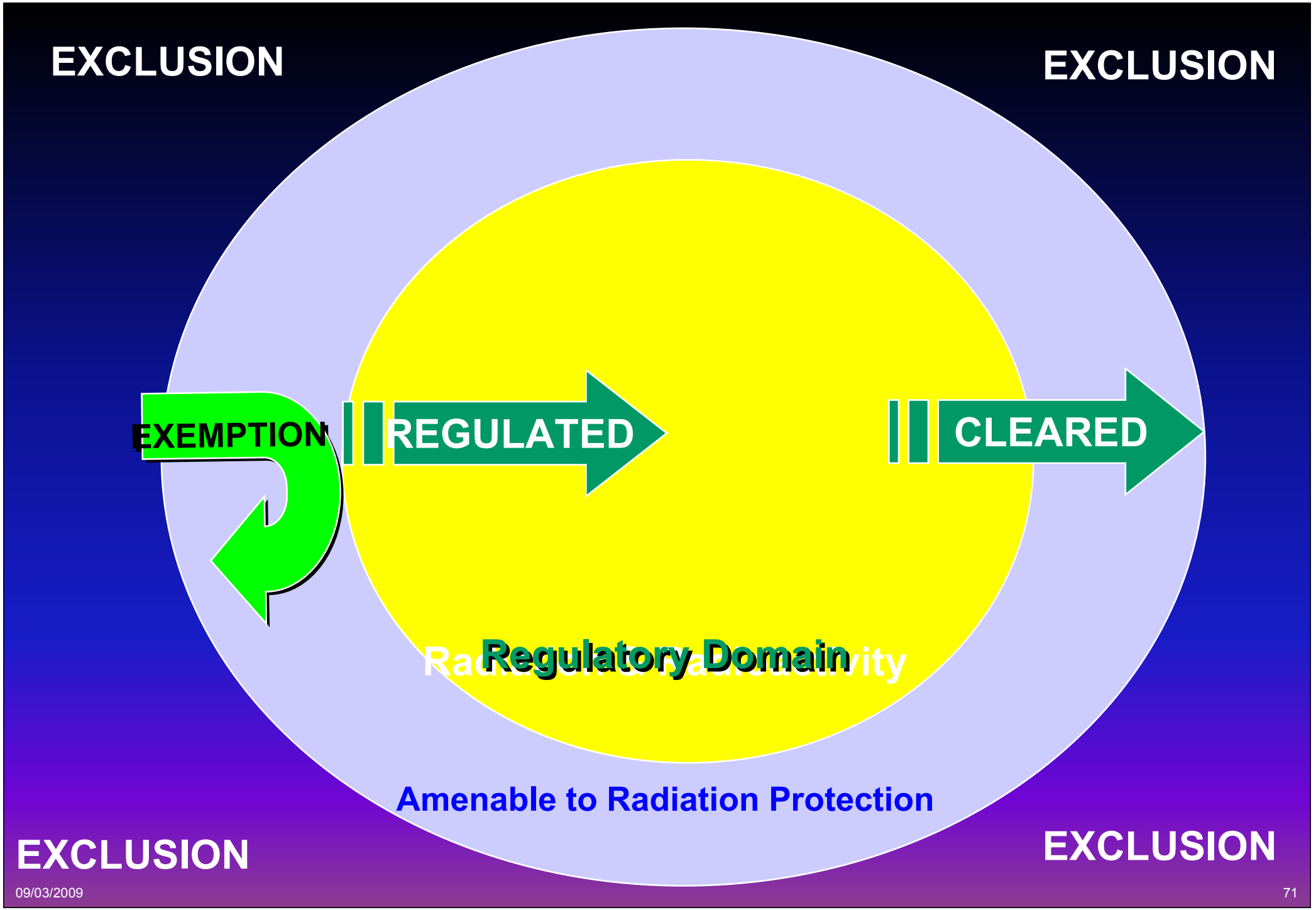
CLEARANCE LEVELS

- The BSS states that clearance levels should not be higher than the exemption levels
- Bulk quantities are involved, whereas the exemption levels were based on small quantities

CLEARANCE


exposures deemed to be amenable (in principle) to regulatory control
Regulated Sources
Excluded exposures
'Cleared' Source
Exempted Sources
Universe of all sources of exposure

Summary of the Conceptual Situation

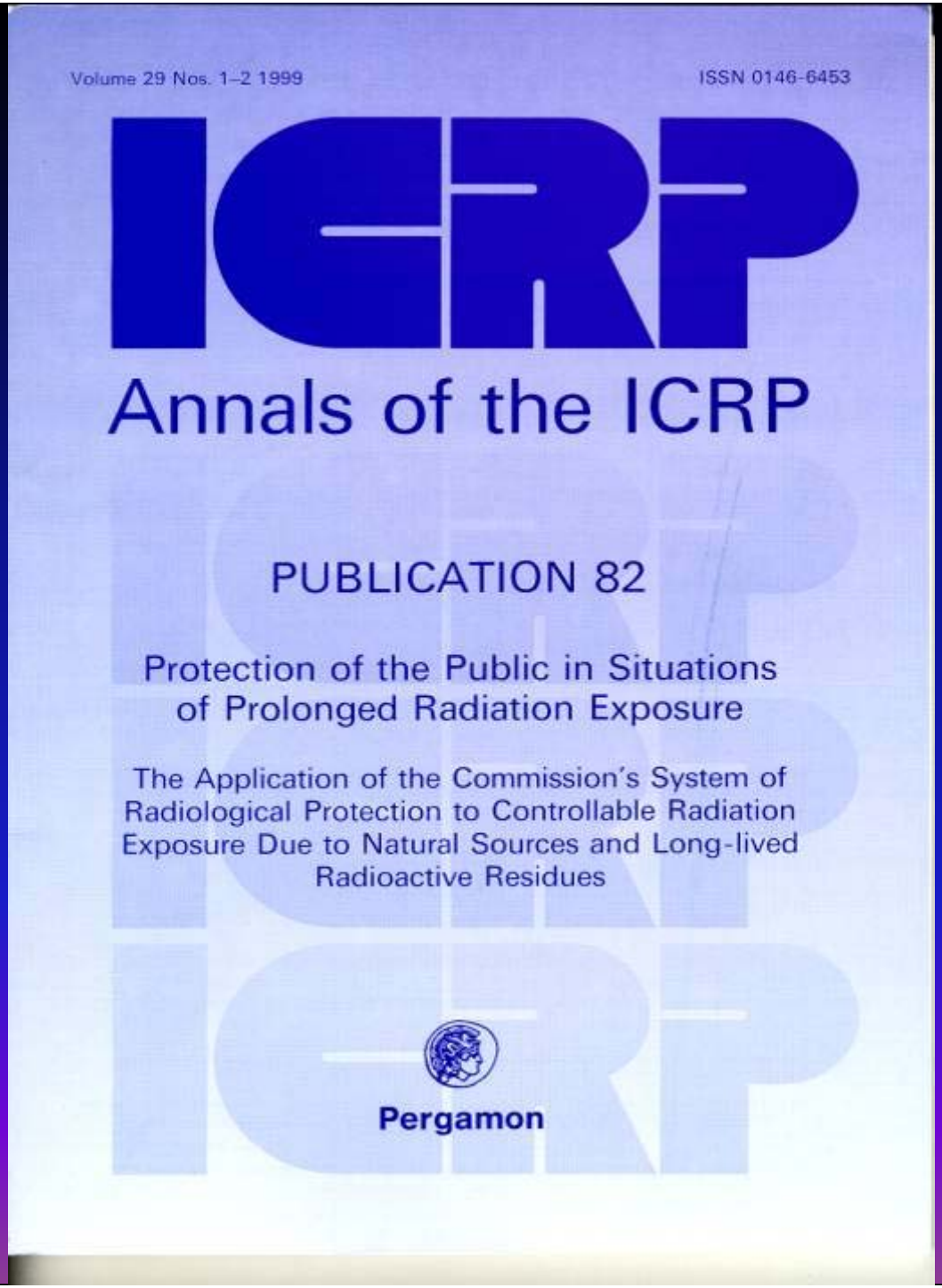

EXCLUSION
EXCLUSION
EXEMPTION
REGULATED
CLEARED
Regulatory Domain
Amenable to Radiation Protection
EXCLUSION
EXCLUSION

Styles

- **"Exempters" - retain as far as possible legal instruments for control of activities involving exposure to radiation. Minimal use of exclusion, preference for exemption (by regulatory decision).**
- **"Excluders" - only regulate activities that need to be brought into the scope of regulation. Preference for exclusion when appropriate, but also make full use of exemption.**

[The terms "exempters" and "excluders" were invented for this presentation only and have no other currency]

NO INTERVENTION


Volume 29 Nos. 1–2 1999
ISSN 0146-6453
ICRP
Annals of the ICRP
PUBLICATION 82
Protection of the Public in Situations of Prolonged Radiation Exposure
The Application of the Commission's System of Radiological Protection to Controllable Radiation Exposure Due to Natural Sources and Long-lived Radioactive Residues
Pergamon

CRITERIA FOR INTERVENING

(Extant Annual Dose)

100 mSv in a year

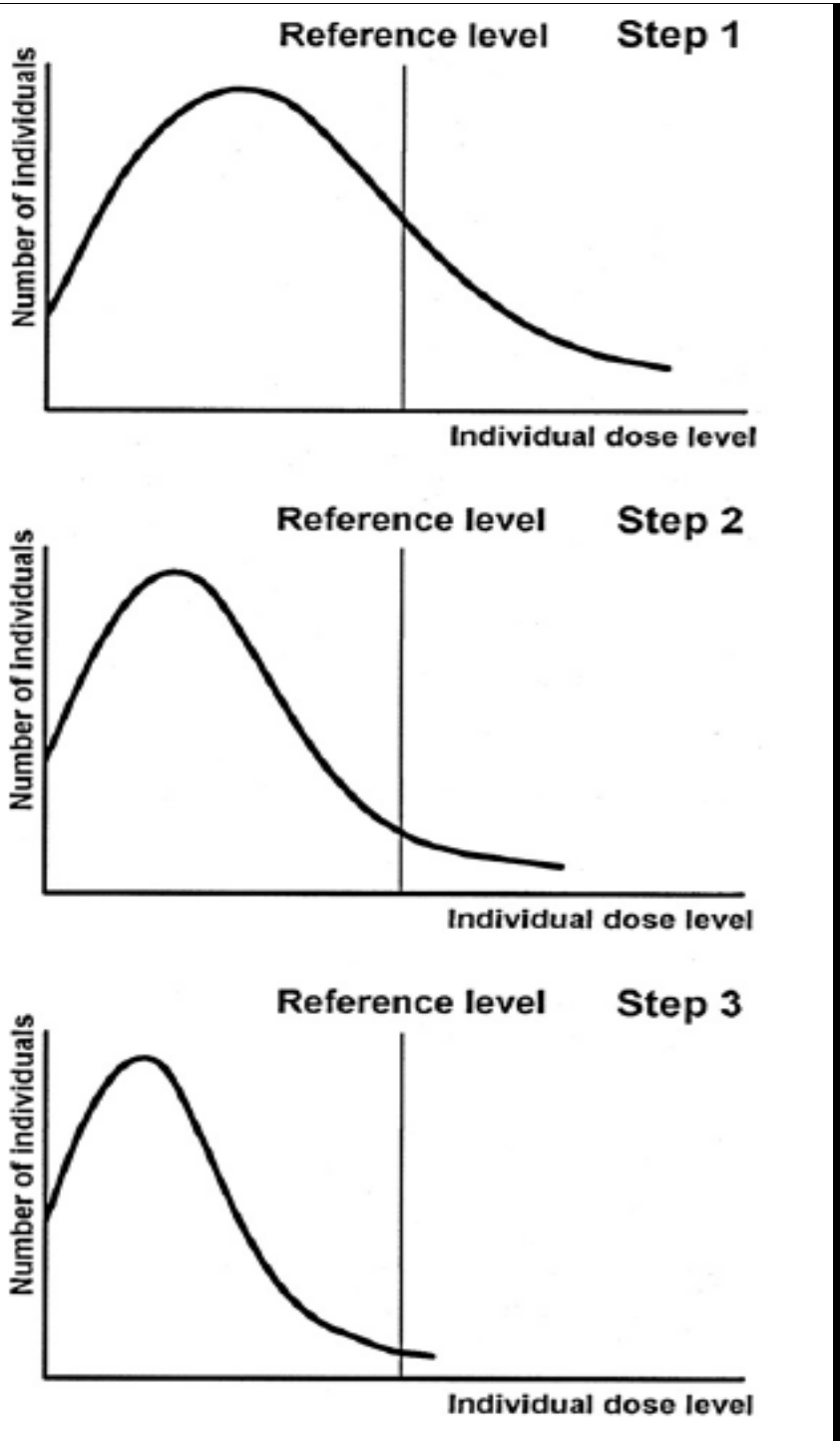
INTERVENTION ALMOST ALWAYS JUSTIFIABLE

10

INTERVENTION MAY BE JUSTIFIABLE

INTERVENTION IS NOT LIKELY TO BE JUSTIFIABLE

1


Reference level
Step 1
Number of Individuals
Individual dose level
Reference level
Step 2
Number of Individuals
Individual dose level
Reference level
Step 3
Number of Individuals
Individual dose level

- **Exclusion**
  - ***unamenable** control*
  - **of radiation exposure**

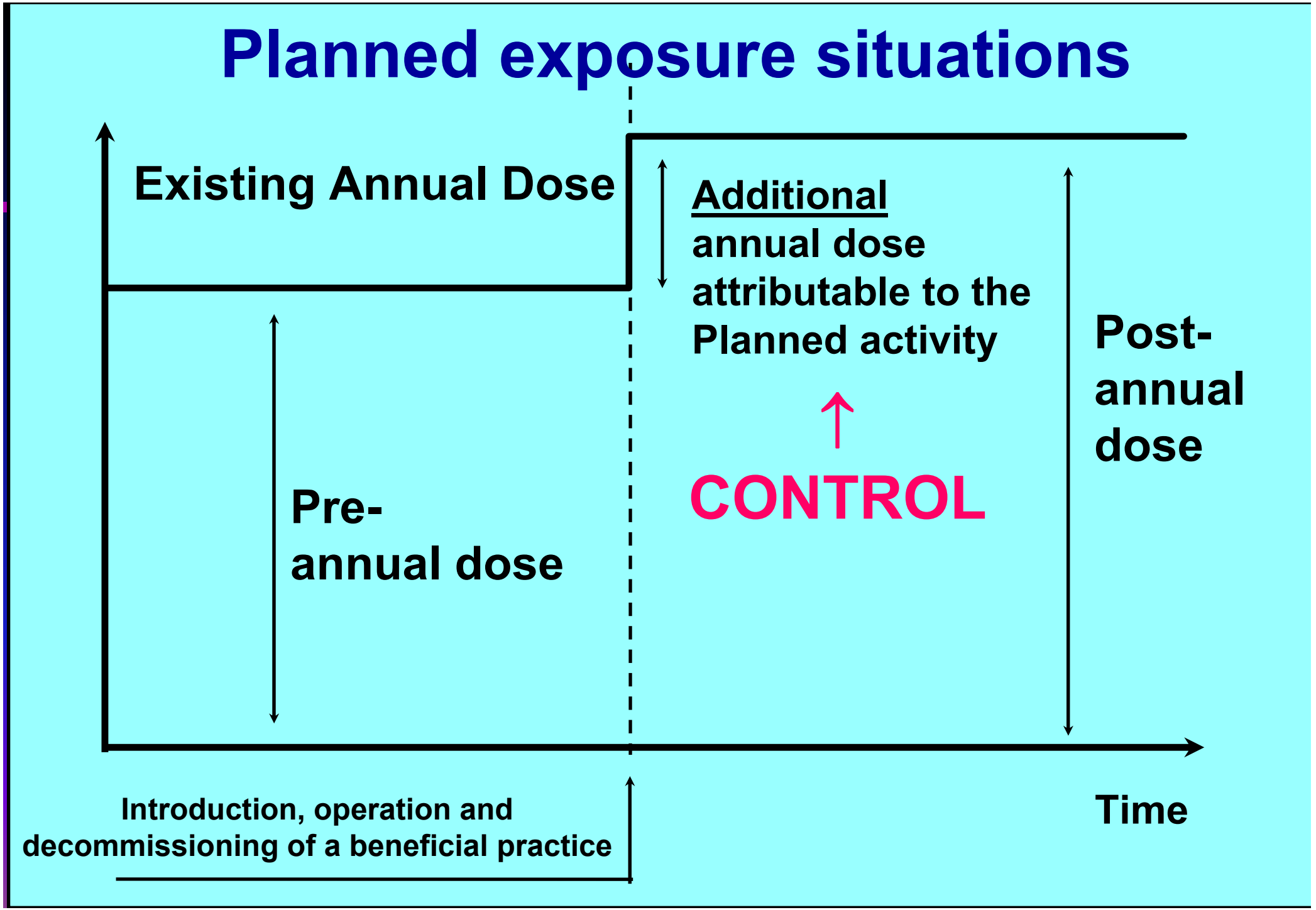
- **Exemption**
  - ***unwarranted** control*
  - **of new and inherently safe radiation sources**
- **Clearance**
  - ***removable** control*
  - **from materials already under control**
- **No Intervention**
  - ***unjustified** control*
  - **of existing situations**

Implications for scrap metal:

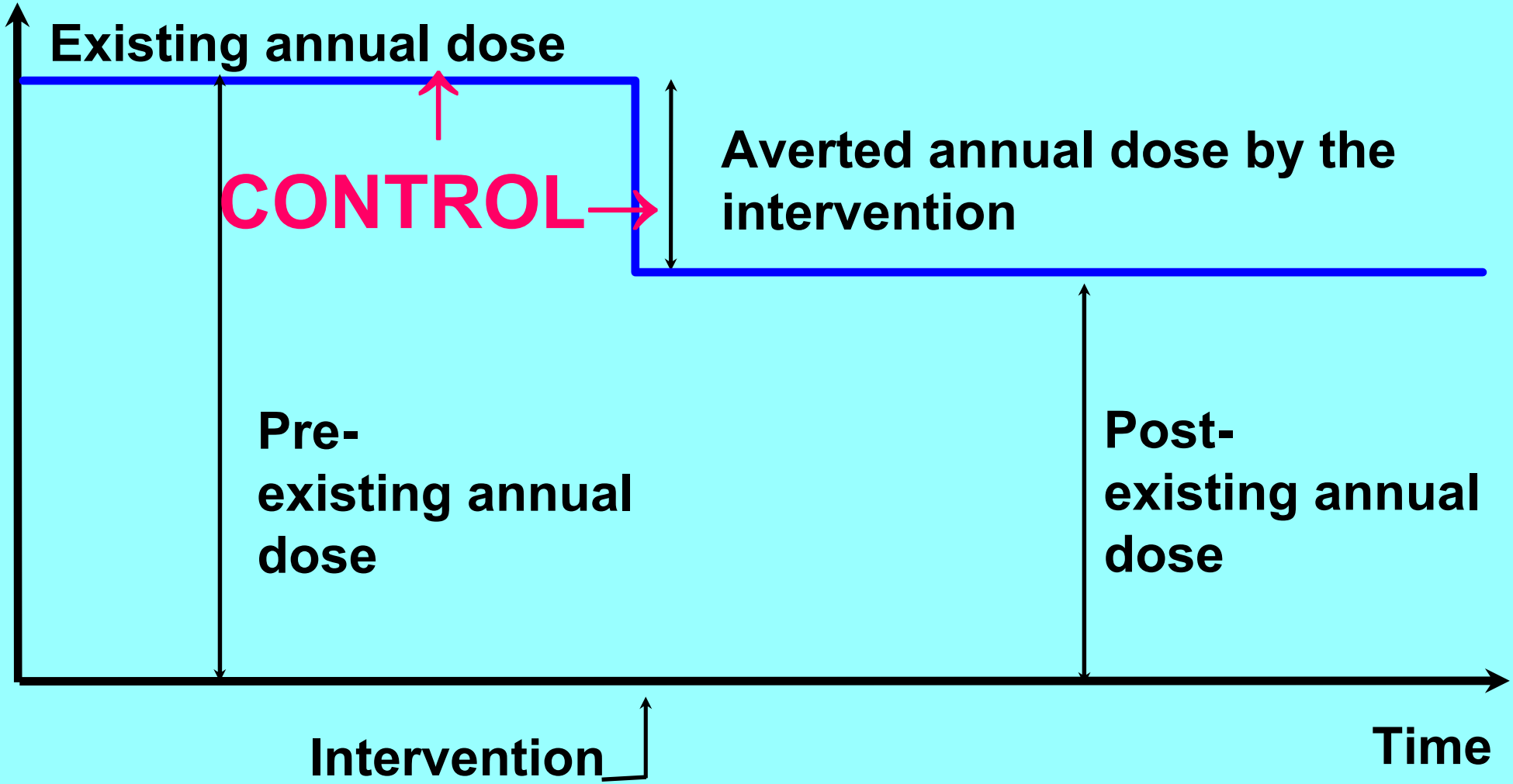
Control and management of inadvertent radioactive material

BASIC SUBDIVISION

- Planned exposure situations
  - prospective activities expecting to add radiation exposure
- Extant and emergency exposure situations
  - protective actions to reduce exposure


Planned exposure situations
Existing Annual Dose
Additional
annual dose
attributable to the
Planned activity
Post-
annual
dose
CONTROL
Pre-
annual dose
Introduction, operation and
decommissioning of a beneficial practice
Time

Extant and emergency exposure situations



THEORY

- If the scrap is attributable to a planned exposure situations,

  control through dose constraints

- In other cases,

  subject to reference levels

DILEMMA

Due to the globalization of markets,

acceptable levels:

- **cannot be established on a case-by-case basis**
- **need to be *standardized***

The political interest…

…and…

the time for action…

THE GENERAL CONFERENCE OF

THE INTERNATIONAL ATOMIC ENERGY AGENCY

Board of Governors
General Conference

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(GOV/2004/51)
Item 13 of the Conference's provisional agenda
(GC(48)/1)

Measures to Strengthen International Co-operation in Nuclear, Radiation and Transport Safety and Waste Management

Radiological Criteria for Radionuclides in Commodities

Report by the Director General

Suggested Approach

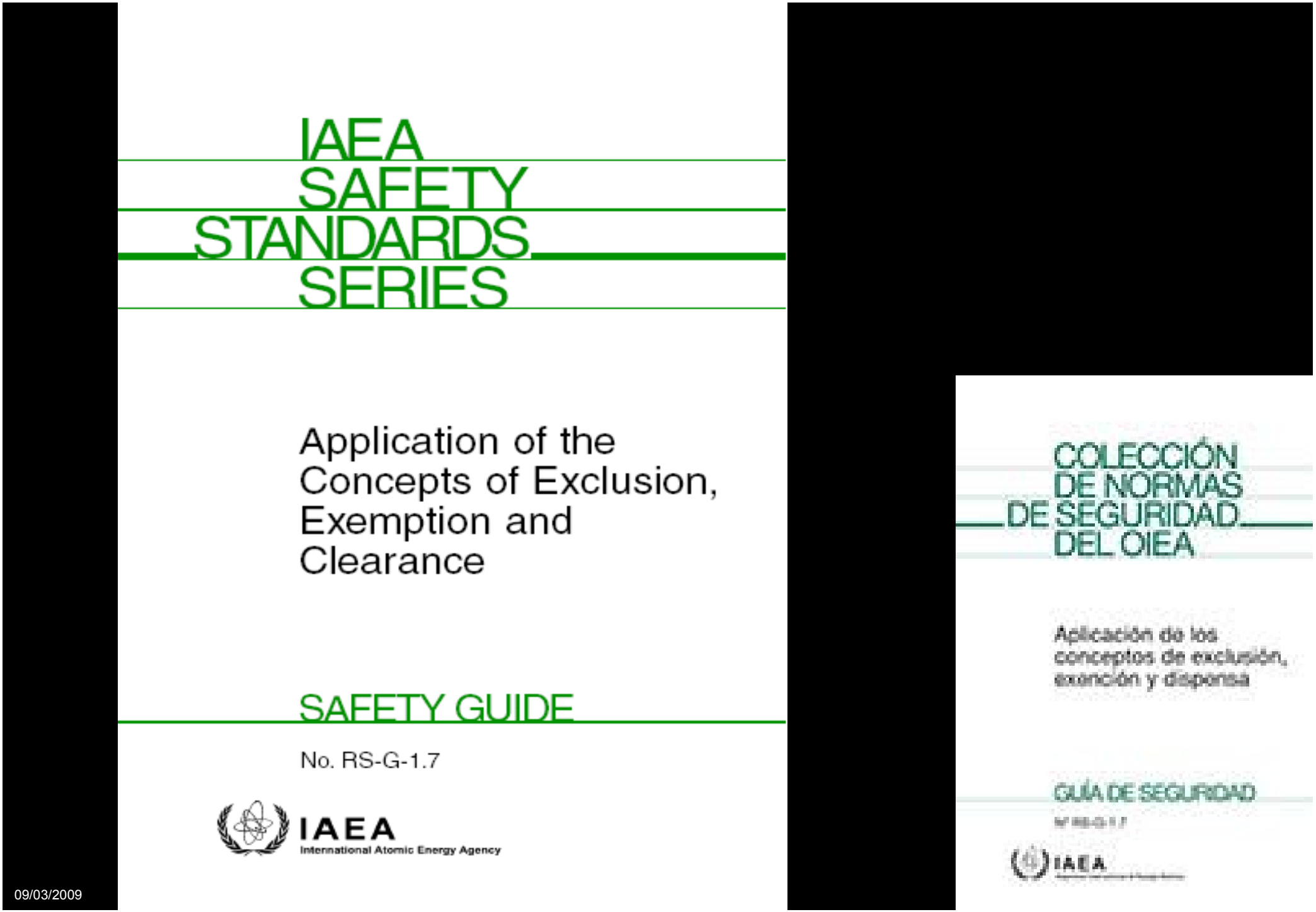
- Define the scope of regulatory control through a

simple set of

radionuclide-specific levels

of

activity concentration


IAEA
SAFETY
STANDARDS
SERIES
Application of the Concepts of Exclusion, Exemption and Clearance
SAFETY GUIDE
No. RS-G-1.7
IAEA
International Atomic Energy Agency
COLECCIÓN DE NORMAS DE SEGURIDAD DEL OIEA
Aplicación de los conceptos de exclusión, exención y dispensa
GUÍA DE SEGURIDAD
IAEA

SAFETY GUIDE RS-G-1.7

The values of activity concentration provided in this Safety Guide do not apply to foodstuffs, drinking water, animal feed and any material intended for this use.

TABLE 2. VALUES OF ACTIVITY CONCENTRATION FOR RADIONUCLIDES OF ARTIFICIAL ORIGIN IN BULK (see para. 4.4)

Radio-nuclide	Activity concen-tration (Bq/g)		Radio-nuclide	Activity concen-tration (Bq/g)		Radio-nuclide	Activity concen-tration (Bq/g)	
H-3	100		Mn-56	10	*	Se-75	1	
Be-7	10		Fe-52	10	*	Br-82	1	
C-14	1		Fe-55	1000		Rb-86	100	
F-18	10	*	Fe-59	1		Sr-85	1	
Na-22	0.1		Co-55	10	*	Sr-85m	100	*
Na-24	1	*	Co-56	0.1		Sr-87m	100	*
Si-31	1000	*	Co-57	1		Sr-89	1000	
P-32	1000		Co-58	1		Sr-90	1	
P-33	1000		Co-58m	10000	*	Sr-91	10	*
S-35	100		Co-60	0.1		Sr-92	10	*
Cl-36	1		Co-60m	1000	*	Y-90	1000	
Cl-38	10	*	Co-61	100	*	Y-91	100	
K-42	100		Co-62m	10	*	Y-91m	100	*
K-43	10	*	Ni-59	100		Y-92	100	*
Ca-45	100		Ni-63	100		Y-93	100	*
Ca-47	10		Ni-65	10	*	Zr-93	10	*
Sc-46	0.1		Cu-64	100	*	Zr-95	1	
Sc-47	100		Zn-65	0.1		Zr-97	10	*
Sc-48	1		Zn-69	1000	*	Nb-93m	10	
V-48	1		Zn-69m	10	*	Nb-94	0.1	
Cr-51	100		Ga-72	10	*	Nb-95	1	
Mn-51	10	*	Ge-71	10000		Nb-97	10	*
Mn-52	1		As-73	1000		Nb-98	10	*
Mn-52m	10	*	As-74	10	*	Mo-90	10	*
Mn-53	100		As-76	10	*	Mo-93	10	
Mn-54	0.1		As-77	1000		Mo-99	10	

TABLE 2. VALUES OF ACTIVITY CONCENTRATION FOR RADIONUCLIDES OF ARTIFICIAL ORIGIN IN BULK (see para. 4.4) (cont.)

Radio-nuclide	Activity concen-tration (Bq/g)		Radio-nuclide	Activity concen-tration (Bq/g)		Radio-nuclide	Activity concen-tration (Bq/g)	
Mo-101	10	*	Sn-125	10		Cs-129	10	
Tc-96	1		Sb-122	10		Cs-131	1000	
Tc-96m	1000	*	Sb-124	1		Cs-132	10	
Tc-97	10		Sb-125	0.1		Cs-134	0.1	
Tc-97m	100		Te-123m	1		Cs-134m	1000	*
Tc-99	1		Te-125m	1000		Cs-135	100	
Tc-99m	100	*	Te-127	1000		Cs-136	1	
Ru-97	10		Te-127m	10		Cs-137	0.1	
Ru-103	1		Te-129	100	*	Cs-138	10	*
Ru-105	10	*	Te-129m	10		Ba-131	10	
Ru-106	0.1		Te-131	100	*	Ba-140	1	
Rh-103m	10000	*	Te-131m	10		La-140	1	
Rh-105	100		Te-132	1		Ce-139	1	
Pd-103	1000		Te-133	10	*	Ce-141	100	
Pd-109	100		Te-133m	10	*	Ce-143	10	
Ag-105	1		Te-134	10	*	Ce-144	10	
Ag-110m	0.1		I-123	100		Pr-142	100	*
Ag-111	100		I-125	100		Pr-143	1000	
Cd-109	1		I-126	10		Nd-147	100	
Cd-115	10		I-129	0.01		Nd-149	100	*
Cd-115m	100		I-130	10	*	Pm-147	1000	
In-111	10		I-131	10		Pm-149	1000	
In-113m	100	*	I-132	10	*	Sm-151	1000	
In-114m	10		I-133	10	*	Sm-153	100	
In-115m	100	*	I-134	10	*	Eu-152	0.1	
Sn-113	1		I-135	10	*	Eu-152m	100	*

TABLE 2. VALUES OF ACTIVITY CONCENTRATION FOR RADIONUCLIDES OF ARTIFICIAL ORIGIN IN BULK (see para. 4.4) (cont.)

Radio-nuclide	Activity concen-tration (Bq/g)		Radio-nuclide	Activity concen-tration (Bq/g)		Radio-nuclide	Activity concen-tration (Bq/g)	
Eu-154	0.1		Ir-192	1		Pa-230	10	
Eu-155	1		Ir-194	100	*	Pa-233	10	
Gd-153	10		Pt-191	10		U-230	10	
Gd-159	100	*	Pt-193m	1000		U-231	100	
Tb-160	1		Pt-197	1000	*	U-232	0.1	
Dy-165	1000	*	Pt-197m	100	*	U-233	1	
Dy-166	100		Au-198	10		U-236	10	
Ho-166	100		Au-199	100		U-237	100	
Er-169	1000		Hg-197	100		U-239	100	*
Er-171	100	*	Hg-197m	100		U-240	100	*
Tm-170	100		Hg-203	10		Np-237	1	
Tm-171	1000		Tl-200	10		Np-239	100	
Yb-175	100		Tl-201	100		Np-240	10	*
Lu-177	100		Tl-202	10		Pu-234	100	*
Hf-181	1		Tl-204	1		Pu-235	100	*
Ta-182	0.1		Pb-203	10		Pu-236	1	
W-181	10		Bi-206	1		Pu-237	100	
W-185	1000		Bi-207	0.1		Pu-238	0.1	
W-187	10		Po-203	10	*	Pu-239	0.1	
Re-186	1000		Po-205	10	*	Pu-240	0.1	
Re-188	100	*	Po-207	10	*	Pu-241	10	
Os-185	1		At-211	1000		Pu-242	0.1	
Os-191	100		Ra-225	10		Pu-243	1000	*
Os-191m	1000	*	Ra-227	100		Pu-244	0.1	
Os-193	100		Th-226	1000		Am-241	0.1	
Ir-190	1		Th-229	0.1		Am-242	1000	*

TABLE 2. VALUES OF ACTIVITY CONCENTRATION FOR RADIONUCLIDES OF ARTIFICIAL ORIGIN IN BULK (see para. 4.4) (cont.)

Radio-nuclide	Activity concen-tration (Bq/g)	Radio-nuclide	Activity concen-tration (Bq/g)	Radio-nuclide	Activity concen-tration (Bq/g)	
Am-242m	0.1	Cm-248	0.1	Cf-253	100	
Am-243	0.1	Bk-249	100	Cf-254	1	
Cm-242	10	Cf-246	1000	Es-253	100	
Cm-243	1	Cf-248	1	Es-254	0.1	
Cm-244	1	Cf-249	0.1	Es-254m	10	
Cm-245	0.1	Cf-250	1	Fm-254	10000	*
Cm-246	0.1	Cf-251	0.1	Fm-255	100	*
Cm-247	0.1	Cf-252	1			

* Half-life of less than 1 day.

Radionuclides	Level (Bq/g)
I-129	0.01
Na-22; Sc-46; Mn-54; Co-56; Co-60; Zn-65; Nb-94; Ru-106; Ag-110m; Sb-125; Cs-134; Cs-137; Eu-152; Eu-154; Ta-182; Bi-207; Th-229; U-232; Pu-238; Pu-239; Pu-240; Pu-242; Pu-244; Am-241; Am-242m; Am-243; Cm-245; Cm-246; Cm-247; Cm-248; Cf-249; Cf-251; Es-254	0.1
C-14; Na-24; Cl-36; Sc-48; V-48; Mn-52; Fe-59; Co-57; Co-58; Se-75; Br-82; Sr-85; Sr-90; Zr-95; Nb-95; Tc-96; Tc-99; Ru-103; Ag-105; Cd-109; Sn-113; Sb-124; Te-123m; Te-132; Cs-136; Ba-140;La-140;Ce-139; Eu-155; Tb-160; Hf-181; Os-185; Ir-190; Ir-192; Tl-204; Bi-206; Th-232 [1], U-233; U-235 [2]; U-238 [3] Np-237; Pu-236; Cm-243; Cm-244; Cf-248; Cf-250; Cf-252; Cf-254	1
Be-7; F-18; Cl-38; K-40; K-43; Ca-47; Mn-51; Mn-52m; Mn-56; Fe-52; Co-55; Co-62m; Ni-65; Zn-69m; Ga-72; As-74; As-76; Sr-91; Sr-92; Zr-93; Zr-97; Nb-93m; Nb-97; Nb-98; Mo-90; Mo-93; Mo-99; Mo-101; Tc-97; Ru-97; Ru-105; Cd-115; In-111; In-114m; Sn-125; Sb-122; Te-127m; Te-129m; Te-131m; Te-133; Te-133m; Te-134; I-126; I-130; I-131; I-132; I-133; I-134; I-135; Cs-129; Cs-132; Cs-138; Ba-131; Ce-143; Ce-144; Gd-153; W-181; W-187; Pt-191; Au-198; Hg-203; Tl-200; Tl-202; Pb-203; Po-203; Po-205; Po-207; Ra-225; Pa-230; Pa-233; U-230; U-236; Np-240; Pu-241; Cm-242; Es-254m	10
H-3; S-35; K-42; Ca-45; Sc-47; Cr-51; Mn-53; Co-61; Ni-59; Ni-63; Cu-64; Rb-86; Sr-85m; Sr-87m; Y-91; Y-91m; Y-92; Y-93; Tc-97m; Tc-99m; Rh-105; Pd-109; Ag-111; Cd-115m; In-113m; In-115m; Te-129; Te-131; I-123; I-125; Cs-135; Ce-141; Pr-142; Nd-147; Nd-149; Sm-153; Eu-152m; Gd-159; Dy-166; Ho-166; Er-171; Tm-170; Yb-175; Lu-177; Re-188; Os-191; Os-193; Ir-194; Pt-197m; Au-199; Hg-197; Hg-197m; Tl-201; Ra-227; U-231; U-237; U-239; U-240; Np-239; Pu-234; Pu-235; Pu-237; Bk-249; Cf-253; Es-253; Fm-255	100
Si-31; P-32; P-33; Fe-55; Co-60m; Zn-69; As-73; As-77; Sr-89; Y-90; Tc-96m; Pd-103; Te-125m; Te-127; Cs-131; Cs-134m; Pr-143; Pm-147; Pm-149; Sm-151; Dy-165; Er-169; Tm-171; W-185; Re-186; Os-191m; Pt-193m; Pt-197; At-211; Th-226; Pu-243; Am-242; Cf-246	1000
Co-58m; Ge-71; Rh-103m; Fm-254	10 000

Mixtures of Radionuclides

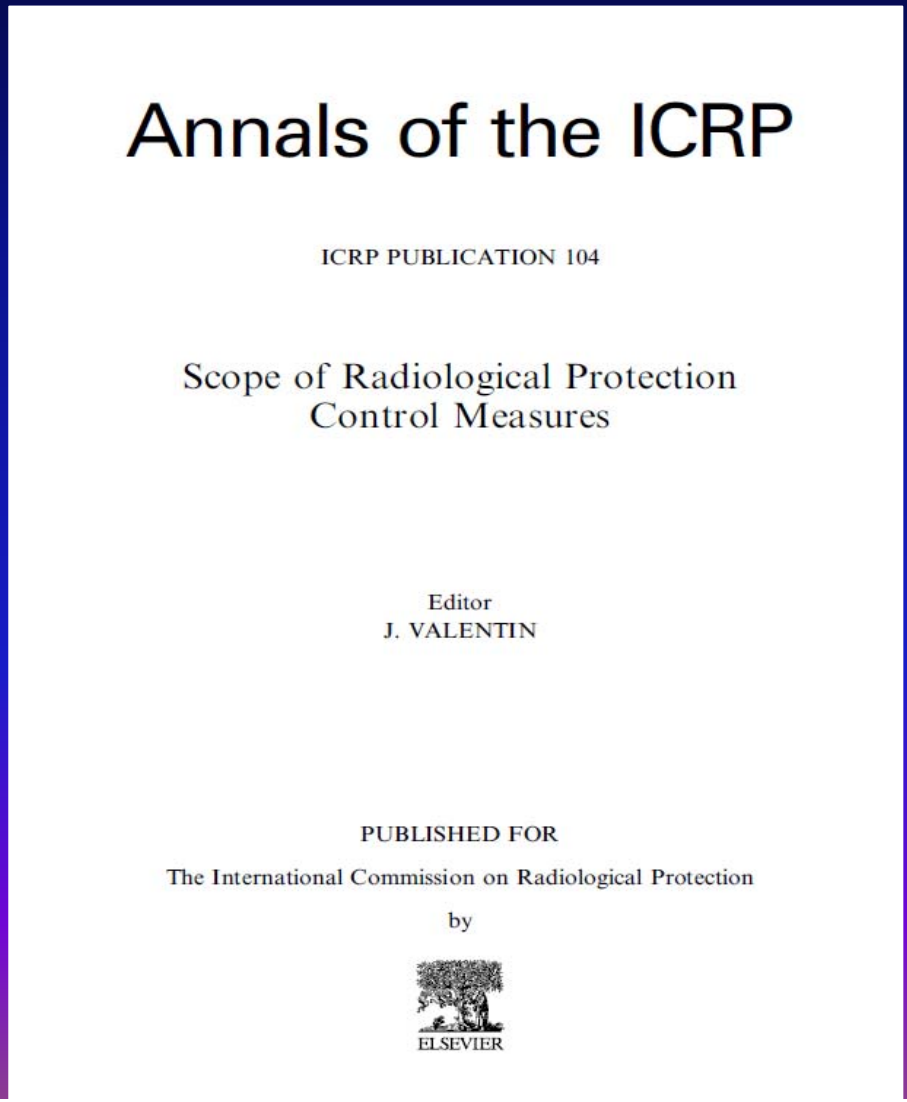
- The following formula should be used:

$$\sum_{i=1}^{n} \frac{C_i}{(\text{activity concentration})_i} \leq 1$$

Where:

- C_i is the concentration (Bq/g) of the i^{th} radionuclide of artificial origin in the material,
- $(\text{activity concentration})_i$ is the value of activity concentration for the radionuclide *i* in the material and
- *n* is the number of radionuclides present.

ICRP Publication 104



Monitoring Compliance

Conundrum

How to solve the problem of satisfying the clearance criterion while considering the uncertainties of the measurement and the nuclide spectrum?

CRIEPI

Central Research Institute of Electric Power Industry

Radiation Safety Research Center

Mr. Takatoshi Hattori

Paragraph (95) ……The Commission recognizes that there may be uncertainty (or variation) in the radionuclide composition of a material. In such a case, there are some concerns that the public could be exposed to a dose above the dose criterion for exemption without further consideration (10 microSv/year), although this has quite a low probability of occurring. However, in the derivation of exemption levels in the BSS (IAEA, 1996) and in the safety guide on the application of the concepts of exclusion, exemption, and clearance (IAEA, 2004b), which were agreed internationally, two dose criteria were used; 0.01 mSv/year for realistic scenarios and 1 mSv/year for low-probability scenarios. This indicates that the exemption levels agreed under the aegis of intergovernmental organisations allow the possibility of doses greater than 10 microSv/year in the case of low-probability situations. In this regard, the Commission considers that, in cases of uncertainty (or variation) in the radionuclide composition of a material, there is not usually a need to make clearance levels stricter. However, if the uncertainties in nuclide composition are very large, or if the presence of alpha- and beta-emitting nuclides cannot be adequately inferred through gamma measurements, the regulatory body may establish specific criteria for clearance, or may demand assessments involving radionuclide analysis in addition to, or in place of, gamma measurements.

Epilogue

How is the situation today?

- Much better than in 2000: an intergovernmental agreement on clearance levels exists!!
- However:
  - inconsistencies and unnecessary complications
  - diaspora of national criteria

Artificial Nuclides
(Numerical Examples)

Radio-nuclide (examples)	Dangerous	Exemption levels	Clearance levels <1 ton	Clearance levels (bulk)
	Activity	Activity	Activity concentration	Activity concentration
	TBq	Bq	Bq/g	Bq/g
Co-60	0.03	100 000	10	0.1
Cs-137	0.1	10 000	10	0.1
Ir-192	0.08	10 000	10	1
Am-241	0.06	10 000	1	0.1

Natural Nuclides

Clearance levels

Radionuclide	Activity concentration (Bq/g)
40K	10
All other radionuclides of natural origin	1

Are we ready for a simplifying and rationalizing revolution?

Yes?

- Let's start negotiating an international protocol, including legal obligations and simple straightforward technical criteria, such as:

- **Any substance/material with activity density lower than 0.1 - 1Bq/g is considered *de minimis not curat lex* and therefore tailored to *exclusion* from radiation protection legislation.**

- **Any commodity with activity density around 1 - 10 Bq/g is considered *de minimis not curat prætor* and therefore subject to *a priori* exemption or *a posteriori* clearance by regulators.**

- **Any commodity with activity density above 10 - 100 Bq/g should be registered before the regulator**

…and this could be an international binding undertaking under the aegis of the IAEA!

Because… *'there will be no protection for any unless there is protection for all'*

Howard Koch (1901-1995)

My last rumination

Exclusion* and *exemption

Bring to me as a temptation,

Reminiscences of a lawyer named Rex,

Who was sadly deficient in sex,

But when confronted with exposure,

He declared with composure,

'de minimis not curat Rex'

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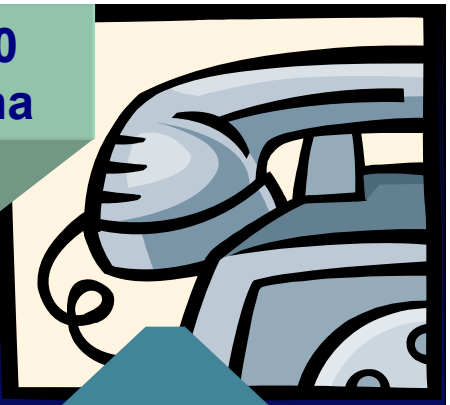
Buenos Aires, Argentina



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Thank you for your tolerance!

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