IAEA安全指針RS-G-1.7改訂の動向と主な論点

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日本原子力学会　2018年秋の大会
岡山大学

2018年9月6日

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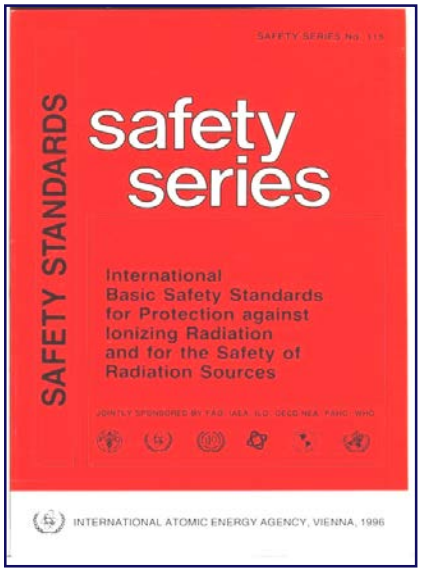
安全指針RS-G-1.7とは

◆規制除外、規制免除及びクリアランスの概念の適用（Application of the Concepts of Exclusion, Exemption and Clearance）（2004年8月出版）。

◆背景その1

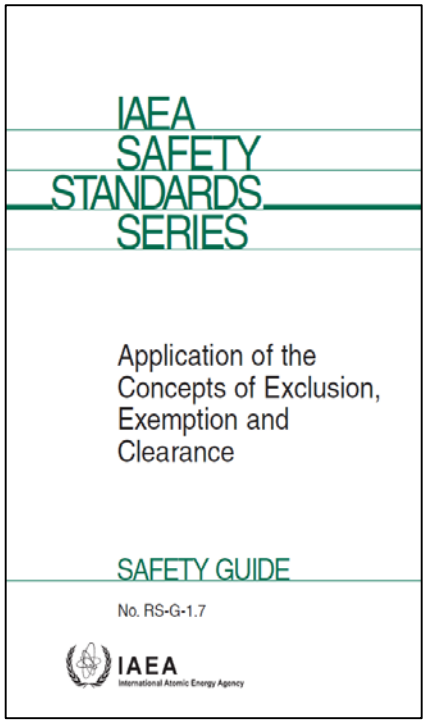
➢「電離放射線に対する防護及び放射線源の安全のための国際基本安全基準」（旧BSS(1996)）には、規制除外、規制免除及びクリアランスの概念と中程度の量(1トンオーダーの量)に関する規制免除レベルは示されていたが、規制除外とクリアランスに関する定量的な濃度基準と大量の物質に対する規制免除レベルは示されていなかった。



安全指針RS-G-1.7とは

◆背景その2

- 旧BSSを補完する目的で、国の規制当局等に対して、規制除外、規制免除及びクリアランスの概念の適用に関する指針を示すために作成された。
- また、天然起源の放射性核種及び人工起源の放射性核種の両方に対して、大量物質を規制除外、規制免除又はクリアランスをする際の「放射能濃度値」を示すことを目的としていた。



安全指針RS-G-1.7の特徴

◆放射能濃度値の算出根拠

➢天然起源の核種

- ■世界規模での土壌、岩石、砂及び鉱石中の天然起源の放射性核種の放射能濃度の測定結果(UNSCEAR 2000年報告書)の上限を基に設定。
- ■この放射能濃度の影響として、旧BSSでも別に取り扱われているラドンの散逸からの寄与を除けば、個人の受ける線量が約1 mSv/yを超えることはありそうもない。

安全指針RS-G-1.7の特徴

◆放射能濃度値の算出根拠

➢人工起源の核種

- ■実効線量に対する基準線量とパラメータの組合せ
  - □ 基準線量が10μSv/yの場合は、現実的なパラメータ値
  - □ 基準線量が1mSv/yの場合は、低確率なパラメータ値
- ■皮膚被ばくの等価線量に対する基準線量は 50mSv/y
- ■全ての固体状物質(all material)を対象に、外部被ばく、ダスト吸入及び経口摂取（直接及び間接）を包含するように選定された典型的な被ばくシナリオ(enveloping scenario)の評価により算出

安全指針RS-G-1.7の特徴

◆天然起源

表１　天然起源の放射性核種の放射能濃度値

放射性核種	放射能濃度(Bq/g)
^{40}K	10
上記以外の天然に存在する放射性核種	1

◆人工起源（一部抜粋）

表２ 大量の物質中の人工起源の放射性核種のための放射能濃度値

＊:半減期1日以下の放射性核種

核種	放射能濃度 Bq/g	
H-3	100	
Be-7	10	
C-14	1	
F-18	10	＊
Na-22	0.1	
Na-24	1	＊

核種	放射能濃度 Bq/g	
As-73	1000	
As-74	10	＊
As-76	10	＊
As-77	1000	
Se-75	1	
Br-82	1	

核種	放射能濃度 Bq/g	
Cd-109	1	
Cd-115	10	
Cd-115m	100	
In-111	10	
In-113m	100	＊
In-114m	10	

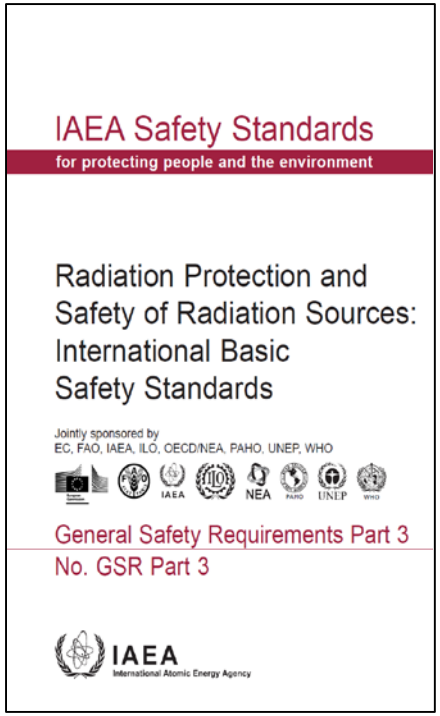
安全指針RS-G-1.7の特徴

- 表１（天然起源）に示された値を下回る天然起源の放射性核種を含む物質を規制することは通常不必要
- 表２（人工起源）をクリアランスレベルとして適用可能
- 表１（天然起源）と表２（人工起源）に示された放射能濃度値を下回る放射能濃度で放射性核種を含む物品の国内と国際取引は、放射線防護の目的のための規制上の管理を受けるべきではない
- 段階的(graded)アプローチ
  - 表1と表2の放射能濃度値を超える場合には、以下のような規制の運用が可能としている。
    - 放射能濃度値を数倍（例えば、10倍まで）超える場合、国内の規制の枠組みによっては、規制機関は規制要件を適用しないことを決定できる。その際、多くの場合は、ケースバイケースで判断が行われるが、この程度であれば、規制が不要であると予め規定することも可能である。

改訂版BSS

- Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards (GSR Part3) (2014).

- 安全指針RS-G-1.7の表1（天然起源）および表2（人工起源）は、改訂版BSSに取入れられた。


IAEA Safety Standards
for protecting people and the environment

Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards

Jointly sponsored by
EC, FAO, IAEA, ILO, OECD/NEA, PAHO, UNEP, WHO

General Safety Requirements Part 3
No. GSR Part 3

IAEA
International Atomic Energy Agency

RS-G-1.7の改訂の背景

- ICRP2007年勧告を受けて、改訂版BSSの被ばく状況（緊急時、現存、計画）別の構成への対応　→福島の現存被ばく状況と深く関連。
- 国の規制の確立、計画立案、組織および実施、技術的・安全上の意味合い、クリアランスプロセスを実施するために必要な資源、といったクリアランスプロセスに関するより詳細なガイダンスを提供する必要性。
- RS-G-1.7には、建物のクリアランス、表面汚染測定に基づくクリアランス、条件付クリアランス（将来の使用に制限を持たせたクリアランス）に関するガイダンスが含まれていない。
- 液体と気体のクリアランスの概念も扱われるべきであり、クリアランスと排出との間の境界が定められるべき。

DPP (DS500 & DS499)

SPESS F
Document Preparation Profile (DPP)
Version 2.0 dated 31-05-2017

1. IDENTIFICATION

Working ID: DS500

Proposed Title: Specific Safety Guide: Application of the Concept of Clearance

Proposed Action: Revision of RS-G-1.7 Application of the Concepts of Exclusion, Exemption and Clearance, 2004

Review Committee(s) or Group: WASSC (leading committee), RASSC, TRANSSC

Technical Officer(s): Vladan Ljubenov, NSRW

2. BACKGROUND

Exclusion, exemption and clearance define the scope of regulatory control as it applies to planned exposure situations. Exclusion applies to those planned exposures that are not deemed amenable to control, regardless of the magnitude of the exposures in question. Exemption refers to the determination by a regulatory body that a source or practice need not be subject to some or all aspects of regulatory control. Clearance is the removal of regulatory control by the regulatory body from radioactive material or radioactive objects within notified or authorized practices.

Requirement 8 of *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards* (GSR Part 3) makes provision for the exemption of practices and sources within practices and for the clearance of sources within notified or authorized practices, consistent with the use of a graded approach. Similar provisions for exemption and clearance were given in SS-115, the previous edition of GSR Part 3 that was published in 1996. SS-115 also provided values (in terms of both activity concentration and total activity) for exemption of moderate amounts of material from regulatory control.

The Safety Guide RS-G-1.7 explained the links between exclusion, exemption and clearance and also provide mass specific values that can be used for exemption or clearance, as appropriate, of bulk quantities of solid material. Values are provided for both natural and artificial radionuclides. The models used in the calculations of individual dose are described in SRS-44 — these scenarios are primarily relevant for clearance, since these were found to be the most restrictive. These values for exemption and clearance of bulk amounts of material now appear in GSR Part 3, together with the values for exemption of moderate amounts of material from SS-115. Regarding for natural radionuclides, the values set out in RS-G-1.7 were selected on the basis of consideration of the upper end of the worldwide distribution of activity concentrations in soil provided by UNSCEAR.

SPESS F
Document Preparation Profile (DPP)
Version 2.0 dated 31-05-2017

1. IDENTIFICATION

Working ID: DS499

Proposed Title: Specific Safety Guide: Application of the Concept of Exemption

Proposed Action: Revision of RS-G-1.7 Application of the Concepts of Exclusion, Exemption and Clearance, 2004

Review Committee(s) or Group: RASSC (leading committee), WASSC, TRANSSC

Technical Officer(s): Haridasan Pappinisseri Puthanveedu, NSRW

2. BACKGROUND

Exclusion, exemption and clearance define the scope of regulatory control as it applies to planned exposure situations. Exclusion applies to those planned exposures that are not deemed amenable to control, regardless of the magnitude of the exposures in question. Exemption refers to the determination by a regulatory body that a source or practice need not be subject to some or all aspects of regulatory control. Clearance is the removal of regulatory control by the regulatory body from radioactive material or radioactive objects within notified or authorized practices.

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専門家会合

- 専門家会合が、2回（2018年2月19～23日、6月4～8日）にわたって、IAEA本部（ウイーン）で開催。
  - 安全指針DS500「クリアランスの概念の適用」作成のための専門家会合（CS-1706033、CS-1801884）
- 会合参加者
  - Ms. Chantal Mommaert, Belgium
  - Ms. Sheelagh Mobbs, UK
  - Mr. Stefan Thierfeldt, Germany
  - Mr. Takatoshi Hattori, Japan
  - Mr. Vladan Ljubenov, IAEA Scientific Secretary

DPPに記載された目次案

1. Introduction
   - 1.1 Background
   - 1.2 Objective
   - 1.3 Scope
   - 1.4 Structure

2. Regulatory framework for clearance
   - 2.1 General
   - 2.2 Responsibilities of the Regulatory Body
   - 2.3 Responsibilities of the Licensee
   - 2.4 Organization and implementation of the clearance process
   - 2.5 Graded approach

3. Concept of Conditional Clearance
   - 3.1 Radiological basis
   - 3.2 Options for management of material

4. Clearance of solid material
   - 4.1 General
   - 4.2 Characterisation of the material to be cleared
   - 4.3 Mass specific criteria for clearance
   - 4.4 Surface criteria for clearance
   - 4.5 Case by case approach
   - 4.6 Monitoring programme
   - 4.7 Statistical Confidence and Uncertainties of Clearance Measurement Results
   - 4.8 Aspects Related to Use of Mixing as Part of the Material Management Process

5. Clearance of liquid material
   - 5.1 General
   - 5.2 Application of concept

6. Clearance of gaseous material
   - 6.1 General
   - 6.2 Application of concept

7. Involvement of interested parties

APPENDIX Screening level for recycle or disposal on landfills of material and waste in the post-accident existing exposure situation

ANNEX I – Dosimetric modelling for derivation of radionuclide specific values for clearance based on surface contamination measurements

Annex II - Examples of surface specific values for unconditional clearance

ANNEX III – Examples of mass specific values for conditional clearance

ANNEX IV Considerations related to uncertainty of the radionuclide vector

4.6' Averaging masses and averaging areas

専門家会合で新たに追加

DPPに記載されたスケジュール

STEP 1: Preparing a DPP	July 2016
STEP 2: Approval of DPP by the Coordination Committee	September 2016
STEP 3: Approval of DPP by the relevant review Committees	November 2016
STEP 4: Approval of DPP by the CSS	November 2017
STEP 5: Preparing the draft	December 2017 - June 2019
STEP 6: Approval of draft by the Coordination Committee	August 2019
STEP 7: Approval by the relevant review Committees for submission to Member States for comments	November 2019
STEP 8: Soliciting comments by Member States	December 2019 – March 2020
STEP 9: Addressing comments by Member States	April 2020
STEP 10: Approval of the revised draft by the Coordination Committee Review in NS-SSCS	October 2020
STEP 11: Approval by the relevant review Committees	June 2021
STEP 12: Endorsement by the CSS	November 2021
STEP 13: Establishment by the Publications Committee and/or Board of Governors (for SF and SR only))	March 2022
STEP 14: Target publication date	August 2022

2月の専門家会合の概要

- DS499側の専門家会合と同時に開催され、会合の初日と最終日は、DS500とDS499の合同セッションを開催。
- 合同セッションにおける情報交換
  - 関連するIAEAの活動（事故後に用いる条件付クリアランスレベルに係るワークショップ）の紹介　（IAEA T. Kilochytska 女史）
  - 福島での経験と日本におけるクリアランスの課題（電中研 服部）
  - 免除とクリアランスに係る表面汚染レベルの策定に向けて（オランダ National Institute for Public Health and the Environment (RIVM) Van Dillen Teun氏）

日本からの紹介・情報共有

◆福島での経験

- 微小なリスクとは？
- 重量濃度レベル
  - 8,000 Bq/kg and 100,000 Bq/kg
- 表面汚染レベル
  - 除染のためのスクリーニングレベル
  - 除染によって生じた汚染土壌の中間貯蔵施設への輸送
  - 日本保健物理学会放射線防護標準化委員会「緊急時/現存/計画被ばく状況における汚染した物の搬出ガイドライン」

Experiences from Fukushima
& current issues of clearance in Japan
for revision of RS-G-1.7

Central Research Institute of Electric Power Industry (CRIEPI)

Associate Vice President Takatoshi Hattori

IAEA Consultancy meeting to commence work on
development of Safety Guide DS500 Application of the Concept of Clearance

Feb. 19, 2018

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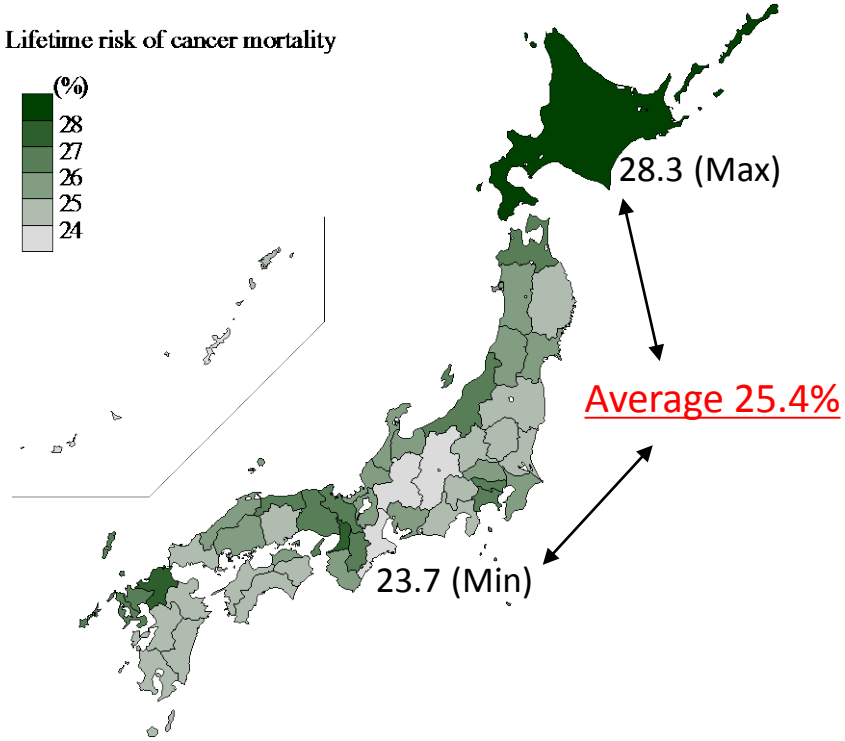
◆クリアランス実施のために解決すべき現行の課題

- どのように不確実性に対する過剰な保守性を避けるか？
- クリアランスに対する公衆の理解 (10μSv/yオーダー)

What is trivial risk ?

Radiation risk 0.5%/100 mSv

- Increase of lifetime risk due to radiation exposure
  100 mSv : 0.5%, is estimated by ICRP, and
  10 mSv : 0.05%
  1 mSv : 0.005%
- Japanese lifetime background risk in cancer mortality* in 2010 was 25.4%(1)
- Therefore, the increase of lifetime risk means:
  25.4% → 25.9% (100 mSv)
  25.4% → 25.45% (10 mSv)
  25.4% → 25.405% (1 mSv)
- On the other hand, the lifetime background risk in cancer mortality ranges from 23.7% to 28.3% among the 47 prefectures in Japan.
- The main cause of the deviation due to location is supposed to be in the differences of daily lifestyle, e.g., smoking and dietary habits.



* Lifetime risk due to radiation exposure defined by ICRP is obtained by taking into consideration loss of lifetime and the reduced quality of life associated with living with a serious illness, in addition to fatal cancer risk. This indicates that the lifetime risk is a little higher than the lifetime risk in cancer mortality.

(1) H. Ogino and T. Hattori, Calculation of Background Lifetime Risk of Cancer Mortality in Japan, Jpn. J. Health Phys., 49 (4), 194-198 (2014)
https://www.jstage.jst.go.jp/article/jhps/49/4/49_194/_pdf

Position statement in the AESJ

Position Statement (View, Suggestion, Explanation, Others)

Dec. 2016

Atomic Energy Society of Japan

Health Physics & Environmental Science Division

Effects of low-level radiation exposure on human health

Introduction

Owing to the Fukushima Dai-ichi nuclear power plant disaster, many people are concerned about the effects of radiation on human health. In this paper, the effects of low-level radiation exposure on human health are explained in an easy-to-understand manner on the basis of recommendations of the International Commission on Radiological Protection (ICRP) that have been adopted in domestic radiation safety regulations in many countries including Japan.

Radiation effects

The effects of low-level radiation exposure can be divided into two main categories, "deterministic effects" and "stochastic effects".

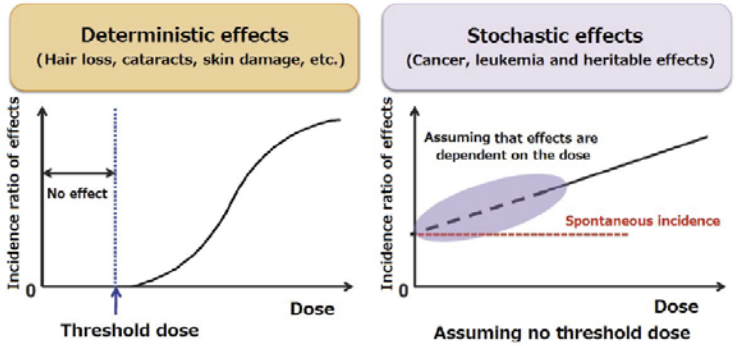


Fig. 1 Deterministic and stochastic effects

Reference: Booklet to provide basic information regarding to health effects of radiation ver.2015001 (http://www.env.go.jp/chemi/rhm/h27kisoshiryo/attach/201606mat2-03-4.pdf)

To realize a risk of 5% per Sv, it is important to understand the cancer risk incurred by Japanese people in daily life due to smoking, alcohol consumption, chemicals agents and so forth, that is, lifetime cancer mortality (hereinafter, lifetime cancer risk). As shown in Fig. 2, the national average lifetime cancer risk in Japan as of 2010 is 25.4%[7]. This indicates that one in four in Japanese people die from cancer. If each Japanese person is exposed to 100 mSv radiation, the lifetime cancer risk will increase by 0.5% according to the LNT model, taking into consideration the risk coefficient of 5% per 1,000 mSv, which means that the national average lifetime cancer risk will increase from 25.4% to 25.9%. On the other hand, the lifetime cancer risk in daily life without additional exposure varies between 23.7% and 28.3% among the prefectures of Japan due to differences in lifestyle such as diet[7]. This increase in risk of 0.5% following exposure to 100 mSv radiation is sufficiently small to be buried in the deviation. In epidemiological studies, it cannot be clarified whether the increase in risk is proportional to the radiation exposure when the radiation dose is approximately 100 mSv or less because the increase in risk is too small. However, assuming that there is a risk based on the LNT model, radiation exposure of 20 mSv and 1 mSv will lead to increases in risk of 0.1% and 0.005%, respectively.

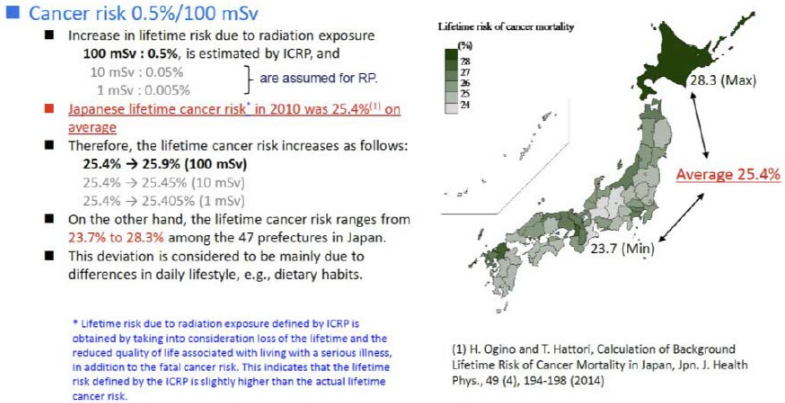
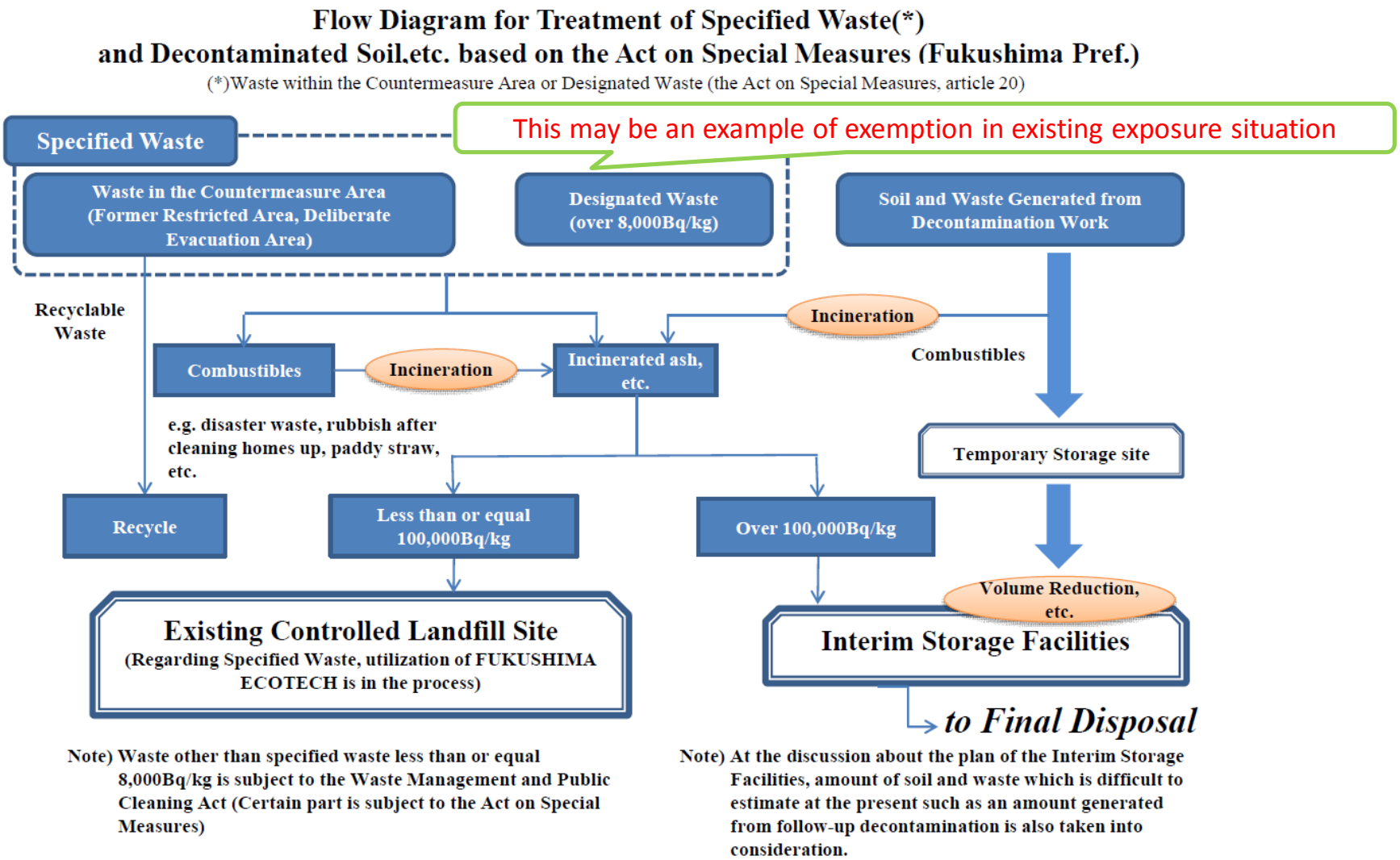


Fig. 2 Deviation of lifetime cancer risk[7]

(http://www.aesj.or.jp/en/about_us/ps/AESJ-PS004e_r2.pdf)

8,000Bq/kg and 100,000Bq/kg



(Source: MOE, FY2014 Decontamination Report, Mar. 2015)

(http://josen.env.go.jp/en/policy_document/pdf/decontamination_report1503_full.pdf)

Below 8,000Bq/kg

1) Waste disposal at conventional controlled type landfills without any further conditioning.

This may be an example of conditional clearance in existing exposure situation

or

2) Recycle managed by the public authority →

This may be NOT an example of clearance because this is a recycle under the Act on Special Measures*1

*1Act on Special Measures concerning the Handling of Environment Pollution by Radioactive Materials Discharged by the NPS Accident Associated with the Tohoku District - Off the Pacific Ocean Earthquake That Occurred on March 11, 2011)

Concept on Safe Use of Recycled Materials

< Basic Concept >

Treated materials after classification of removed soil (with radioactivity level below 8,000Bq/kg in principle and set according to purpose) should be used mainly for public projects and be managed by the public authority

7k, 6k, 5k or 4kBq/kg are options for their purpose of recycle.

< Limited Use >

The use will be limited such as for basic structure material of banking for coastal levee, disaster-prevention forest on the beach, or roads, which assumed not to change the form artificially for a long time period. It will be also used for soil-covering materials for waste disposal site

< Management by the public authority >

- The criteria should be formulated based on the Act on Special Measures and managed by MOE and public management entities (municipality, etc.)
- To be specific, in order to confine additional exposure dose as below 1mSv/y at the time of construction and below 0.01mSv/y at the time of service, radioactive level of recycled materials should be limited, soil-covering should be installed, and date should be recorded

< Procedure of recycling >

To realize the recycling of removed soil, demonstration and model projects based on concepts above should be implemented, keeping the safety of radiation, specific verification of management method and consensus-building measures in mind

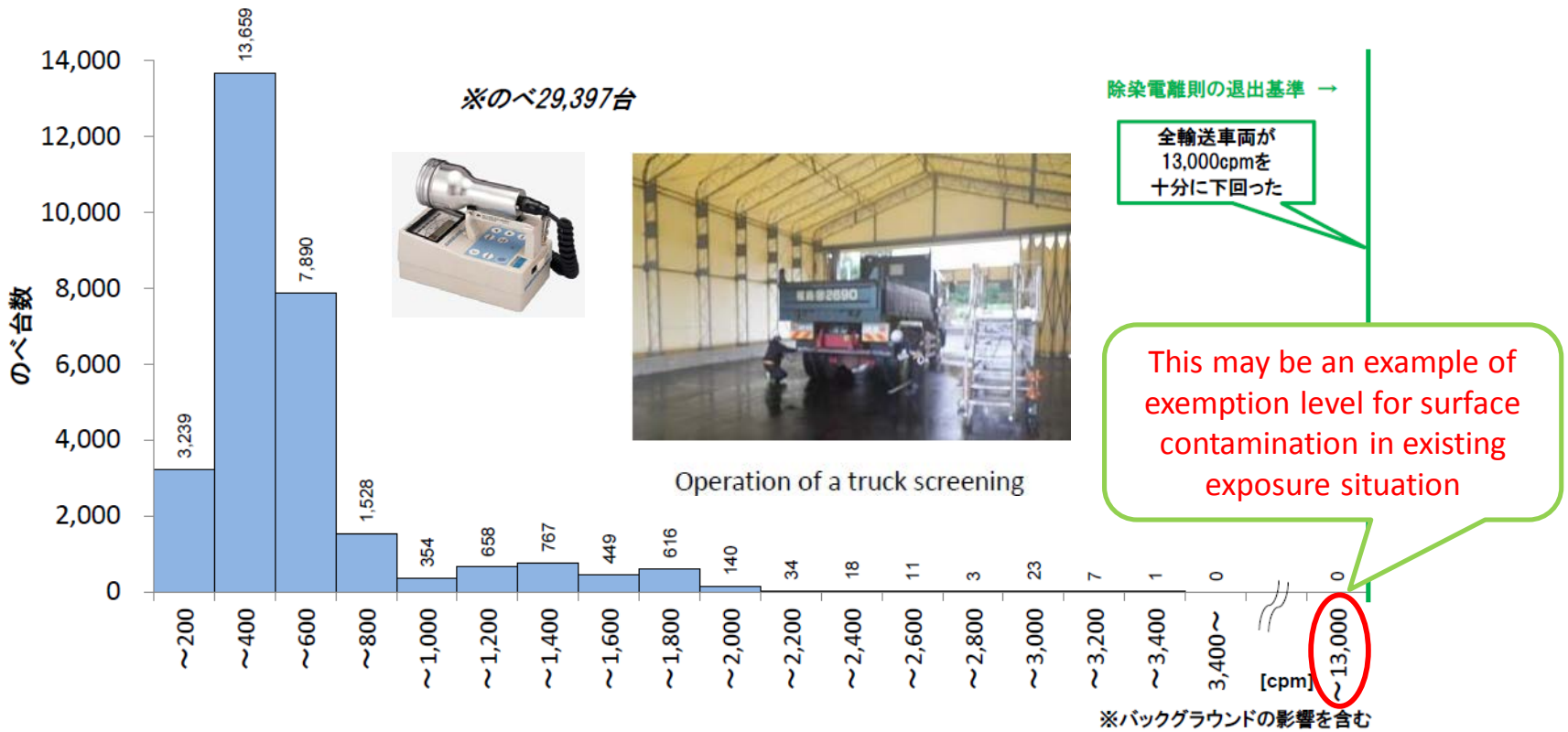
(Source: MOE, Environmental Remediation in Japan, Jan. 2018)

(http://josen.env.go.jp/en/pdf/progressseet_progress_on_cleanup_efforts.pdf)

Max. contamination density

保管場退出時の輸送車両のスクリーニング結果

○ 保管場からの退出時に、除染土壌等を荷下ろしした輸送車両の汚染検査（スクリーニング）を行い、除染電離則に定められた基準を超えていないことを確認している。



輸送車両のスクリーニング時の最大の表面汚染密度の分布（平成28年4月～平成29年3月15日）

49

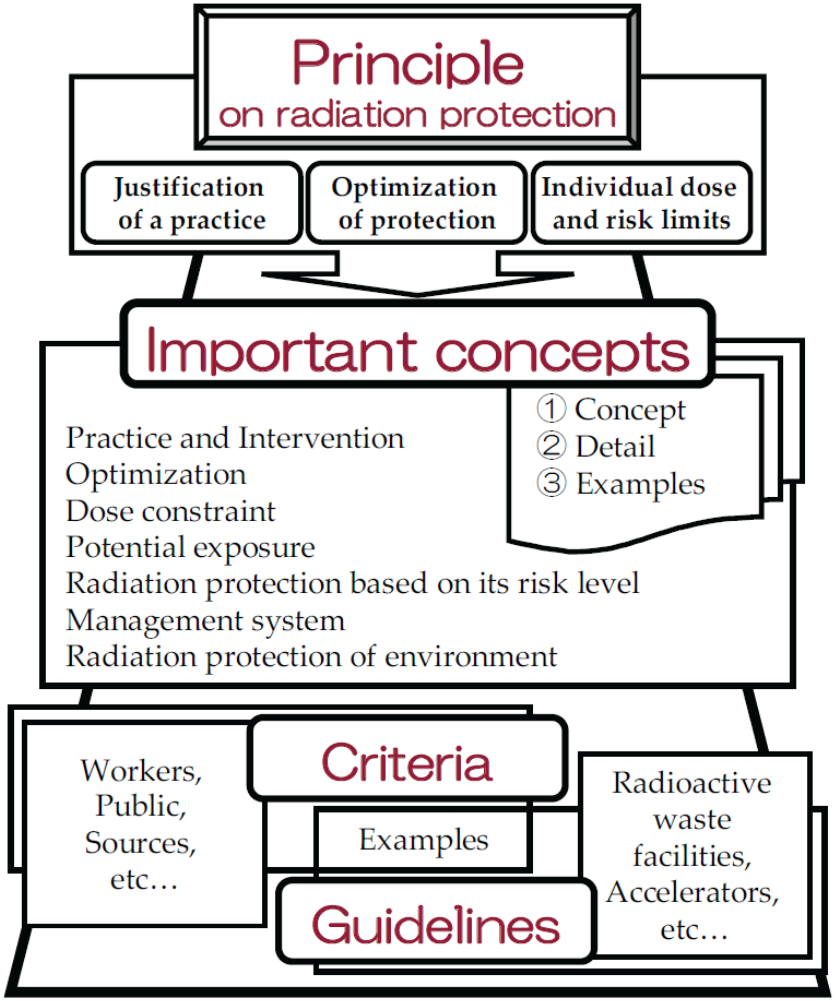
(Source: http://josen.env.go.jp/chukanchozou/action/safety_commission/pdf/safety_commission_01_170321.pdf)

JHPS Standardization Committee

Japan Health Physics Society (JHPS)

- To understand radiation safety and its management effectively and easily, Japanese nuclear/radiation users as well as regulators have required the fundamental Japanese standards on RP based on the global standards.
- Standardization Committee on RP was organized in JHPS in June 2006.
- Standards on RP consist mainly of four classes; the principle, important concepts, criteria and guidelines.

Conceptual Image of Standard



Comparison of three guidelines

Table 1 Comparison of three guidelines for moving out commodities contaminated with radioactive materials in planned, emergency and existing exposure situations.

	Guideline for Moving Out Commodities Contaminated with Radioactive Materials in Planned Exposure Situation (GlPl)	Guideline for Moving Out Commodities Contaminated with Radioactive Materials in Emergency Exposure Situation (GlEm)	Guideline for Moving Out Commodities Contaminated with Radioactive Materials in Existing Exposure Situation (GlEx)
Dose Criteria	Order of 0.01 mSv or less of annual effective dose	Less than 10 mSv of annual effective dose	Less than 1–10 mSv of annual effective dose
Referred Concept	Radiation protection in planned exposure situation Clearance	Radiation protection in emergency exposure situation Generic Criterion of IAEA GSR Part 7	Radiation protection in prolonged exposure to public Intervention
Basic Point of View	> Moving out from controlled area to general > Application of the concept of clearance of many relatively small objects moved out	> Moving out from the area where affected by radioactive materials released significantly in nuclear or radiological emergency > Justification and Optimization > A tithe of the maximum of the reference level of 20–100 mSv in emergency exposure situation > Upper bound of 1 mSv of annual effective dose for international export	> Moving out from the area where affected by nuclear or radiological emergency or area where in recovery from accident to less affected or ordinary area > Justification and Optimization > The lower part of the 1–20 mSv band which is the reference level in existing exposure situation > Upper bound of 1 mSv of annual effective dose for international export
Exposure Scenarios	Handling of small packages [6)] Handling of general objects [7)]	Handling of bulk spent fuel cask [6)] Handling of general objects [7)]	Handling of bulk spent fuel cask [6)] Handling of general objects [7)]
Readings of Typical GM Survey Meter	1,000 cpm (10 Bq/cm^2 of ^{60}Co) 2,300 cpm (10 Bq/cm^2 of ^{137}Cs)	460,000 cpm ^{131}I: 1,900 Bq/cm^2 ^{134}Cs: 19 Bq/cm^2 ^{137}Cs: 19 Bq/cm^2	21,000 cpm ^{131}I: 0.44 Bq/cm^2 ^{134}Cs: 44 Bq/cm^2 ^{137}Cs: 44 Bq/cm^2

Non-governmental standard

- The present approach has been adopted in the non-governmental standard entitled "Monitoring for Compliance with Clearance Level (Jul. 2005)" by the Standards Committee of the Atomic Energy Society of Japan (AESJ).

  (http://www.aesj.net/publish-0502) (in Japanese)

AESJ-SC-F005:2005

日本原子力学会標準

クリアランスの判断方法：2005

2005年7月

社団法人 日本原子力学会

- The PDCS is referred from the CRIEPI web site for free use (http://criepi.denken.or.jp/en/nuclear/download/index.html)

- An original paper (in Japanese) on the present approach received the Awards for outstanding paper in the 2005 AESJ Awards.

  Ref.) T. Hattori, An Approach to Safety Margin for Measurement Error and Scattered Nuclide Spectrum on the Monitoring for Compliance with Clearance Level, Transactions of the Atomic Energy Society of Japan, Vol. 3, No.4, 363-368 (2004) (in Japanese).

  (https://www.jstage.jst.go.jp/article/taesj2002/3/4/3_4_363/_pdf)

IAEA Safety Reports Series No. 67

5. EVALUATION OF DATA AND FOLLOW-UP ACTIONS

5.1. TREATMENT OF MEASUREMENT UNCERTAINTIES

Treatment of measurement uncertainties needs to include uncertainty for contamination involving a single radionuclide, and uncertainty for measurement for contamination involving a mixture of radionuclides. The first case relates to measurement uncertainty, and the second case relates to a combination of measurement uncertainty and radionuclide spectrum.

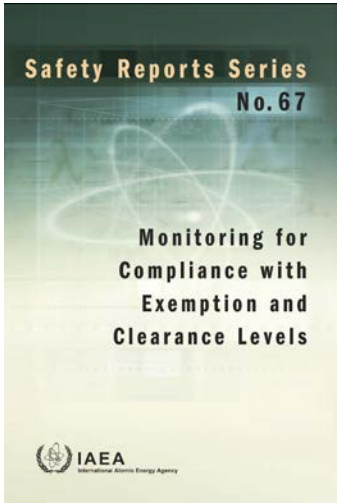
It needs to be noted that the established activity concentration values of Ref. [2] are generally based on trivial potential doses to the public and, therefore, provide significant safety margins.

Monitoring techniques to determine whether established activity concentration values are satisfied rely on the performance of the instrument or the condition of measurement, for example, background level and measurement time. It has to be ensured that the detection limit determined by such factors is sufficiently lower than the activity level required for the clearance judgement and that the measurement has been carried out with appropriate sensitivity and an adequate uncertainty margin.

The treatment of the uncertainty is strongly related to the detection limit. The uncertainty of measurement is generally expressed by a normal distribution. For example, in Japan [37], for a measurement to be considered as exceeding the detection limit, the net count must exceed by three times the net standard deviation of the measurement. In the case of the monitor checked on such a detection limit, the relative error of measurement results is always less than approximately 33.3%, since the measurement results are usually beyond the detection limit. This indicates that an uncertainty of less than approximately 30% is required in the measurement results.

In the United States of America, the concept of detection limit is expressed by the minimum detectable concentration (MDC) [38]. In this case, the detection limit cannot simply be expressed by a factor of the standard deviation, but approximately regarded as 3.29σ, which is twice the value of 1.645σ. (Appendix III). This implies that an uncertainty of less than approximately 30.4% is required in the measurement results, which is the same conclusion drawn in the Japanese concept of the detection limit.

As described above, it can be ensured that the uncertainty of measurements is lower than approximately 30% by complying with the detection limit of measurement. On the other hand, there can be a large scattering of more than an order of magnitude of the radionuclide spectrum of target radionuclides, which can be expressed by a log normal distribution with two parameters, a geometric mean and a geometric standard deviation.



(http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1511_web.pdf)

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5.3. TREATMENT OF UNCERTAINTY FOR MEASUREMENT OF RADIONUCLIDE SPECTRUM

In treating uncertainties due to a mixture of radionuclides, the radionuclide spectrum is applied, meaning that uncertainties in measurement data and ratios of radionuclide concentrations to the key radionuclide concentration are taken into account. To estimate the validity of the uncertainty of the radionuclide spectrum, it is necessary to know the geometric standard deviation that indicates the degree of the scattering ratio of the subsidiary radionuclides to the key radionuclide, after the confirmation of whether the frequency distribution can be fitted to the log normal one.

Reference [2] establishes the value of activity concentration that is equivalent to clearance values for single radionuclides and also shows that the summation (ΣC/CL) of the estimated radionuclide concentration for each radionuclide (C) divided by the clearance level (CL) for each radionuclide has to be less than one to satisfy the clearance criterion for the treatment of a mixture of radionuclides (see Section 2.2.1). It also states that verification of the values is to be based on a procedure that may include direct measurement of a material, laboratory measurements of representative samples and the use of properly derived radionuclide relationships.

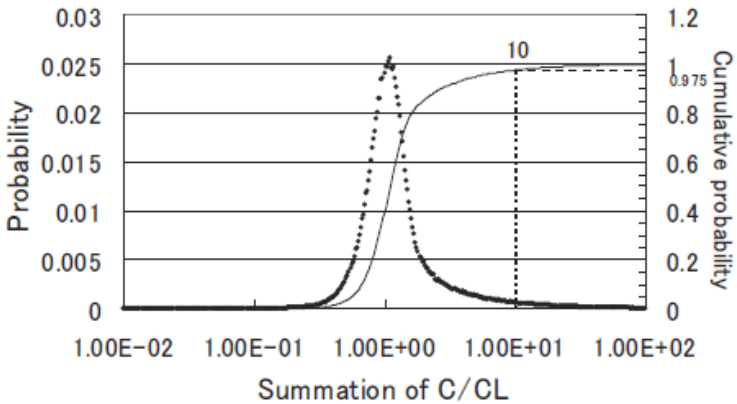


FIG. 10. Probability distribution of ΣC/CL.

In the case of *complex mixtures*, such as those found in a nuclear power plant, the clearance requirement could be that the measurement uncertainty plus the uncertainty due to the radionuclide spectrum cannot be ten times higher than the ΣC/CL, with a 97.5% probability.

Specifically, Fig. 10 shows a probability distribution of ΣC/CL obtained by assuming that:

— A key radionuclide for measurement was ^{60}Co;
— The uncertainty was 30%;
— The distribution derived from measurement of the radionuclide ratio was log normal.

For ^{90}Sr/^{60}Co, the geometric mean and the geometric standard deviation (GSD) were 1.0 and 10.5, respectively. Other radionuclides are taken into consideration using similar approaches. The concentration of ^{60}Co is then normalized, so as to satisfy the relation ΣC/CL = 1, obtained by using a median of C. Finally, a Monte Carlo method, using the information about all applicable radionuclides as input, produces the curve shown in Fig. 10. From Fig. 10, it can be seen that the 97.5% value of ΣC/CL distribution is ten. Thus, the clearance level is satisfied based on the fact that mean dose does not exceed 100 μSv/a, with a 97.5% probability.

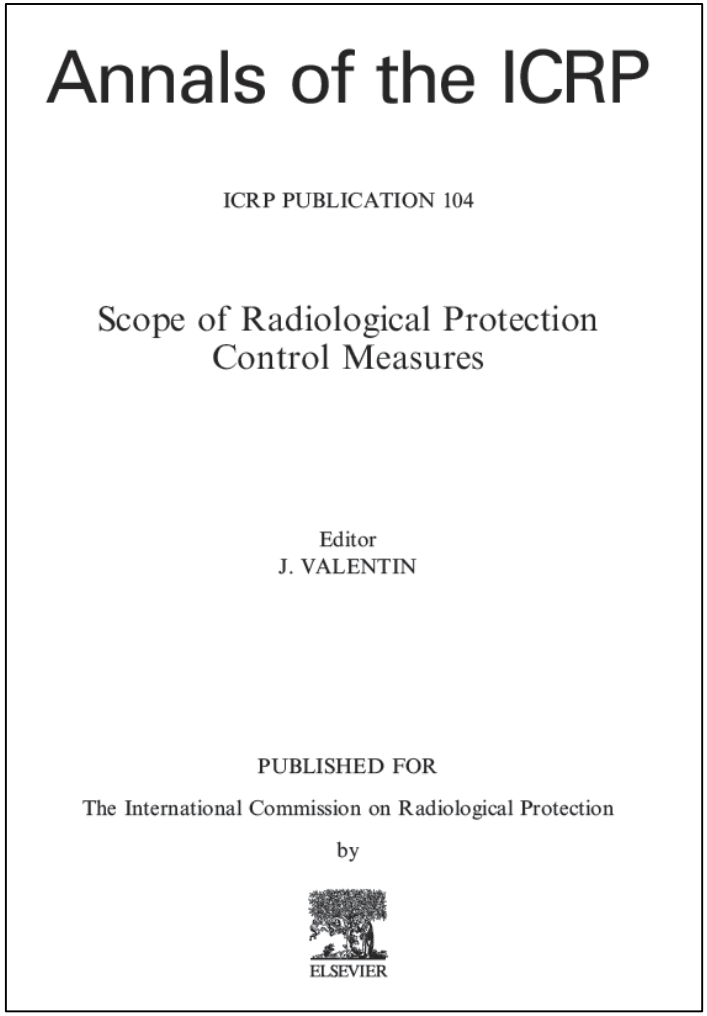
Different approaches for treatment of uncertainties related to the radionuclide spectrum are being developed, and an example is the Monte Carlo code prepared for release by the Standard Committee of the Atomic Energy Society in Japan or Central Research Institute of Electric Power Industry [20].

[20] ATOMIC ENERGY SOCIETY OF JAPAN, Monitoring for Compliance with Clearance Level, AESJ-SC-F005:2005, Tokyo (2005).

(http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1511_web.pdf)

ICRP Publication 104

(95) The concept of clearance enables the release of low-level radioactive material from regulatory control, and could be an effective tool for avoiding the unnecessary application of resources to radioactive waste disposal. For this reason, many scenarios presuming the disposal and the recycling of bulk materials, e.g. those generated from the decommissioning of a nuclear reactor site, have been applied to derive clearance levels; e.g. radiological protection criteria for the recycling of metals from the dismantling of nuclear installations (EC, 1998), radiological protection criteria for the clearance of buildings and building rubble from the dismantling of nuclear installations (EC, 2000b), and exemption levels for bulk solid materials (IAEA, 2004b). A demonstration of compliance with clearance levels for such bulk materials is necessary. In the case of a mixture of nuclides, it is generally only practical to measure easily measurable gamma emitters. To estimate the other alpha or beta emitters, most applicants of clearance use a previously assessed nuclide spectrum (namely, a nuclide vector) to ensure that the sum of the values obtained by dividing radioactivity concentrations by clearance levels is lower than 1 (IAEA, 2004b). The Commission recognises 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 μSv/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 μSv/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.


Annals of the ICRP

ICRP PUBLICATION 104

Scope of Radiological Protection Control Measures

Editor
J. VALENTIN

PUBLISHED FOR

The International Commission on Radiological Protection

by

ELSEVIER

6月の専門家会合の概要

- DS499とは独立して、DS500の単独開催
- DS500のドラフト作成を継続することが目的
- 2018年2月の第1回専門家会合でカバーされなかったセクションの作成が中心

主な論点その1

- 現存被ばく状況下でクリアランスという用語を用いるか？
  - 計画被ばく状況におけるクリアランスの線量基準：10 μSv/y（現実的シナリオ）
  - 現存被ばく状況における参考レベル（1～20mSv/yの下方から選定）
    - 再利用と埋設処分のためのScreening level の説明と福島での事例を、APPENDIXに
- 表面汚染に対する新しいクリアランスレベル（Bq/cm^2）
  - クリアランスレベル（無条件）のように統一した値を提示するのか？
    - 様々な状況に応じて、すでに国際的に運用されていることに配慮し、ANNEX II を参照して事例を示すだけにとどめる
  - 表面とは？ （土壌やコンクリートがら等の扱い）
  - 重量濃度と表面密度の2つの基準の適用方法は？
    - 表面密度基準は、体積に対して表面積が大きな、例えば、paper, card, plastic sheeting and clothing, and glass and thin metal sheeting of low to moderate densityのような場合に適用し、重量濃度基準に加えて、その遵守が必要とする
  - 物品持ち出し基準との関係は？
    - ^{60}Coや^{137}Cs等のような高エネルギーガンマ線放出核種については、表面汚染基準値を導出する際に想定した表面汚染物のサイズに依存して、その基準値が大きく変わることを明記
    - 日常的に小さなサイズの汚染物しか取り扱わない放射線管理の現場では、大きなサイズを取扱うクリアランスとは別の緩和した基準を適用することを推奨

主な論点その2

- 表面汚染に対する新しいクリアランスレベル（Bq/cm^2）
  - 物品持ち出し基準との関係性は？
    - 表面汚染クリアランスレベルを導出する線量評価モデルの事例を示すANNEX Iに、欧州のECの基準を導出した考え方等に加えて、日本保健物理学会 放射線防護標準化委員会の策定した「計画被ばく状況における汚染した物の搬出ガイドライン（2016年6月）」を引用
    - ^{60}Coや^{137}Cs等のような高エネルギーガンマ線放出核種については、表面汚染基準値を導出する際に想定した表面汚染物のサイズに依存して、その基準値が大きく変わることを明記
    - 日常的に小さなサイズの汚染物しか取り扱わない放射線管理の現場では、大きなサイズを取扱うクリアランスとは別の緩和した基準を適用することを推奨
- 新しい条件付クリアランスレベル（Bq/g）はどのように規定するか？
  - クリアランスレベル（無条件）のように統一した値を提示するのか？
    - 様々な状況に応じて、すでに国際的に運用されていることに配慮し、ANNEX IIIを参照して事例を示すだけにとどめる
- どのように過剰に保守的な評価を避けるか？
  - TECDOC 1000における平均化の10倍ルール
    - 平均してCLを満足していれば、部分的に平均値より10倍高くても許容できる
  - クリアランス判断における測定と核種組成比の不確実性の取扱い
    - 日本原子力学会標準「クリアランスの判断方法: 2005」
    - IAEA Safety Report No. 67、ICRP Pub.104

の考え方をANNEX IVに採用

今後の予定

- 次回のDS500ドラフト作成に係る専門家会合は、2019年1月21～25日、DS499に係る専門家会合と同時に開催する
- その後、IAEA技術会合（候補日：3月19～22日）を開催し、加盟国から意見を集める
- IAEA/WASSC（廃棄物安全基準委員会）会合等での審議を経て、2022年8月の発行を目指す

Thank you for your attention!