Guidance for developing and applying an in-house methodology for radiological characterisation of conditionally non-radioactive waste

GUIDELINES

KP-INPP-003

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IGNALINA NUCLEAR POWER PLANT

CHALLENGES TODAY. RESPONSIBILITY FOR AGES

Foreword

In 2021, the European Commission (EC) adopted a new proposal for a Council Regulation[1] establishing a dedicated financial programme for decommissioning nuclear facilities and managing radioactive waste. This instrument covers the co-funding of the decommissioning programmes of Bulgaria, Slovakia, and the decommissioning of the Joint Research Centre (JRC). A separate Council Regulation[2] was adopted for the decommissioning programme of Lithuania.

The EC JRC is mandated to foster the spread of decommissioning knowledge across all the European Union Member States and facilitate knowledge sharing arising from implementing the abovementioned decommissioning programmes, funded by the Nuclear Decommissioning Assistance Programme (NDAP).

The decommissioning operators from the NDAP (NDAP Operators) implemented and tested a knowledge management methodology in 2021 through Project ENER/D2/2020-273. Using this methodology, the NDAP Operators can develop Knowledge Products that are currently available to share with other European stakeholders. In addition, this methodology is under implementation in the JRC Nuclear Decommissioning and Waste Management Directorate (NDWMD), which becomes a knowledge generator extracting the knowledge from the ongoing decommissioning activities at the different sites (Geel, Ispra, Karlsruhe, and Petten).

The JRC NDWMD aims to become a Centre of Excellence in nuclear decommissioning knowledge management and develop a decommissioning knowledge platform which allows exchanging information and building on the best practices in the EU inside the multi-annual financial framework (2021 – 2027) strategy. The operational phase of the project is expected to start in 2024 to develop ties and exchanges among EU stakeholders and document explicit knowledge and make it available through multi-lateral knowledge transfers on decommissioning and waste management governance issues, managerial best practices, technological challenges, and decommissioning processes at both operational and organisational level, to develop potential EU synergies.

This is a Knowledge Product prepared by State Enterprise Ignalina NPP for the JRC NDWMD.

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[1] Council Regulation (Euratom) 2021/100 of 25 January 2021 establishing a dedicated financial programme for the decommissioning of nuclear facilities and the management of radioactive waste, and repealing Regulation (Euratom) No 1368/2013

[2] Council Regulation (EU) 2021/101 of 25 January 2021 establishing the nuclear decommissioning assistance programme of the Ignalina nuclear power plant in Lithuania and repealing Regulation (EU) No 1369/2013

PRODUCT DESCRIPTION

The *"Guidance for developing an in-house methodology for radiological characterisation of conditionally non-radioactive waste"* was prepared by a team of experts from the Radiation Safety Division at Ignalina Nuclear Power Plant in Lithuania. The guidance and recommendations of this product are collected from the experience gained during the execution of the free release activity in the scope of decommissioning, sponsored by the European Commission via the Nuclear Decommissioning Assistance Program (NDAP) between 2008 and 2010.

The guidelines presented in this report aim to assist NPP Decommissioning personnel in free release equipment and material from NPP for future use with less effort or even without size reduction and destroying integrity.

This product was developed as part of an effort to disseminate and share with all EU State Members the knowledge acquired during the decommissioning and radioactive waste management activities performed with NDAP funding under Council Regulation (EU) 2021/101 of 25 January 2021 Establishing the nuclear decommissioning assistance programme of the Ignalina nuclear power plant in Lithuania and repealing Regulation (EU) No 1369/2013.

ABSTRACT

The "Guidance for developing and applying an in-house methodology for radiological characterisation of conditionally non-radioactive waste" provides D&WM organisations with technical guidance for **developing and applying in-house free release (unconditional release) radiological characterisation methodologies for materials and equipment** arising from decommissioning if it is potentially uncontaminated but requires a lot of effort or even destruction to prepare for measurements.

OBJECTIVE

To share Ignalina NPP (INPP) experience and to give some recommendations for developing and applying methodologies for the free release of potentially non-contaminated materials and equipment with complex geometry arising from decommissioning with less effort or even **without size reduction and integrity disruption**.

APPROACH

This document, "Guidance for developing an in-house methodology for radiological characterisation of conditionally non-radioactive waste", was developed by representatives of the Radiation Safety Department State Enterprise Ignalina NPP. The project team incorporated **experiences and lessons learned from more than 15 years of decommissioning project implementation experience and RAW treatment** procedures improvement to minimise expenses and raise potentially not contaminated RAW amount.

It has been written to assist EU operators in developing a methodology covering requirements: (1) for dismantling sequence and material/waste treatment, (2) for sequencing and developing methods for serial radiological measurements, (3) obtaining data processing and making a final decision on release from regulatory control. Methodologies and guidance produced by users of this product must be consistent with national regulatory bodies. In the case of INPP, this guidance was a specific requirement in national regulations and therefore the methodology was agreed with the Lithuanian regulatory authority.

RESULTS, FINDINGS, AND INSIGHTS

This product sheds light on the practical implementation of radiological characterisation of equipment/material/waste with minimum or even without size reduction (generally size reduction is needed for loading into standard packages prior to the final characterisation stage). This significantly reduces labour, time, and costs, increases measurement performance, and opens the possibility for free release, reuse or selling of dismantled equipment as a product.

TARGET USERS

The main beneficiaries of this knowledge product are nuclear industry facilities, science / medical institutions and research organisations that deal with equipment with a very low probability of contamination with radionuclides that need to be dismantled and released during operation or decommissioning.

This guideline is intended for use by personnel who are experienced in performing radiological measurements, as well as for young professionals.

APPLICATION, VALUE AND USE

This guidance can be used to develop, implement or improve procedures for free release of large-scale complex geometry components. INPP experience can help other organisations in the EU:

- Release materials and equipment with a very low probability of contamination, with less effort, making this process more efficient.
- Gain additional income from selling free released materials and equipment as a product.
- Reduce the volume of radioactive waste in the facility

Developing methodologies for the free release of equipment can also facilitate the development of side products. Users should consider potential limitations in the application and use of this guidance related to the measurement process, which is time-consuming and may need more data or adequate field conditions for data collection. Specifically:

- *Absence of information on equipment operation history: tasks, working parameters and conditions,* emergencies *and failures.*
- The presence *of alpha contamination* requires more restricted *and precise measurement procedures.*

KEYWORDS

FREE RELEASE, CLEARANCE, LARGE-SCALE COMPONENTS, RADIOLOGICAL MEASUREMENTS, SURFACE CONTAMINATION, SPECTROSCOPY.

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LIST OF ACRONYMS AND DEFINITIONS

CNRW	Conditionally non-radioactive wastes
EDR	Equivalent dose rate
(SE) INPP	(State Enterprise) Ignalina Nuclear Power Plant
NPP	Nuclear Power Plant
RAW	Radioactive waste

Clearance levels	A set of values established by the regulatory body in a country, expressed in terms of activity concentrations at or below which materials can be released from nuclear regulatory control.
Conditionally non-radioactive	Waste, material, or equipment at controlled area, which contamination probability is very low, but couldn't be excluded.
Disposal	The emplacement of waste in an approved, specified facility without the intention of retrieval.
Free Release	Release of the conditionally non-radioactive waste from regulatory control.
Regulatory body	An authority designated by the government of a country for conducting and licensing process, for issuing licenses and thereby for regulating the siting, design, construction, commissioning, operation, closure, decommissioning etc. of the nuclear facilities or specific aspects thereof.

LIST OF FIGURES

1. FREE RELEASE MATERIAL AND EQUIPMENT FROM DECOMMISSIONING

During the dismantling of contaminated equipment, part of the generated waste can be **released from the regulatory control (free released)** and used further as uncontaminated material or still equipment. Decontamination, size reduction, packing and preparing for measurement could require much effort in terms of labour, time, and money. Preparation activities like measurement methodology development or measurement sequences and technic improvement could lead to significant time savings, the final repository for RAW volume reduction and overall cost savings due to the decrease of material volume for disposal.

Based on international guidance, there is a common practice for free release using different but very similar techniques when raising waste. The materials are cut up, pre-measured, loaded in standard packages (containers or drums) and finally go through free-release monitors to measure the activities of radionuclides.

INPP experience shows that the free release process can be optimised through in-house radiological characterisation methodology development. **This knowledge product provides examples, tips and recommendations to develop an in-house methodology for free release in accordance with identified best practices and international regulations**.

1.1. Current Practice in Free Release

Free release procedure generally consists of four main steps:

PRELIMINARY MEASUREMENTS

Preliminary equivalent gamma dose rate and surface contamination measurements using hand-held measuring equipment such as Thermo Scientific FH-40, Atomtex AT1125 or similar dose rate meters (see Figure 1) and Microcont, Contamat, CoMo-170 etc. surface β-contamination meters (see Figure 2) to ensure that contamination distributed homogeneously and to avoid the presence of "hot spots". In case of "hot spots", they must be removed.

Figure 1. Examples of equivalent gamma dose rate-measurement equipment.

Figure 2. Examples of β-contamination measurement equipment.

The main requirement for this type of measurement is that **all surfaces** must be accessible. If the access is not granted:

- Access must be provided
- Considering construction features must be proven, there was no access to closed cavities of the equipment during operation, and radiation contamination was impossible.

	Direct measurements, as well as wipe testing, are allowable for β-contamination measurements.
	The paint cover should be removed before measurement if its origin is not from fabrication. Otherwise, **contamination could be covered under paint and measurement (by wipe test or direct) may not detect contamination**.

Figure 3. Surface β-contamination measurements.

WASTE CHARACTERISATION

The waste is characterised by using radiometric or spectrometric measuring equipment. There are two main ways to take measurements:

- Using standard packages like containers or drums (see Figure 4) using methodologies provided with the measuring equipment and usually agreed with the regulatory body;
- As large-scale components/objects (see Figure 5) using mobile gamma-spectroscopy equipment (see Figure 6). In this case, methodologies are also supplied with measuring equipment, and separate **in-house methodologies could be developed by** specialists and usually approved by the regulatory body.

Figure 4. Examples of waste measurements in standard containers and drums.

Figure 5. Examples of large-scale components.

Figure 6. Example of mobile gamma-spectroscopy measurement system

CALCULATION OF UNCONDITIONAL CLEARANCE FACTOR

The calculation of the unconditional clearance factor to decide object release from regulatory control involves:

- Estimating activities of all declared nuclides. The scaling factors (nuclide vector) are used when the materials and waste contain different radionuclides (more than one). The principle of the scaling method is to establish correlations between difficult-to-measure nuclides and easy-to-measure nuclides (key nuclides), for example, ^{137}Cs or ^{60}Co. Such correlations are estimated for each waste stream.
- All declared nuclide activities are calculated using the activity of the key nuclide.
- The unconditional clearance factor is calculated using the activities of all declared nuclides. The wastes are considered to be released from regulatory control if they meet the following condition:

$$\sum_{i}^{n} C_i / C_{Li} \leq 1$$

Where:

C_i – the activity concentration or surface activity of the *i*-radionuclide in the material or waste (Bq/kg or Bq/cm^2);
C_{Li} – the unconditional clearance level or corresponding surface activity of the *i*-radionuclide in the material or waste (Bq/kg or Bq/cm^2);
n – the number of radionuclides in the mixture.

REGULATORY BODY APPROVAL

Getting approval from the regulatory body for unrestricted use of released material and equipment if the radionuclide activity meets unconditional clearance levels.

If the radionuclides activity of the waste **does not meet unconditional clearance levels, the waste should be subject** to decontamination or loading into RAW packages for further disposal.

1.2. Free Release in Lithuania

To avoid cross-contamination, potentially not contaminated equipment is treated separately from radioactive waste. Such wastes are called conditionally non-radioactive waste (CNRW). To classify dismantling waste as CNRW, measuring the equivalent dose rate and surface beta contamination of all waste surfaces is mandatory, and the measurement results should not exceed preliminary set values.

The Regulatory Document of the Republic of Lithuania describes the waste release process from regulatory control (Nuclear safety requirements BSR-1.9.2-2018. "Establishment and application of clearance levels of radionuclides for the materials and waste generated during the activities with the sources of ionising radiation in the area of nuclear energy) allows the development of individual radiological characterisation procedure-descriptions (from now on referred to as methodology) for equipment components or whole equipment, the nature of the contamination which is the same, and statistical optimisation methods can be applied to them.

> For example, if it is known that the piped space of the heat exchanger receives non-contaminated heated oil and non-contaminated cooling water circulates inside the pipes, it can be assumed that the probability of contamination and the levels of contamination of the inner surfaces of pipes are the same in whatever part of the heat exchanger it is. In this case, it is possible to make selective measurements of the internal surfaces of some tubes and assume that the other tubes have the same condition.

1.3. Relevance of this Guideline

The abovementioned example depicts a very particular case in which plant-specific free release procedures following national regulations and internal experience can help optimise the process of Free Release. This guidance is aimed at assisting organisations to outside Lithuania to develop these procedures, extrapolating conclusions from the experience gained in Lithuania during these activities.

This guidance may be particularly relevant for operating or decommissioned nuclear facilities with a **generation of complex geometry wastes**, which can potentially be released from radiation control but are difficult to handle due to the high cost of measurement preparation activities.

This guideline can be used to develop procedure descriptions of activities and specific procedures without an established process for the free release of waste from regulatory control (measurement methodologies, specific containers for waste measurement, complex waste handling equipment).

2. SCOPE OF THE GUIDELINES

This guideline will provide tips and recommendations for the development of free-release activities and in-house radiological characterisation Methodologies to conduct these activities, covering the following tasks and aspects of the process:

- Economic feasibility of different strategies
- Selection of the handling equipment
- Establishment of requirements for measurement conditions
- Selection requirements for the measurement equipment
- Information collection about objects/materials
- Description of measurement methods/techniques
- Description of measurements results processing
- Quality assurance (staff qualifications, equipment)
- Safety and radiological protection aspects
- Regulatory and licensing considerations
- Human and organisational aspects (if applicable)
- Etc.

3. GUIDELINE FOR THE DEVELOPMENT OF FREE-RELEASE METHODOLOGY

3.1. Outline and Contents

A methodology for free release should include at least the topics suggested in Annex 1. Annex 1 contains a generic proposal for a free release procedure structure/index, covering the most important aspects to consider in these activities based on INPP's experience.

3.2. Economic Feasibility of Free Release Strategies

Before developing the methodology, it is recommended to determine the economic feasibility. **A simple economic comparative analysis** should be performed using the following steps:

ASSESSMENT OF METHODOLOGY DEVELOPMENT

Methodology development and approval with regulatory body expenses and the benefit to be derived from the sale of released materials calculation:

$$C_{dev} = (t \times R) - (m \times S)$$

Where:

C_{dev} – the cost of development and approving one methodology, considering the benefit from the sale of the material (€);

t – time amount for development and approval of one methodology (hour);

R – pay rate (€/hour);

m – mass of wastes (ton);

S – material price (€/ton).

ASSESSMENT OF RAW DISPOSAL

Disposal cost of the same amount of material as radioactive waste in the very low-level waste repository in case if Free Release is not implemented, calculation:

$$C_{disp} = m \times D$$

Where:

C_{disp} – the waste disposal in the very low-level waste facility cost (€);

D – disposal of 1 ton of the waste in the very low-level waste facility cost (€/ton).

EFFICIENCY OF METHODOLOGY DEVELOPMENT

The efficiency coefficient K calculation:

$$K = C_{disp} / C_{dev}$$

If the condition $K > 1.0$ is met, then it can be concluded that the development of the methodology is **economically feasible**.

The following formula can be used to calculate the minimum waste mass when the development of the methodology is economically feasible:

$$m = t \times R / (D + S)$$

The analysis at INPP showed that developing the descriptions for equipment with a total mass of less than 3.0 tons is not economically feasible.

3.3. Selection of the Handling Equipment

Selection of the necessary equipment for large-scale component transportation and positioning needs to be done, and the demand for special instruments and devices to perform measurements efficiently has to be identified.

For the layer-by-layer **measurement of pipes extracted from the heat exchanger** and the formation of a parallelepiped shape package for further gamma-spectroscopy measurements, a holder in the form of the letter U could be manufactured.

3.4. Establishment of Requirements for Measurement Conditions

A critical stage is establishing requirements for the measurement conditions (temperature, humidity, equivalent dose rate of background), locations for measurement implementation and further storage of measured equipment selection. Measurements shall be carried out in non-contaminated premises **to decrease influence on measurement results and to prevent re-contamination of the measured wastes**.

The equivalent dose rate of background at the place of measurement **is limited to 0,15 μSv/h** at INPP.

3.5. Selection Requirements for the Measurement Equipment

Considering expected contamination levels, the **consistency and requirements for the measuring equipment to be used should be determined** and described in the methodology.The set of measuring equipment used at INPP consists of:

- Hand-held dosimeters for measurement of gamma radiation EDR with a range from 0,1 μSv/h (see Figure 1).
- Hand-held radiometers measuring surface β-contamination with surface activity range from 0,05 Bq/cm^2 (see Figure 2).
- Mobile gamma-spectroscopy system for gamma-emitting radionuclides activity measurement with a gamma-radiation energy range of 50 - 3000 keV (see Figure 6).

To increase surface β-contamination measurements efficiency and rate, it is recommended to use **equipment with different detector areas** depending on **the** surface size to measure (for example, detectors with an area of 100, 300, or 600 cm2).

3.6. Information Collection about Objects/Materials

Guidance should promote collecting as much **information** related to the measurement object as possible. This information should be analysed in detail, including:

- Purposes and tasks for equipment during operation – working conditions.
- Environment conditions during operation, media used, operation parameters and settings – working conditions.
- Equipment design (drawings, technical description) – possibility to access all surfaces.
- Operating history, emergency event, equipment failure – possibility to gain contamination.
- Dismantling technology (important to exclude possible cross-contamination) – preparedness for the free release procedure.

Typically, the time required for this stage could vary significantly and depend on the availability and accessibility of staff from operation, the availability and type of database (paper or electronic), and the complexity of the equipment. This crucial stage impacts the following stages and the possibility to prepare and implement methodology. The methodology should consistently present all information listed above and anything that could help prove that contamination was not possible during the operation.

If **radioactive media was used** in the operation of the equipment (inside the tubes, for example), **the release** of the equipment **according to the procedure descriptions is not possible**.

3.7. Description of Measurement Methods/Techniques

This part of the methodology should describe the methods used to perform measurements and measurement results processing procedures.

Do not forget that if there is more than one similar equipment, measurements in the scope defined by the Methodology are **performed for each individual equipment**.

Typical measurement sequence (used at the INPP):

- EDR measurement at 10 cm from the surface;
- Measurement of the surface β-contamination of the outer surfaces at a distance of 1 cm from the surface;
- Measurement of surface β-contamination of accessible internal surfaces and difficult-to-reach places (or justification that this is not obligatory);
- Gamma-spectroscopy measurements of equipment elements.

If reference levels in the methodology are exceeded at any stage, measurements should be terminated. Consequently, the whole object should be considered contaminated and not released.

The reference levels for dose rate and surface contamination measurement issued at Ignalina NPP based on operational experience:

Dose rate	not more than 0,2 μSv/h
Surface β-contamination	not more than 0,2 Bq/cm^2

3.8. Description of Measurements Results Processing

This section should describe what data should be collected and how to process these data. The most common way is to use a scaling factor or nuclide vector. The main idea of such a method is that activities of all declared nuclides (difficult to measure, for example, alpha- and beta-emitting nuclides) are determined by the activity of measured key radionuclides (easy to measure gamma nuclides). Scaling factors or nuclide vectors should be obtained in advance. Data processing should describe:

- The use the nuclide vector method (the activities of all declared nuclides are determined by the activity of key radionuclides)
- How the activities of the declared nuclides are compared with the unconditional clearance levels (or conditional clearance level is applicable) and how the unconditional clearance factor is calculated (see Section 1.1)
- The decision to release from radiation control making
- The measurement results protocol and what information it should include.

3.9. Quality Assurance: Staff Qualifications and Equipment

To assure measurement quality, staff and equipment should meet the specified requirements (staff qualification, equipment verification, quality control). All these should be listed in the methodology:

- Dosimetry and radiometric measurements shall be performed by qualified staff (dosimetrists) with practical experience and certified knowledge in the field.
- Staff like radiometric engineers and/or radiometric laboratorians with practical experience and certified knowledge in gamma radiation spectrometry should conduct the measurements with gamma spectrometric equipment and process measurement results.
- Staff should know applicable manuals for working with the software before measuring and presenting results, have computer skills, and be familiar with equipment and measurement system manuals.
- All used equipment should meet national requirements for equipment verification (generally once a year by an accredited laboratory) and quality control procedure before measurement (typically described in manufacturer's manuals).

3.10. Safety and Radiological Protection Aspects

To prevent staff skin contamination and inhalation of the dust arising during waste handling operations (before measurement, all equipment from controlled areas considered possibly contaminated), all the staff involved in this activity should use personal protective means such as protective coveralls, gloves, and respirators. All protective means should be used without contamination and periodically (before entering the measurement area) monitored to exclude cross-contamination.

The background equivalent dose rate in the work area must be continuously monitored.

The measurement area should be fenced off (could be STOP tape) and marked to avoid cross-contamination. Only personnel wearing clean personal protective means may enter the measurement area.

3.11. Regulatory and licensing considerations

Regulatory approval must be obtained before removing cleared equipment, materials, and wastes outside of the site. The procedure for obtaining such regulatory approval should be clearly described in national legislation.

In Lithuania, according to the national legislation, in order to get approval for free release, the licensee shall prepare a radionuclide activity certificate for each single shipment of materials or waste, which shall include:

- Name of the licensee's department that carried out the measurements
- Measurement date
- Name of the materials and/or wastes
- Origin of materials and/or wastes
- Size of the shipment (mass or volume)
- Measured activity of the radionuclides
- Final destination (the recipient) of the materials and/or wastes
- Reference to the radiological characterisation methodology

3.12. Human and Organisational Aspects (if applicable)

An optional section that could contain information about the responsibility of every participant described in the methodology process (starting from task setting and resource allocation and finishing with Methodology development, measurement collection, data processing and issuing the final report) to make the activity more transparent.

4. EXAMPLES OF FREE-RELEASE METHODOLOGY IMPLEMENTATION

4.1. Example of Free Release of Tubes from a Heat Exchanger

Example of what optimisation could be implemented for tubes from a heat exchanger:

- EDR measurement at a distance of 10 cm from the surface could be conducted by laying out tubes on the table in one layer.
- Measurement of the surface β-contamination of the outer surfaces at a distance of 1 cm from the surface could be conducted by laying tubes on the table in one layer (simultaneously with EDR measurement).
- Measurement of surface β-contamination of accessible internal surfaces for tubes: the measurement is performed using a wipe test every tenth tube in random order. One wipe is taken from each side of the tube. The justification of such optimisation is that all tubes worked in the same conditions, so if we check the randomly selected amount of tubes (operational experience shows that 10% is a good approach), it is enough to prove that contamination is not present (or opposite).
- Gamma-spectroscopy measurements could be implemented for tube packs (see Figure 7). (According to the Lithuanian normative document BSR-1.9.2-2018, the surface measurement should be not less than 300 cm^2).

Figure 7. Example of tube pack prepared for gamma-spectroscopy measurements.

4.2. Example of Free Release of Valve Servo Actuator

Example of what optimisation could be implemented in valve servo actuators:

- EDR measurement at a distance of 10 cm from the surface could be conducted by laying out tubes on the table in one layer;
- Measurement of the surface β-contamination of the outer surfaces at a distance of 1 cm from the surface could be conducted by laying out tubes on the table in one layer (simultaneously with EDR measurement);
- Measurement of surface β-contamination at a distance of 1 cm from the outer surface of the servo actuator using a hand-held radiometer. In addition, two smears are taken in difficult-to-access places from a 300 cm^2 surface.
- Measurement of surface β-contamination of inner surfaces of servo actuator by taking smears from 300 cm^2 inner surfaces. It needs to open the lids of the servo actuator to ensure access (see Figure 8).
- Gamma-spectroscopy measurements could be implemented for all taken smears and any outer surface of the valve servo actuator (see Figure 9). (According to the Lithuanian normative document BSR-1.9.2-2018, the surface measurement should be not less than 300 cm^2).

Figure 8. Valve servo actuator with open lid to access to the inner surface.

Figure 9. Valve servo actuator prepared for gamma-spectroscopy measurements.

4.3. Use of Unconditional Clearance Levels for Surface Contamination.

According to Lithuanian legislation, the free-release measurement should be conducted as specific radioactive contamination [Bq/g]. But this is inefficient, for example, for electrical equipment with thin surfaces such as electric cabinets, that could be the subject for future sale or reuse.

It is recommended to discuss with the regulator and agree to implement in legislation the set of limits for surface contamination [Bq/cm2] if the limits for specific activity are ensured. In that case, there is no need to cut and put equipment as waste to packages – the surface contamination is measured directly, and calculations assess specific activity.
Another advantage of this approach is that by separate estimation, the value in [Bq/cm^2] could be higher than [Bq/g]. For example, at INPP, it was shown that 0.4 Bq/cm2 could be used as a limit for the Co-60 and Cs-137. At the same time, the limit for specific activity of 0.1 Bq/g is ensured.

5. RECOMMENDATIONS FOR FREE RELEASE METHODOLOGY DEVELOPMENT

1.	Ensure that the possibility of applying statistical optimisation methods is allowed by the country's legislation base regarding the free release of wastes.
2.	Ensure that the organisation or enterprise has personnel with sufficient knowledge level to develop the methodology.
3.	Collect all available historical information and operational data on the equipment to be subject to free release. Analyse its sufficiency to develop the methodology.
4.	Perform feasibility analysis as described in chapter 3.2 of the document.
5.	Ensure that the organisation or enterprise has available premises or areas for clearance measurement and temporary storage of wastes. It should be ensured that cross-contamination is excluded and that the background equivalent dose rate allows for implementation measurements for unrestricted release.
6.	Ensure that the organisation or enterprise has all the necessary equipment for handling and transporting the waste.
7.	Ensure that the organisation or enterprise has all necessary measurement equipment and that its technical specifications are sufficient for radiological measurements.
8.	Ensure that the organisation or enterprise has trained personnel to perform radiological measurements.

6. CONCLUSIONS

This guideline provides the critical elements identified at INPP to develop an in-house procedure for free release, which could be used as experience in order to make free-release equipment, material, or waste, arising from controlled areas more efficient.

Based on INPP experience, eight major elements must be considered when developing methodology.

This knowledge product could be used as a guide to implement the basic steps towards the development of this type of methodology while providing examples of best practices and lessons learned from the implementation of this activity at INPP.

Annex 1

TYPICAL METHODOLOGY STRUCTURE

	1) Purpose of document
Contains a clear statement explaining the purpose of the methodology.	
	2) Field of usage
Contains a description of the activity for which the methodology is being developed and identifies specific personnel using the document performing the work.	
	3) Responsibility
Contains a list of the positions involved in the performance of the works and clearly defines their responsibilities.	
	4) List of definitions
Contains a list of definitions, abbreviations, and their corresponding meaning.	
	5) Links
Contains a list of documents based on which the Methodology was developed and the documents that must be additionally used in the performance of work, such as requirements, normative documents, design documents, factory documentation, operational manual etc.	
	6) Input data and equipment description
Contains a detailed description of the equipment to be measured, its purpose during operation and its operating history.	
	7) Description of radiological characterisation methods
Contains a description of the measurements sequence step by step in general.	
	8) Description of measurement equipment
Contains a description of measurement equipment and its detailed technical characteristics.	
	9) Measuring conditions

Contains a list of factors determining the conditions for performing measurements and allowable ranges of these factors, such as ambient dose rate, range of air humidity and temperature.	
	**10) Measurements performing and data analysis**
Contains a detailed description of actions at each step, presented in section 7, measurement data analysis and making interim and final decisions.	
	**11) Recording of measurement results**
Contains a detailed description of how and in what form the results are recorded. Next, the names of the documents that must be prepared and issued in accordance with the requirements of the methodology should be listed.	