Joint Research Centre

The European Commission's in-house science service

1

Clearance procedure:

JRC approach according to Italian nuclear legislation

Giovanni Macchi
L&O Sector
Nuclear Decommissioning Unit
Ispra Site Management

Gregori Dimitroff
NDE/NDA Engineer
BCSN - France

http://www.jrc.ec.europa.eu

11 November 2015

2

COURSE CONTENT

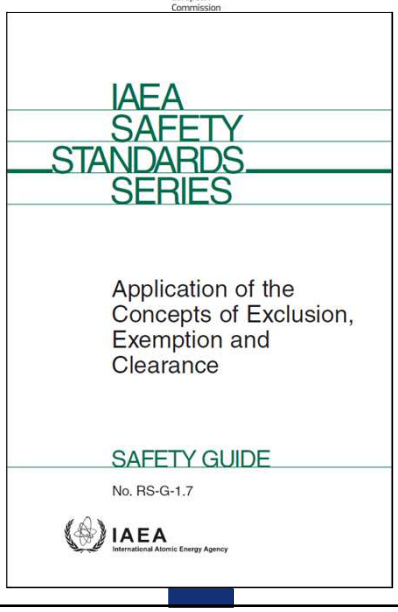
1. Definition and Criteria
2. International overview
3. Italian Legislation
4. JRC situation

3

COURSE CONTENT

1. Definition and Criteria
2. International overview
3. Italian Legislation
4. JRC situation

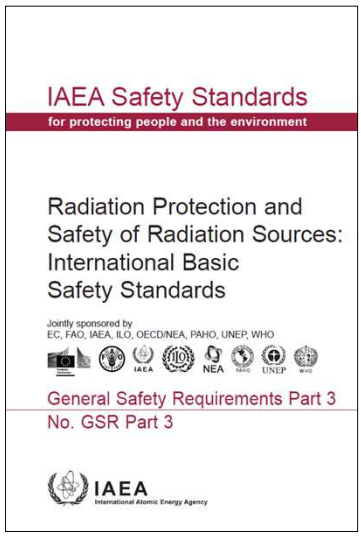
4



5

Clearance is defined as the **removal of radioactive materials** or radioactive objects within authorized practices **from any further regulatory control** by the regulatory body" (IAEA RS-G-1.7)

6



7

CRITERIA FOR CLEARANCE

I.10. The general **criteria for clearance** are that:

(a) **Radiation risks** arising from the cleared material **are sufficiently low as not to warrant regulatory control**, and there is no appreciable likelihood of occurrence for scenarios that could lead to a failure to meet the general criterion for clearance; or

(b) **Continued regulatory control** of the material would yield **no net benefit**, in that no reasonable control measures would achieve a worthwhile return in terms of reduction of individual doses or reduction of health risks.

8

COURSE CONTENT

1. Definition and Criteria
2. International overview
3. Italian Legislation
4. JRC situation

9

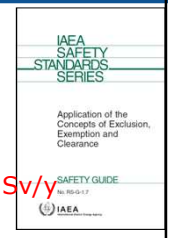
International Regulations

- IAEA RS-G-1.7

- EU RP 89 Metals
RP 113 Buildings
RP 122 Materials

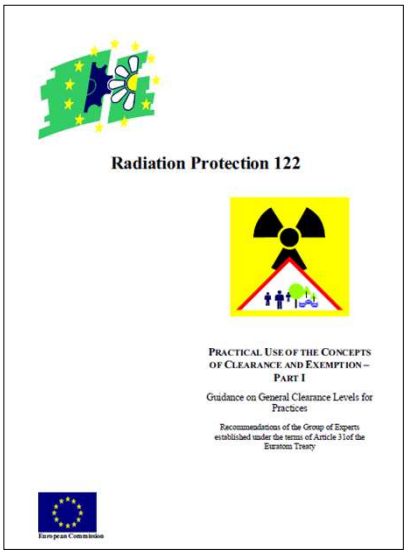
10

International Regulations – IAEA RS-G-1.7



- Dose for a member of the public in the range of 10 µSv/y
- Single events with low likelihood can be accepted if < 1 mSv/y effective dose and < 50 mSv/h skin dose
- 1 man Sv/y collective dose
- No mass restriction
- 100% exhaustion of the clearance levels assumed; all applications
- Values are based on several international studies, the lowest values for every nuclide were chosen to ensure universal applicability
- Up to the tenfold of the given level, the national regulator may decide not to apply any regulation (graded approach)
- Application of guide is not mandatory – "may be used"

11



12

International Regulations - EU

- EU – RP 89 – Metals
  - Steel, aluminium & copper or their alloys
  - Recycling or direct reuse
  - Mass restricted to 10 000 Mg/y; local markets
  - 100% exhaustion of the clearance levels assumed
- EU – RP 113 – Buildings and Rubble
  - Unrestricted clearance (reuse or demolition)
  - Restricted clearance of buildings (demolition only)
  - Unrestricted clearance of rubble
  - 200 000 Mg (controlled area of a commercial NPP); local markets
  - 33% exhaustion of clearance levels assumed (100% for rubble)
- EU – RP 122 – Materials
  - Scenarios for external radiation, inhalation, ingestion and skin contamination
  - No explicit mass restrictions, some 1000 t are covered by model
  - 100% exhaustion of clearance levels assumed

13

- EU – RP 122 4. GENERAL CLEARANCE LEVELS

Isotopes contribution to 10 μSv/y

$$\sum_{i=1}^{n} \frac{c_i}{c_{Li}} \leq 1.0$$

c_i is the total activity in the structure per unit mass of radionuclide i(Bq/g),

c_{Li} is the clearance level of radionuclide i (Bq/g),

n is the number of radionuclide in the mixture.

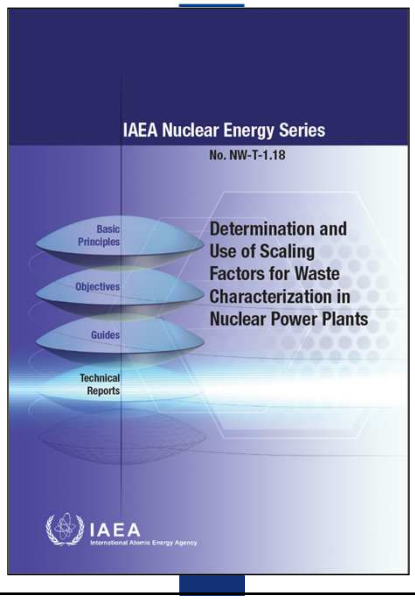
4.3. Table of General Clearance Levels

Table 1: Rounded General Clearance Levels

Nuclide[1]	Rounded General Clearance Level [Bq/g]
H-3	100
Be-7	10
C-14	10
Na-22	0.1
P-32	100
P-33	100
S-35	100
Cl-36	1
K-40	1
Ca-45	100

Nuclide[1]	Rounded General Clearance Level [Bq/g]
Y-90	100
Y-91	10
Zr-93	10
Zr-95+	0.1
Nb-93m	100
Nb-94	0.1
Nb-95	1
Mo-93	10
Mo-99+	1
Tc-96	0.1
Tc-97	10

14



15

IAEA RS-G-1.7 Dose for a member of the public in the range of 10 μSv/y

Contribution to dose from γ and β α (n) emission

* **difficult to measure (DTM) nuclides:** a radionuclide whose radioactivity is difficult to measure directly from the outside of the waste package by non-destructive assay means.
Example: Alpha emitting nuclides, beta emitting nuclides and characteristic X ray emitting nuclides (Expensive)

* **easy to measure (ETM) nuclides.** Gamma emitting nuclide whose radioactivity can be readily measured directly by non-destructive assay means. (Less Expensive)

16

* **key nuclide.** A gamma emitting nuclide whose radioactivity is correlated with that of DTM nuclides and can be readily measured directly by non-destructive assay means.
Note: Also called 'easy to measure nuclide' or 'marker nuclide'.
Example: 60Co and/or 137Cs.

* **scaling factor (SF).** A factor or parameter derived from a mathematical relationship used in calculating the radioactivity of a DTM nuclide from that of an ETM key nuclide as determined from sampling and analysis data. (**Nuclide Vector**)

17

	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
	H-3 [Bq/g]	Fe-55 [Bq/g]	Co-60 [Bq/g]	Ni-63 [Bq/g]	Sr-90 [Bq/g]	Cs-137 [Bq/g]	Pu-238 [Bq/g]	Pu-239/240 [Bq/g]	Pu-241 [Bq/g]	Am-241 [Bq/g]	[Bq/g]
MS 304411/3	4,26	0,36	0,732	17,8	0,01	0,241	0,001	0,005	0,224	0,0172	23,6502
MS 309288/X	1,15	0,21	0,022	1,6	0,04	0,204	0,001	0,002	0,138	0,0157	3,3827
VL 050515/8	2,31	0,22	0,346	1,2	0,83	0,268	0,001	0,001	0,138	0,0127	5,3267
	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
MS 304411/3	18,0%	1,5%	3,1%	75,3%	0,0%	1,0%	0,0%	0,0%	0,9%	0,1%	100,0%
MS 309288/X	34,0%	6,2%	0,7%	47,3%	1,2%	6,0%	0,0%	0,1%	4,1%	0,5%	100,0%
VL 050515/8	43,4%	4,1%	6,5%	22,5%	15,6%	5,0%	0,0%	0,0%	2,6%	0,2%	100,0%
MW (NV)	**31,8%**	**4,0%**	**3,4%**	**48,4%**	**5,6%**	**4,0%**	**0,0%**	**0,0%**	**2,5%**	**0,3%**	100,0%
	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
clearance limit	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	[Bq/g]	
Anl. III Tab. 1 Sp. 9	1000	10000	4	3000	2	10	1	1	100	1	
	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
weighted	0,00032	0,00000	0,00853	0,00016	0,02801	0,00403	0,00018	0,00033	0,00025	0,00258	0,04440
normalized	0,7%	0,0%	**19,2%**	0,4%	**63,1%**	**9,1%**	0,4%	0,7%	0,6%	5,8%	100,0%
NV for clearance meas. fac.			**21,0%**		**69,0%**	**9,9%**					100,0%
	H-3	Fe-55	Co-60	Ni-63	Sr-90	Cs-137	Pu-238	Pu-239/240	Pu-241	Am-241	
			[Bq/g]		[Bq/g]	[Bq/g]					
derived limits			**0,84**		**1,38**	**0,99**					

18

1	characterisation	measuring the **radiation source** not clean material
2	characterisation	to avoid **historical waste** production
3	characterisation	reduce **meas-ment**
4	characterisation	save **money**
5	characterisation	save **time**

19

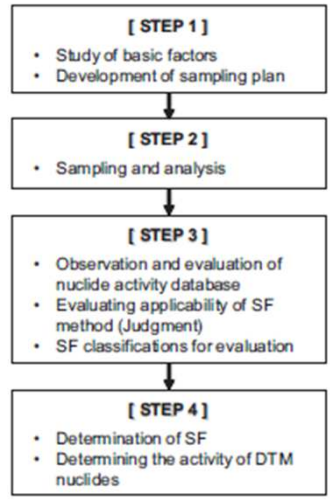


FIG. 3. Basic flow for application of the SF method.

20

RP122 – Annex 1

2.1. Criteria for dose calculations and Derivation on Clearance Levels

Basic criteria for the dose calculations and the derivation of clearance levels are the following:

- Clearance levels are calculated on the basis of an additional effective dose of **10 µSv/y** and on a skin dose of 50 mSv/y. "Additional" means that the doses caused by exposure from material which has been cleared under compliance with these general clearance levels may be received in addition to other exposure.
- It is checked whether clearance of material in compliance with these general clearance levels will lead to collective doses below 1 man Sv/y (referring to a single country).

21

COURSE CONTENT

1. Definition and Criteria
2. International overview
3. Italian Legislation
4. JRC situation

22

Different approach depending on a Country:

France:
- **Zoning** is carried out before any activity.
- It is based on a **priori considerations** and the operational history
- Waste from **radioactive zones** is always **radioactive waste**
- Waste from **non-radioactive zones** is **conventional waste**, but will be **controlled** when leaving the facility

Spain
Clearance is regulated on a **case-by-case** basis (usually for dedicated waste streams during the licensing of decommissioning)

United Kingdom
- General Clearance **0.4 Bq/g** (Substances of Low Activity- SoLA)
- Radioactive Substances Act (RSA93**) lists levels** for several
- The levels are also applied for clearance of these materials
- On a **case-by-case** basis there is the possibility of a restricted clearance for the disposal on **municipal landfills**

Germany
- **Clearance** is regulated in § 29 StrlSchV
- There are **4 series of levels for unrestricted** and **3 series of levels for restricted** clearance
- Applicable **for all materials** from practices that may be contaminated or activated
- This can **never be excluded** from any material, areas and buildings having been part of a **controlled area**
- If contamination or activation can be excluded for materials, areas and buildings in the monitored area, § 29 StrSchV is not applicable.

23

Italy

- Italian Legislation

Act 230/1995 as amended on Implementation of the directives 89/618/Euratom, 90/641/Euratom, 92/3/Euratom and 96/29/Euratom in the field of ionizing radiation.

- §30 Specific clauses for clearance of wastes.
- A general **exemption** criterion is in force in Italy, which can also be used for clearance:
  - activity concentration ≤ 1 Bq/g, and
  - half-life < 75 days
- If compliance with either of the two is failed, **clearance** requires an authorization on a **case-by case** basis.

New classification of WASTE (G.U 191 – 19 August 2015)

24

European

Correlazione tra classificazione G.T. n. 26 e nuova classificazione

Classificazione GT n. 26	Nuova classificazione
Prima Categoria	Rifiuti radioattivi a vita media molto breve
Seconda Categoria	Rifiuti radioattivi di attività molto bassa
	Rifiuti radioattivi di bassa attività
Terza Categoria	Rifiuti radioattivi di media attività
	Rifiuti radioattivi di alta attività

25

European Commission

Destinazione finale delle diverse categorie (non sono compresi i rifiuti contenenti radionuclidi di origine naturale, articolo 2, comma 5, del presente decreto)

Categoria	Condizioni e/o Concentrazioni di attività		Destinazione finale
Esenti	• Art. 154 comma 2 del D.Lgs n. 230/1995 • Art. 30 o art. 154 comma 3-*bis* del D.Lgs n. 230/1995		Rispetto delle disposizioni del D.Lgs. n. 152/2006
A vita media molto breve	• T1/2 < 100 giorni Raggiungimento in 5 anni delle condizioni: • Art. 154 comma 2 del D.Lgs n. 230/1995 • Art. 30 o art. 154 comma 3-*bis* del D.Lgs n. 230/1995		Stoccaggio temporaneo (art.33 D.Lgs n. 230/1995) e smaltimento nel rispetto delle disposizioni del D.Lgs. n. 152/2006
Attività molto bassa	• ≤ 100 Bq/g (di cui alfa ≤ 10 Bq/g)	Raggiungimento in T ≤10 anni della condizione: • Art. 30 o art. 154 comma 3-*bis* del D.Lgs n. 230/1995	
		Non raggiungimento in T ≤10 anni della condizione: • Art. 30 o art. 154 comma 3-*bis* del D.Lgs n. 230/1995	
Bassa attività	•radionuclidi a vita breve ≤ 5 MBq/g •Ni59-Ni63 ≤ 40 kBq/g •radionuclidi a lunga vita ≤ 400 Bq/g		Impianti di smaltimento superficiali, o a piccola profondità, con barriere ingegneristiche (Deposito Nazionale D.Lgs n. 31/2010)
Media attività	•radionuclidi a vita breve >5 MBq/g •Ni59-Ni63 > 40 kBq/g • radionuclidi a lunga vita >400 Bq/g •No produzione di calore	Radionuclidi alfa emettitori ≤400 Bq/g e beta-gamma emettitori in concentrazioni tali da rispettare gli obiettivi di radioprotezione stabiliti per l'impianto di smaltimento superficiale.	
		Radionuclidi in concentrazioni tali da non rispettare gli obiettivi di radioprotezione stabiliti per l'impianto di smaltimento superficiale.	Impianto di immagazzinamento temporaneo del Deposito Nazionale (D.Lgs n.31/2010) in attesa di smaltimento in formazione geologica
Alta attività	Produzione di calore o di elevate concentrazioni di radionuclidi a lunga vita, o di entrambe tali caratteristiche.		

26

COURSE CONTENT

1. Definition and Criteria
2. International overview
3. Italian Legislation
4. JRC situation

27

Licence of SGRR (24.07.2008)

Technical Prescriptions (21.08.2012)

I.15 Unconditional clearance of solid materials

JMP/26/1bis

Allegato

PRESCRIZIONI

I. (Prescrizioni ISPRA – nota prot. 10077 del 12.03.2012)

La Tab. 1, relativa alla Prescrizione Gestionale I.15.1 di cui al D.I. 23/07/2008, è sostituita con la Tab. 1 di seguito riportata:

TAB. 1: LIVELLI DI ALLONTANAMENTO

Radionuclide (i)	Materiali metallici ($C_{i,l}$)		Materiali cementizi ($C_{i,l}$)		Altri materiali ($C_{i,l}$)
Simbolo	massa (Bq/g)	superficie (Bq/cm^2)	massa (Bq/g)	superficie (Bq/cm^2)	massa (Bq/g)
^{3}H	1	10000	1	10000	1
^{14}C	1	1000	1	1000	1
^{22}Na	1	1	0,1	10	0,1
^{36}Cl	1	100	1	100	1
^{39}Ar	0,1	1	0,1	1	0,1
^{41}Ca	0,1	1	0,1	1	0,1
^{54}Mn	1	10	0,1	1	0,1

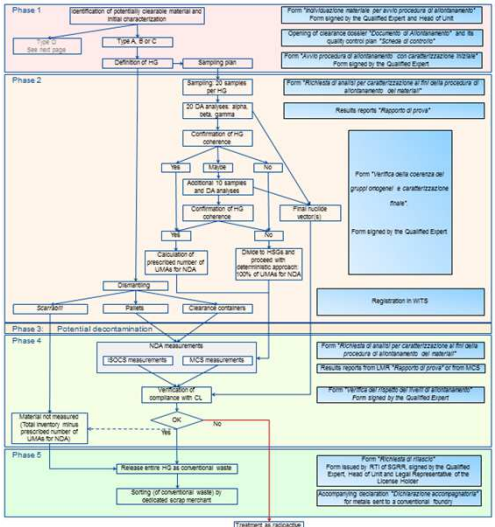
28

JRC . Ispra Site

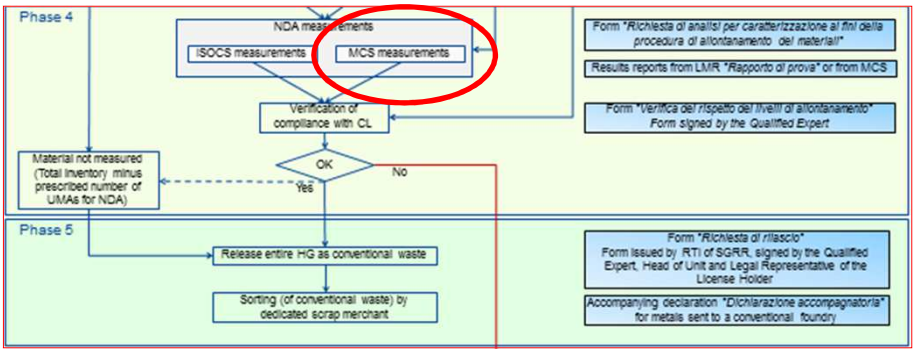
- Characterisation performed at 80% for six installations
  - **MIRADIS** Database:
    1. Physical characterization -structural survey (21.000 objects)
    2. Characterization of hazardous materials
    3. Radiological pre-characterization (470.000 radiometric values)

- Set of procedures in force for clearance:
- **NE.2607.A.002** Procedura Generale
- **NE.2607.A.003** Campionamento, caratterizzazione e verifica radiometrica
- **NE.2607.A.004** Individuazione, segregazione e campionamento
- **NE.2607.A.005** Stoccaggo, verifica livelli allontanamento e rilascio
- **PG 23** Analisi per la caratterizzazione e verifica radiometrica di materiali solidi per l'allontanamento

29



30



31

MATERIAL CLEARANCE SYSTEM (MCS)

32

MATERIAL CLEARANCE SYSTEM (MCS)

- *Non Destructive Assay system*
- *Final radiological characterisation of potentially clearable material → sentencing for final release*
- *8 plastic scintillators shielded by 5 cm Pb – tunnel dedicated for 0,5m3 container volume*

33

MATERIAL CLEARANCE SYSTEM (MCS)

- *No energy discrimination of gamma photons → total gamma counting → necessity of nuclide vector as input data for radiological activity evaluation*
- *Measurement chain calibrated on ^{60}Co radionuclide → all other nuclides concentrations are evaluated in equivalent ^{60}Co (experimental equivalence curve)*
- *Short time acquisition for very good MDA (Minimum Detectable Activity) performance: ~1000Bq for 1,5 kg/dm^3; ~300Bq material density 0,3 kg/dm^3*

34

Measurement chain dedicated for 0,5m3 container geometry

Standard clearance container

« Bespoke container »

Used as « Shuttle »

35

IWMS

MCS PROCESS

INPUT DATA:
- Artificial and natural Nuclide Vector
- Matrix definition and category for Clearance limits
- GEODENS parameters

Transfer of data into WITS and creation of measurement campaign

Implementation of MCS database and setting of base parameters

Measurement through TGMC MCS

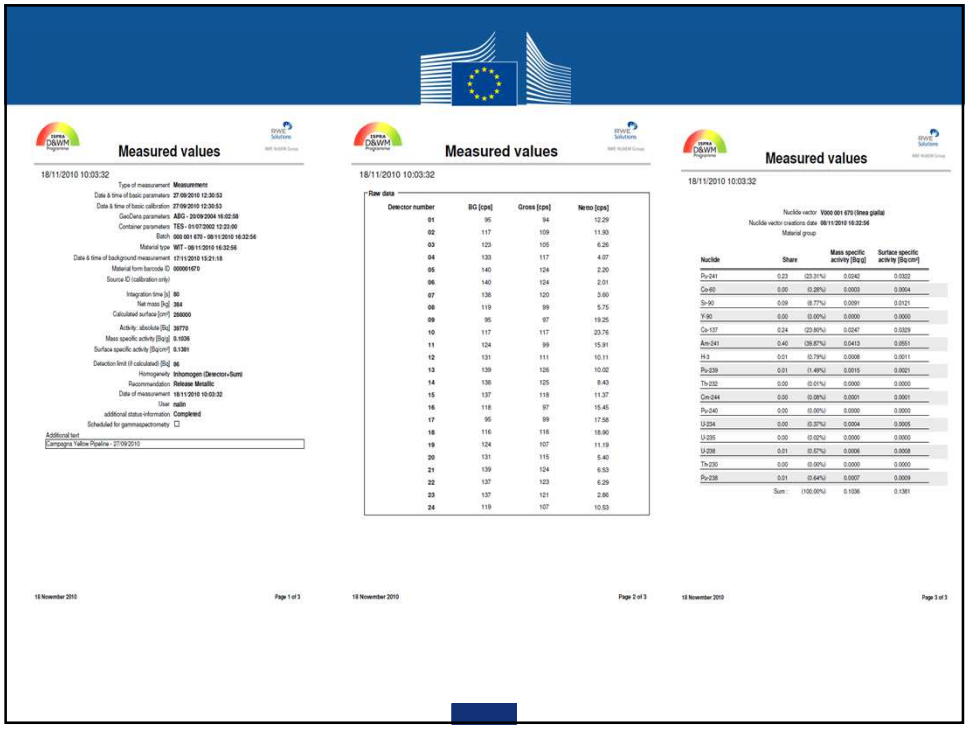
Final radiological sentencing

Material processed as Rad Waste

Temporary storage for release (outside ZC/ZS)

$$A_W^d = \left(\dot{R}_\Delta^d + z_{sta}^d\right) \frac{c^d \cdot f_T^d \cdot f_{mon}}{r_W}$$

36



Measured values

18/11/2010 10:03:32

Type of measurement **Measurement**
Date & time of basic parameters **27/09/2010 12:30:53**
Date & time of basic calibration **27/09/2010 12:30:53**
GeoDens parameters **ADG - 20/09/2004 16:02:58**
Container parameters **TES - 01/07/2002 12:23:00**
Batch **000 001 670 - 06/11/2010 16:32:56**
Material type **WIT - 06/11/2010 16:32:56**
Date & time of background measurement **17/11/2010 15:21:18**
Material form barcode ID **000001670**
Source ID (calibration only)
Integration time [s] **80**
Net mass [kg] **384**
Calculated surface [cm²] **260000**
Activity: absolute [Bq] **39770**
Mass specific activity [Bq/g] **0.1036**
Surface specific activity [Bq/cm²] **0.1361**
Detection limit (if calculated) [Bq] **86**
Homogeneity **Inhomogen (Derector+Sum)**
Recommendation **Release Metallic**
Date of measurement **18/11/2010 10:03:32**
User **nalin**
additional status-information **Completed**
Scheduled for gammaspectrometry ☐

Additional text
Campagna Yallow Pipeline - 27/09/2010

18 November 2010 Page 1 of 3

Measured values

18/11/2010 10:03:32

Raw data

Derector number	BG [cps]	Gross [cps]	Netto [cps]
01	95	94	12.29
02	117	109	11.93
03	123	105	6.26
04	133	117	4.07
05	140	124	2.20
06	140	124	2.01
07	138	120	3.60
08	119	99	5.75
09	95	97	19.25
10	117	117	23.76
11	124	99	15.91
12	131	111	10.11
13	139	126	10.02
14	138	125	8.43
15	137	118	11.37
16	118	97	15.45
17	95	99	17.58
18	116	116	18.90
19	124	107	11.19
20	131	115	5.40
21	139	124	6.53
22	137	123	6.29
23	137	121	2.86
24	119	107	10.53

18 November 2010 Page 2 of 3

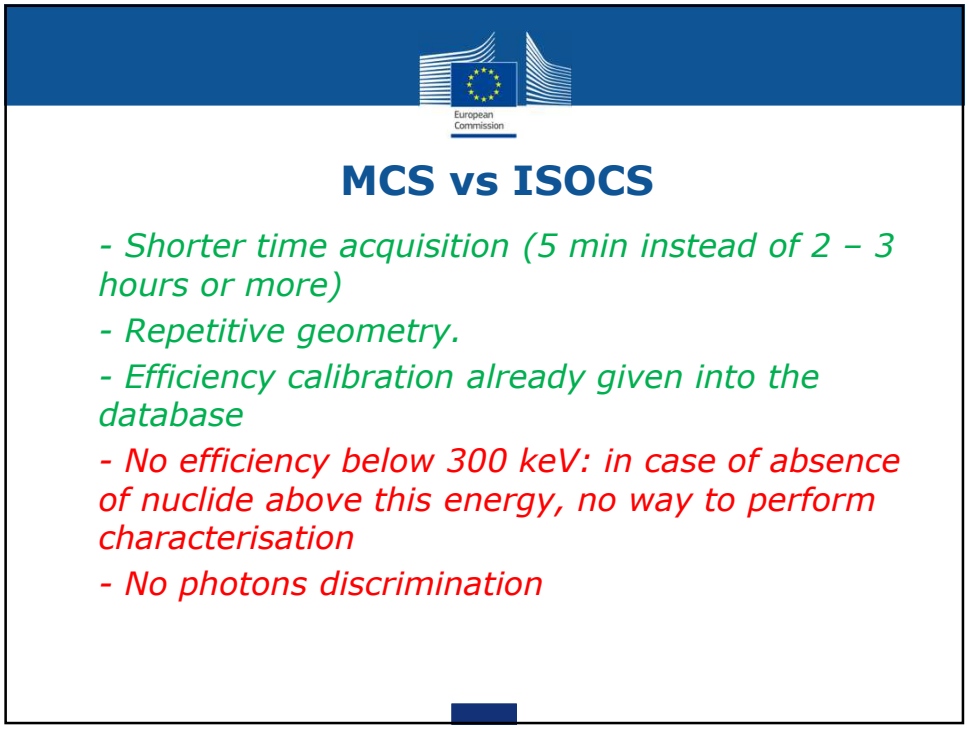
Measured values

18/11/2010 10:03:32

Nuclide vector **1000 001 670 (linea gialla)**
Nuclide vector creations date **06/11/2010 16:32:56**
Material group

Nuclide	Share		Mass specific activity [Bq/g]	Surface specific activity [Bq/cm²]
Pu-241	0.23	(23.31%)	0.0242	0.0322
Co-60	0.00	(0.28%)	0.0003	0.0004
Sr-90	0.09	(8.77%)	0.0091	0.0121
Y-90	0.00	(0.00%)	0.0000	0.0000
Cs-137	0.24	(23.80%)	0.0247	0.0329
Am-241	0.40	(39.87%)	0.0413	0.0551
H-3	0.01	(0.79%)	0.0008	0.0011
Pu-239	0.01	(1.49%)	0.0015	0.0021
Th-232	0.00	(0.01%)	0.0000	0.0000
Cm-244	0.00	(0.08%)	0.0001	0.0001
Pu-240	0.00	(0.00%)	0.0000	0.0000
U-234	0.00	(0.37%)	0.0004	0.0005
U-235	0.00	(0.02%)	0.0000	0.0000
U-238	0.01	(0.57%)	0.0006	0.0008
Th-230	0.00	(0.00%)	0.0000	0.0000
Pu-238	0.01	(0.64%)	0.0007	0.0009
Sum :		(100.00%)	0.1036	0.1381

18 November 2010 Page 3 of 3



European Commission

MCS vs ISOCS

- Shorter time acquisition (5 min instead of 2 – 3 hours or more)

- Repetitive geometry.

- Efficiency calibration already given into the database

- No efficiency below 300 keV: in case of absence of nuclide above this energy, no way to perform characterisation

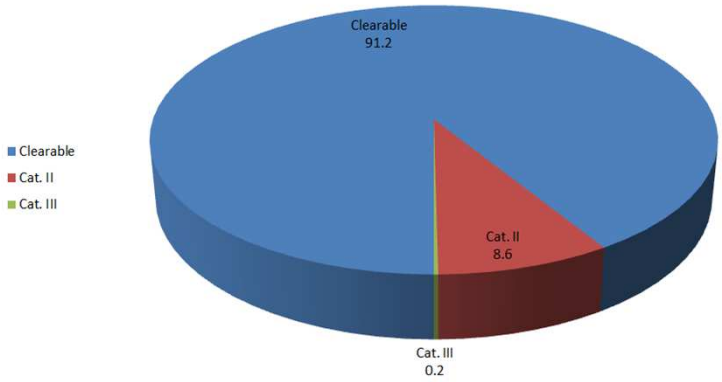
- No photons discrimination

Source	Potentially clearable/exempt (m^3)	Currently considered Category 2 (m^3)	Currently considered Category 3 (m^3)
ISPRA 1 (note 1)	12,596	614	48.3
Area 52, STRRL (Stazione Trattamento e Raccolta Rifiuti Liquidi Radioattivi)	3,715	485	0.2
INE (Impianto Nucleare ESSOR, Essais Orgel organique, eau loured)	33,172	1,537	62.6
LCSR (Laboratorio Caldo Studi e Ricerche)	5,108	129	1.9
ECO (Bldg. 42, Experience Critique Orgel)	8,675	32	-
FARO (Fuel Assemblies Melting Release Oven)	228	29	-
POCO Buffer drums (Post operational clean out mainly from RCHL, Radiochemical hot Laboratory)	-	307	-
Area 40 drummed & loose historic waste	66	1,388	35.9
Bulk containers of soil & concrete	271	163	-
Bitumen drums (6,150 of) (and after planned off-site treatment)	-	1,353 (641 after planned off-site treatment)	-
Irradiated and non-irradiated nuclear materials (note 2)	-	-	≈0.4
Historic, mainly drummed waste & future decommissioning waste	**Total solids ≡ 63,832 m^3** Plus ≈1,800 m^3 of aqueous to be treated and converted to Category 2 sludge; treated liquid discharged.	**Total ≡ 6,037 m^3** **Total ≡ 5,325 m^3** (with planned off-site treatment of Bitumen drums)	**149 m^3**
Roman Pits (15 of)	-	-	150
Concrete Blocks (237 of)	-	-	570
Sources (≈700 remaining on site) (note 2)	-	-	≈3
Orphan waste	-	≈3	≈3

Note 1) A heavy water, graphite moderated assembly. Included in the current report for JRC NDU pending finalisation of the 2009 Settlement Agreement with the Italian Government.
Note 2) 95% of nuclear material and over 1,700 sources have already been consigned off site, together with some other wastes.

39

JRC Ispra site - Waste inventory %



40


European Commission
THANK YOU
FOR YOUR KIND ATTENTION!
41