AUTORITÉ DE SÛRETÉ NUCLÉAIRE

A S N G U I D E

B N I

Complete post-operational clean out methodologies acceptable in Basic Nuclear Installations (BNIs) in France

GUIDE N°14

Version of 08/30/2016

Preamble

The collection of ASN guides comprises documents intended for professionals interested in the regulation of nuclear safety and radiation protection (licensees, users or transporters of sources of ionising radiation, health professionals). These guides can also be distributed to the various stakeholders, such as the local information committees (CLIs).

Each guide gives a number of recommendations aiming to:

- explain a regulation and the rights and obligations of the persons concerned by it;

- explain the regulatory objectives and, as applicable, describe the practices that ASN considers to be satisfactory;

- provide practical and useful information about nuclear safety and radiation protection.

Contents

1 INTRODUCTION

1.1 Context and regulatory references

[1] Environmental Code, specifically title IX of book V
[2] Order of 7th February 2012 amended, setting the general rules concerning basic nuclear installations
[3] ASN Resolution 2008-DC-106 of 11th July 2008 concerning the use of internal authorisation systems in BNIs
[4] ASN Resolution 2015-DC-0508 of 21st April 2015 relative to the study of waste management and the inventory of waste produced in the BNIs
[5] ASN guide N°6 on final shutdown, decommissioning and delicensing of BNIs in France, version of 30th August, 2016
[6] ASN Guide N°23: Drafting and modification of the waste zoning plan for basic nuclear installations – version of 30th August 2016
[7] ASN Guide N°24: Management of soils, contaminated by the activities of a basic nuclear installation – version of 30th August 2016
[8] IRSN Guide concerning the management methodology for industrial sites potentially contaminated by radioactive substances
[9] Basic principles of the ASN doctrine of 4th October 2012 on the management of sites contaminated by radioactive substances

1.2 Scope of the guide

This document applies to any basic nuclear installation (BNI), whether operating or in decommissioning, where the operator is required to carry out post-operational clean-out to address the parts of a structure where contamination is suspected or known.

1.3 Purpose of the guide

All BNIs evolve during their operating period. Certain areas or buildings are thus likely to change use or demolished. These changes, as well as any events that may occur during operations; may require the implementation of structural post-operational clean-out (POCO) operations in order to eliminate radioactive substances and contamination.

This guide outlines ASN's recommendations regarding the remediation methodology described in chapter 3.6 of the annex to the resolution [5] that the licensee must develop in order to carry out POCO operations. This guide does not apply to the treatment of polluted soils, which is the subject of guide [7].

1.4 Status of the document

This updated guide replaces the draft version of 21 June 2010 that had been published. This updated version takes into account the publication of several texts, particularly the decree [2], the resolution [5], the guide [7] and also the codification of the law of 13 June 2006. This guide was subject to a stakeholder consultation in the first half of 2016.

1.5 Definitions

The following definitions used in this guide are the same as those used in guide [7]: "Decommissioning," "Remediation," and "Declassification." The definition for the "waste zoning plan" is from the resolution [5]. The definition of a "ZDC with enhanced memory" is from the guide [7.]

For the purposes of this guide, the following definitions are used:

Remediation Objective
The maximum activity, defined for a typical spectrum of radioelements associated with a surface with regard to the nature of the components constituting it and the physical phenomena to which it has been exposed, which must be attained at the end of the remediation operations. This value does not constitute a release threshold.

Decision Criterion
A value chosen to allow operational verification of the achievement of the remediation objective. In order to take into account all the radioelements present, the value of this criterion must lie between the remediation objective and the detection limit of the measuring devices.

Hot Spot (or singularity)
A point located in an area with possible nuclear waste production, where localized physical phenomena have led to a mass or surface activity of a value higher than that measured in the whole area.

Structure
Building elements, or an arrangement of building elements involved in the definition of a room or building (e.g. wall, beams, floor, roof, ceiling, etc.).

Any use
All established, envisaged and conceivable uses of buildings and land affected by contamination or activation.

Zone
A zone, defined under waste zoning, is delimited either by the installation of physical barriers (wall, airlock, ceiling, etc.) or by another appropriate manner.

2 REMINDER OF GENERAL WASTE MANAGEMENT POLICY IN BASIC NUCLEAR INSTALLATIONS (BNI) IN FRANCE

The management of nuclear waste in France is part of the general framework set by the Environmental Code and its corresponding decrees. It is based on the principles that the producer of the waste has responsibility and that the waste should be traceable from production to its final destination. It complies with the provisions specified in the environmental code [1], the decree of 7 February 2012 [2], and the resolution of 21 April 2015 [5].

Waste management is based on the waste zoning plan mentioned in article 6.3 of the decree of 7 February 2012 [2] and set out in title III of the annex to the resolution of 21 April 2015 [5]. This waste zoning plan designates areas with potential nuclear waste production (ZppDN) where the waste generated is contaminated, radioactive or likely to be contaminated. The areas of the BNI that are not defined as ZppDN are conventional waste areas (CWA).

In order to ensure a high level of confidence in the designation of waste as non-radioactive, several independent and consecutive lines of defence are put in place:

- the development of the waste zoning plan, which is based on an in-depth analysis of the state of the BNI,
- confirmation, in particular through radiological surveys, of the adequacy of the waste zoning plan,
- confirmation, in particular through radiological surveys, of the characterization as non-radioactive of waste from CWAs.

Waste from the ZDCs is, after confirming that it is free of contamination and radioactivity, directed into approved channels in accordance with article 3.1.4 of the annex to the resolution of 21 April 2015 [5].

Waste from the ZppDNN must be managed as radioactive waste unless it can be shown that it could not, in any way and at any time, be contaminated or radioactive, in accordance with article 3.1.3 of the annex to the resolution of 21 April 2015 [5]. These waste management procedures are specific in §4 of the guide [6].

3 PRINCIPLES FOR COMPLETE POST-OPERATIONAL CLEAN-OUT OF STRUCTURES

The ASN policy relating to remediation is detailed in chapter 9.1 of the guide [5].

3.1 Complete remediation

The reference approach recommended by ASN is to perform a full remediation.

As recommended by ASN in its doctrine [9], this approach provides for, "where possible, to completely clean up contaminated sites, even if the exposure to people caused by the contamination appears limited," (i.e. to return to the initial state before contamination of structures).

After the complete remediation operations, the declassification of the waste zones can be carried out (see §4.3) and, in addition, at the time of the delicensing of the installation (see guide [5]), no institutional controls are required.

3.2 Advanced remediation

In situations where, based on the characteristics of the contamination or radioactivity, the reference approach would pose implementation challenges, the licensee must go as far as reasonably possible in the remediation process and commit to a management approach whose primary objective is to make the structures or facility compatible with any use. This process is known as advanced remediation.

Compatibility with any uses refers to compatibility with established, planned and foreseeable uses of contaminated structures. Impact assessments demonstrating this compatibility shall be carried out regard given to the relevant exposure scenarios from the guide [8][1]. For each scenario, the licensee should identify all exposure pathways and indicate the assumptions used in the calculations. In this case, after the complete remediation operations, the declassification of the waste zones can be carried out (see §4.3) and, in addition, at the time of the delicensing of the installation (see guide [5]), no institutional controls are required.

In the case that radioactivity or contamination remains, rendering the structures incompatible with certain uses, the licensee must demonstrate that the remediation process has been carried out as far as reasonably possible, under acceptable technical and economic conditions. The extent of the remediation should not be determined based on the radiological impact.

ASN believes that, in this case, the decommissioning of the BNI, with the implementation of institutional controls, can only be considered when the contamination or radiation is limited and contained and the remediation would require the deconstruction of the building whilst a permanent, established used is planned in the short term by the licensee for this building. The procedure for taking into account possible soil contamination is specified in the guide [7].

The declassification of the waste zones can be considered in the form of a "ZDC with enhanced memory." In this case, the institutional controls implemented during the decommissioning of the BNI ensures that waste from final remediation is managed in channels authorised to manage radioactive waste.

3.3 Remediation during operation

For the installations currently in operations, given that the normal operations of the site may present technical restraints regarding the implementations of the work that would be necessary for complete or advanced remediation, ASN believes that is may be necessary to perform remediation in two stages (an operational stage and a decommissioning stage). To this end, the licensee:

- proposes and implements management measures with the goal of controlling radioactive sources, or failing that, manage the consequences (restrictions for uses, transport routes) in order to ensure that there is impact to workers, the public or the environment for the established use;

[1] Not all of the scenarios from the guide [8] are applicable. Some only apply in the event of soil pollution (e.g. gardening).

- keeps information on actions taken to facilitate remediation during the dismantling of the installation (classification of the area as a "*ZDC with enhanced memory*").

4 PRINCIPLES FOR THE REMEDIATION OF THE STRUCTURES IN AN AREA WITH POTENTIAL NUCLEAR WASTE PRODUCTION

Prior to the start of any remediation work, and in accordance with the resolution [5], the facility's waste zoning plan must be updated to take into account:

- prior events which have or may lead to contamination or activation of the structures of the areas classified as a conventional waste zone (ZDC) (notably, reclassification of "*ZDC with enhanced memory*" within the definition given in the guide [6]);
- the state of the installation[2];
- the remediation methods utilised (breakdown of barrier between ZppDN and ZDC).

Complete remediation of structures involves treatment of these structures in order to eliminate the parts considered to be contaminated or radioactive, with the goal of downgrading a nuclear waste zone (ZppDN) to a conventional waste zone (ZDC) or eliminating a "*hot spot*" present in a ZDC.

Any clean-out operation proposed by a licensee, whatever its degree of complexity, must be based on the development of a waste zoning system which takes into account the presence of added radioactivity within the structures constituting a ZppDN. This waste zoning system must be based on the design of the facility, its operating rules and any events that may have occurred which led to contamination or activation of the structures.

Consistently with the resolution [5] and the guide [7], the creation of the new limit between the ZppDN and the ZDC is based on the use of independent and successive lines of defence, the combination of which guarantees a high degree of confidence in distinguishing between these two zones. In the case of a penetrating activation or contamination phenomenon, the limit between the nuclear and non-nuclear parts must be understood as being a depth beyond which the licensee's target remediation objectives calls for.

- **The first line of defence** is based on an in-depth examination in order to define the clean-out procedures for each structure (clean-out technique and/or thickness to be removed):
  - based on the modelling of the physical phenomena liable to lead to contamination or activation of the structure concerned or, failing that, based on a statistical method knowledge of the facility to define a profile for distribution of the contaminated or activated section within the thickness.
    Other methods can be proposed by the licensee provided that they do not lead to a one-time analysis of the physical phenomena involved, but rather a global analysis based on the dimensions of the surfaces to be cleaned out. In particular, in the case of old structures, some input data may be unavailable, thereby making this quantification difficult or uncertain. Additional investigations into the state of the installation (visual investigations, technical reviews, analysis of the civil engineering, sampling and radiological measurements, special pre-treatments) may be necessary to better understand and quantify the physical phenomena involved;
  - taking into account an additional precautionary fixed margin to account for the uncertainties associated with insufficient data for understanding and quantifying the physical phenomena involved, or for quantifying the effectiveness of the technical means used for clean-out. Any reduction or elimination of this margin must be justified (see §7.1.3).

[2] See § 6.1 of guide [5] concerning the update of the waste study.

- **The second line of defence** consists of confirming the conventional nature of the structures after clean-out. This confirmation must be based on a sufficiently exhaustive method to obtain a high degree of confidence with regard to the contamination or activation phenomena which affected the surface.

- The third line of defence consists of the radiological surveying of any conventional waste leaving the site (in accordance with article 3.4.4 of the annex to the resolution [5]). This barrier is maintained at least until the delicensing of the BNI.

In the event that the remediation process does not result in the compatibility with any use of the installation, the approach to be implemented in terms of zoning plan development and lines of defence is similar, provided that the declassification of the waste zones after clean-out operations is not systematic and is considered on a case-by-case basis (see §3.2). The second line of defence consists of confirming, not the conventional nature of the structures, but the achievement of the remediation objectives.

ASN suggests that the licensee, as much as possible, should implement global approaches for the BNI or site in order to treat multiple structures within the framework of a single remediation methodology. A justification of the appropriateness of the approach for multiple buildings that may house different processes or radioactive elements must be developed, particularly if the model if verified by sampling that is only carried out in part of the installation.

5 ADMINISTRATIVE PROCEDURES

This section deals with the administrative steps to be performed in accordance with chapter 3.6 of the annex to the resolution [5] and, in the event of complete or advanced remediation, to achieve the declassification of a ZppDN to a ZDC. It also presents the procedure to be followed in the event of activation or residual contamination that is not compatible with any use.

5.1 Before the remediation work

Except where otherwise provided[3] and in accordance with the provisions of Chapter 3.6 of the annex to the resolution [5], the licensee shall provide the remediation methodology for the proposed clean-out work to ASN for approval. ASN recommends, except in special cases, submitting the methodology at least 12 months before the planned start date. The licensee shall evaluate the compliance of the remediation plan with the provisions of this guide. The main principles are presented in Appendix I. The licensee shall also justify its proposed strategy for declassifying the waste zones.

This methodology may apply to all or part of the BNI or several BNIs operated by the same licensee.

5.2 During the remediation work

Any incidental finding or event that would significantly affect the remediation methodology (see §4.1) must be reported to ASN, with appropriate justifications, and may be subject to an additional review and approval in accordance with the provisions of Chapter 3.6 of the annex to the resolution [5].

During the work phase, ASN may, in accordance with the provisions of article 9.2 of the order [2], have inconsistent measurements carried out by a third party entity, at the licensee's expense, to ensure that the values recorded are consistent. If necessary, ASN may order a stop work until any ambiguity is removed.

5.3 End of the remediation work, where the structures have been made compatible with any use

The final declassification of the waste zones, described in Chapter 3.6 of the annex to the resolution of 21 April 2015 [5], corresponds to a significant change as defined in article L. 593-15 of the Environmental Code. This topic is addressed in § 5.2.2.2 of the guide [6].

i. General case: provision of the environmental code [1]

When the final declassification of the waste zones are subject to approval by ASN under article L. 593-15 of the Environmental Code [1], the file submitted in support of the application for authorisation must demonstrate that the area will be returned to a ZDC based on several independent and successive

[3] Many decommissioning decrees issued before the implementation of the decision [5] have specific provisions on remediation.

lines of defence. The licensee must also provide to ASN a report summarizing the activities at the site and demonstrating that the proposed remediation methodology has been followed. This report should demonstrate that the objectives of the remediation methodology have been achieved, and should specify, when the clean-out process has been completed, the depth of the cleaning for each structural element and justify why that depth is sufficient. A proposed outline for this document is provided in Appendix 2.

ASN may perform, if necessary, an inspection with sampling and measurements prior to the authorisation for declassification of the ZppDN to a ZDC.

If ASN authorises the final declassification of the ZppDN to a ZDC, the licensee shall update the waste zoning plan for the facility and create a summary sheet based on the model in Appendix 3, which it shall attach to the update of the waste study. The remaining items in the declassified area are considered as conventional waste and are managed as such.

ii. Special Case: provisions of article L. 593615 of the Environmental Code [1]

If the licensee has a remediation methodology approved by ASN for the applicable zone (see § 5.1), the declassification of a ZppDN, or part of one after putting in place appropriate containment barriers[4], may be subject to reporting requirements under article L. 593615 of the Environmental Code [1], provided that the criteria set by ASN for establishing the list of reportable operations covers such operations.

In this case, the radiological conditions of the location must be verifiable for a period of 6 months[5] from the declaration of declassification. As such, no irreversible works may be initiated before that date, unless otherwise approved by ASN.

ASN may, if needed, have samples taken from declassified locations.

The declaration shall be accompanied by a simplified assessment which details:

- The locations of the area affected by the declassification of the waste zones,
- The past activities or events for the location concerned,
- A summary of the remediation objectives
- Where applicable, a summary of the deviations from the remediation methodology,
- A summary of the results achieved,
- The safety committee report, if any,
- The declassification summary sheets for each location (see Appendix 3),
- Operating experience from the remediation methodology

5.4 The end of the remediation work, where structures have not been made compatible with every use

The licensee shall send a report summarizing the status of the site, demonstrating that the remediation methodology has been adhered to. Any deviations from the methodology should be justified. The report will specify and justify the depth of the cleaning performed for each structural element. This

[4] See article 3.4.1 of the annex of the decision [5]

[5] A different time period may be proposed by the licensee in the remediation methodology with appropriate justifications (e.g. safety constraints, decommissioning schedule).

summary also includes the relevant operating experience from similar operations that would apply to this installation. A proposed outline for this document is provided in Appendix 2.

ASN may, if necessary, have sampling performed prior to the verification that the remediation objectives have been achieved.

i. For a decommissioning installation

For a facility undergoing decommissioning, the licensee must provide detailed justification that it has gone as far as reasonably possible in the remediation process and in the application of the principle of optimisation.

In this case, after verifying that clean-out operations have gone as far as reasonably possible, ASN will make the decommissioning of the BNI subject to the implementation of institutional controls in accordance with the provision of article L. 596-5 of the Environmental Code [1].

ii. For an operating installation

For an operating facility, the licensee shall keep all the elements relating to the remediation and take them into account in the installation's decommissioning plan. In addition, during the rest of the operation of the facility, the licensee shall avoid any action that compromises the subsequent remediation of areas that have not yet been completely cleaned. ASN may prescribe management measures to the licensee under the environmental code [1].

A declassification of the waste zones may be considered, in accordance with the provisions of the decision [5] and guide [7], when the structures have been remediated at the surface but remain contaminated or radioactive within the structure provided that the area is considered a "ZDC with enhanced memory" and subsequently reclassified as a ZppDN when the waste study is updated at the time of decommissioning (see guide [5]).

5.5 The end of the remediation process in the event that the remediation objective is not achieved in certain areas

In the event of singular points that could not be sufficiently cleaned to meet the remediation objectives approved by ASN due to technical or economic constraints, the licensee shall inform ASN and send the report described in §4.3.i together with the following information:

- the reasons for not achieving the remediation objectives,
- the location of the point(s) that do not meet the objectives,
- the management measures they plan on implementing.

After reviewing the report, ASN notifies the licensee of its decision regarding the management measures envisaged for the points specified, and if necessary, sends requests for additional information to the licensee, or where appropriate prescribes provisions under the environmental code [1].

6 QUALITY ASSURANCE REQUIREMENTS

ASN believes that clean-out work constitutes activities important for protection (AIP) and will be subject to defined requirements and an acceptable quality acceptance program that is integrated into the facility management system. If the licensee separates the remediation activities into basic activities these activities are also considered AIPs, unless sufficient justification is provided to demonstrate why they should not be.

The discovery of unexpected elements during the clean-out operations should lead the licensee to reconsider the validity of each step of the remediation methodology, particularly the assumptions used in the development of the methodology.

7 METHODS FOR DEFINING THE LINES OF DEFENSE

7.1 The first line of defense

7.1.1 Understanding the physical phenomenon

The licensee must define and understand the physical phenomena that may lead to the contamination or activation of the structures affected by clean-out. In the event that activation and contamination phenomena occur simultaneously, the licensee shall study both phenomena and justify the remediation methodology accordingly.

7.1.2 Quantifying the physical phenomenon

7.1.2.1 Definition of a physical representation or simplified model of the phenomenon or phenomena involved

The licensee must quantify, using the best available techniques, the physical phenomena identified by a **physical representation or a simplified model,** enabling it to make a link between the activity liable to be present and the interior of the structure concerned by clean-out according to the depth. This representation may be remote from the physical reality if the representation chosen can be shown to **encompass all possibilities**.

This quantification of the physical phenomena may in particular be estimated on the basis of:
- mathematical models;
- the analysis of operating experience feedback data;
- a statistical method with a high degree of confidence, leading to an overall analysis of the phenomena, rather than an isolated analysis.

In any case, the method adopted shall be based on an overall understanding of the physical phenomena which have developed, rather than on an isolated analysis based on measurements alone.

This quantification of the phenomena may lead to a categorisation of the surfaces to be cleaned out, and an association with the type of treatment to be applied with each category thus defined. For example, it is possible to categorise the surfaces to be treated in the following way:

Type of surface	Characteristics of the surface	Treatment of the surface
Category 0	Absence of proven contamination or irradiation of said surface	No treatment
Category 1	Evidence or suspicion of radioactive contamination in the form of aerosol or radioactive dust	Surface treatment to a very small thickness
Category 2	Surface with suspected or proven liquid radioactive contamination	Treatment by removal of material to a specified thickness
Category 3	Activated wall or surface with penetrating radioactive contamination	Treatment on a case by case basis

Once the initial categorisation has been defined, it can be upgraded to a higher categorisation based on the initiative of the licensee depending on the hazards of the site. Such as upgrade and its justification

must be documented. If modifications lead to changes in the remediation methodology or to a degradation in the surface characterisation, the procedures to be followed are explained in § 5.1.

Depending on the method adopted, it may be necessary to use on-site investigations (visual inspection, technical appraisal, civil engineering analysis, consideration of any pertinent operating experience feedback from clean-out operations in similar nuclear waste zones, sampling and radiological measurements, particular pre-processing) to ensure that the physical representation actually encompasses the situation.

In some cases, it may be necessary to conduct an initial clean-out to deal with any structural singularities or to reduce the background noise (these provisions must be specified in the remediation methodology mentioned in §5.1).

Any structural singularities which offered pathways for activation and/or migration of contamination (structural discontinuities, isolated irregularities, cracks, etc.) will also be taken into account. These investigations aim to better understand and quantify the physical phenomena. Under no circumstances may the clean-out methodology be based on radiological measurements alone.

Based on this spatial representation of the physical contamination and/or activation phenomenon, the licensee shall define and justify a remediation objective, if applicable, by building, zone or room. This remediation objective must correspond to a minimum modelled remediation thickness (not in category 0) to which a flat-rate margin must be added (cf. §7.1.3)

7.1.2.2 Implementation of a "case-by-case approach" when it is impossible to define a bounding physical representation of the phenomena involved

In the event that the assessments carried out on site under the first line of defence show that the phenomena of activation or contamination are difficult to generalize or not make it possible to define a physical model of the phenomena, a "case-by-case approach" may be acceptable, subject to the licensee providing an explicit definition of the organisation chosen, the criteria for choosing the proposed treatment and the relevant justifications for the choice. This approach should only be used as a last resort.

The remediation methodology must contain, as the first line of defence; the organisation selected, the criteria for choosing the proposed treatment and the associated justifications. The licensee must also demonstrate that it achieves a level of confidence equivalent to that resulting from the application of the general methodology, in particular by taking into account important margins and reinforced lines of defence.

7.1.2.3 Particular cases

Case of large surface areas

In order to optimise the quantity of nuclear waste generated by the clean-out operations, ASN recommends dividing up large surface areas into smaller, delimited unit areas, taking into account the particular physical phenomena encountered (activation, contamination by liquids, etc.). The licensee shall justify in the remediation methodology the delimitations chosen based on the associated physical phenomena.

Case of singularities

In areas where nuclear waste may be produced, there may be singularities where particular local physical phenomena may have developed, for example greater migration in the thickness of the structures to be cleaned out. In this specific case, localised clean-out should be performed. These singularities must be of high importance in terms of production of waste or structural safety.

7.1.3 Fixed safety margin

The uncertainties linked to the physical representation or the simplified model adopted, the lack of information concerning the initial data (uncertainties linked to the source term, knowledge of the facility's history, knowledge of the actual condition of the structure in question, etc.) and the effectiveness of the technical means implemented for clean-out, must be compensated for by the application of a fixed safety margin to the minimum clean-out thickness resulting from the physical representation proposed in §7.1.2.

This margin must correspond to an additional clean-out thickness if a material removal process is used, the size of which is justified by the remediation methodology. The thickness of this fixed margin may change according to operating experience obtained from a pilot project or similar worksite.

In cases where the conservativeness of the physical representation (or simplified model) and the clean-out technique is demonstrated, it may not be necessary to apply a fixed safety margin (e.g. certain ceilings or metallic structures contaminated only on the surface, coatings painted with decontaminable paint). The conservativeness of the physical representation and the clean-out technique must then be demonstrated in the remediation methodology.

7.1.4 Definition of the waste zoning limit

Based on the application of the principles defined above and their corresponding justifications, the licensee then defines the **total clean-out thickness** (for processes involving removal of material), corresponding to the boundary between the nuclear waste zone (ZppDN) and the conventional waste zone (ZDC) (see Figure 1).

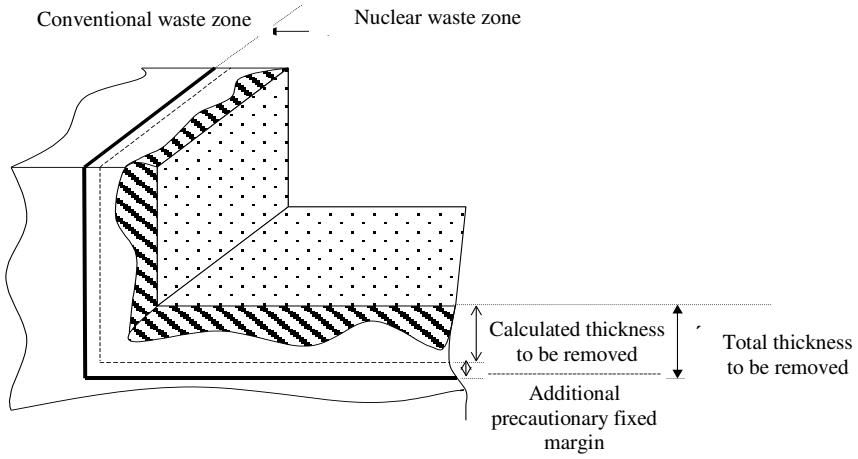


Figure 1

7.1.5 Verification of the conservatism of the first line of defence

ASN recommends setting up a "pilot worksite" to verify that the first line of defence is satisfactory and to enable the remediation methodology to be adjusted according to the results obtained on this pilot worksite.

In the event of the implementation of a "case-by-case" approach (see § 7.1.2.2.2), the use of a pilot worksite is especially recommended as the first line of defence is weakened.

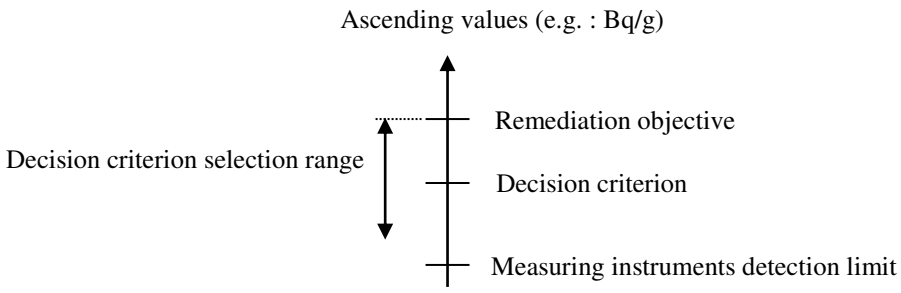
7.2 The second line of defence

Following the clean-out operations, a radiological inspection program should be implemented in order to confirm that the remediation objectives were met and that the remaining waste is conventional in nature.

The description of the radiological inspection program must comprise:

- the sampling rate and the method for establishing sampling points; a statistical approach can be adopted (e.g. application of standard ISO TR 8550);
- the measurement methods and techniques (e.g. surface measurement, specific activity measurement specifying the depth of integration and possibly of sampling) taking into account the energy levels of the radionuclides involved, and adapting them to the standard spectra. In accordance with the provisions of article 8.3.2 of the order [3], these methods and techniques must correspond to the best available methods and techniques under acceptable economic conditions.
  When a large surface area corresponds to a single measurement of activity, the uniformity of the radioactivity must be checked, in order to verify that there are no hot spots. If necessary, the specific activity will be remeasured at individual points based on the chosen decision criteria.
- the detection limits of the measuring instruments and the verification criteria defined by the licensee prior to performance of the operations.

The decision criteria must be described and justified. They must be situated between the remediation objective and the detection limit of the measuring instruments, in order to take into account of all the radionuclides liable to be present (*Figure 2*). These criteria are such that the measurement remains operational. The detection limits of the measuring instruments must also take into account any uncertainties associated with the measurement. These limits are defined according to ISO 11929. The decision criteria may in no case be considered to be "clearance thresholds".



Example: in a given facility, the cleanness objective is X Bq/g added artificial radioactivity. This corresponds to gamma spectrometry measurement of X' Bq/g of ^{60}Co or ^{137}Cs for the chosen activity spectrum. In this case, the value Y, which is the chosen decision criterion for gamma spectrometry measurements, is between the detection limit of the measuring instruments and the value X'.
Figure 2

The measurements, sampling and analysis methods used to verify compliance with the remediation objectives must meet the requirements defined by the current national standards or internationally recognized standards of an equivalent level of rigour.

ASN recommends that the expertise of the laboratories chosen to carry out the controls under the second line of defence should be in accordance with the current version of standard NF EN ISO/IEC 17025, "General requirements for the expertise of calibration and testing laboratories" or an equivalent standard. The licensee will describe this in the remediation methodology.

The measuring instruments to be used should be appropriate for the level and type of radionuclides being measured. The performance of these measuring instruments is presented by the licensee in its remediation methodology for structures. Measurement uncertainties should be systematically recorded.

The radiological inspection programme must be justified with respect to:
- the type of radionuclides present in the facility or the area to be cleaned-out and the characteristics of their radiation;
- the technical and industrial feasibility;
- the margin of error in the quantification of the physical representation,
- the detection limits of the measuring instruments.

The inspection programme must be independent of any radiological investigations which may have been carried out under the first line of defence.

The licensee should develop a deviations management procedure that specifies the steps to be taken if a value higher than the decision criterion is detected after clean-out. The provisions planned by the licensee are intended to ensure that the deviation encountered is isolated and that the proposed clean-out methodology is not flawed in terms of understanding of the physical phenomenon. When necessary, the licensee informs ASN of the deviation, of its analysis and the steps taken.

7.3 Third line of defence (for information)

The radiological inspections carried out for all conventional waste leaving the facility and the site (e.g. through a site exit portal) constitute a third line of defence. This line of defence is maintained at least until delicensing of the BNI.

8 POST-OPERATIONAL CLEAN-OUT OPERATIONS PERFORMANCE REQUIREMENTS

8.1 Controlling the dispersal of contamination

The disposal and remediation operations in nuclear waste zones (ZppDN) should not lead to the transfer of contamination to the neighbouring conventional waste zones (ZDC). If this proves impossible, the clean-out operations must be performed within containment in order to protect the environment and adjacent structures from the dissemination of nuclear materials. No clean-out operations may be performed in the open, unless authorised by ASN on the basis of a safety analysis demonstrating that, despite the lack of containment of the structures, the risk of dispersal of radioactive materials is controlled and the environmental impact is acceptable.

8.2 Intervention conditions

In the remediation methodology, the licensee shall justify the conditions under which intervention shall occur, both in terms of radiation protection and safety conditions.

8.3 Civil engineering metal structural elements

The clean-out of metal structural elements (inserts, doors, structural steelwork, frames, scrap, etc.) present in the structural elements to be cleaned out should be considered when these elements are intended to be part of the structure remaining after downgrading of the nuclear waste zone to a conventional waste zone. The methodology employed for clean-out of these elements must then comply with the principles defined in this present guide.

8.4 Monitoring of structural elements remaining after post-operational clean-out

Following the post-operational clean-out operations and pending approval from ASN concerning downgrading of the nuclear waste zone to a conventional waste zone, the remaining structural elements must be treated as a nuclear waste zone.

A physical barrier separating this nuclear waste zone from all adjacent or external conventional waste zones must be maintained. Access to the interior of these zones must remain in compliance with the nuclear waste zones access management principles. Until the downgrading of the nuclear waste zone to a conventional waste zone has been approved, any waste originating from these zones shall be considered to be nuclear waste in accordance with article 3.1.3 of the annex to the decision [4].

The structural elements remaining after clean-out must be subject to appropriate monitoring in order to prevent, detect and mitigate any spread of radioactive materials (e.g. rainwater entering the premises).

9 PARTICULAR CASES

This section aims to present certain specific situations for which the complete remediation methodology can be adapted and presents any compensatory measures to be implemented.

Special case: Clean-out of large structural elements that are removable or which are made removable

In the event that clean-out operations must be performed on large removable structural elements (i.e. crane, bridge, rail, etc.), or elements that can be made removable (concrete blocks marking a nuclear waste zone, slabs, etc.), it is possible, under certain conditions, to move these structural elements in order to carry out the planned clean-out operations in a more suitable location, thus improving the conditions in which these operations are performed (minimising work at height, improved accessibility to removable structural elements, etc.). Where applicable, the licensee shall describe these operations, their implementation conditions, their duration and the deadline for completion in the remediation methodology.

The elements concerned must be identified and linked to the original nuclear waste zone (ZppDN) in the formal documents and the remediation methodology applied must be absolutely identical to and consistent with that for the clean-out of structures.

To avoid delaying the clean-out of removable structural elements of large size in relation to the other structural elements in the area to be remediated, the approval for downgrading a nuclear waste zone to a conventional waste zone cannot be issued until the clean-out operations on the relevant large size elements have been completed. In all cases, the completion of these operations to rehabilitate the large removable structural elements is a prerequisite for the decommissioning of the facility.

APPENDIX 1: Standard contents of file plan presenting the complete remediation methodology the licensee intends to use

A – General information concerning the purpose of the document and its scope and presenting the corresponding reference documents and terminologies used.

B- Description of operations envisaged and nuclear waste zones concerned

C- Description and justification of the first line of defence implemented

- presentation of the physical phenomena considered;
- quantification of the physical phenomena, specifying the associated spectrum/spectra according to the nature of the surface affected;
- *in situ* investigations performed;
- definition and justification of the remediation objectives for each of the physical phenomena identified and for each type of surface;
- definition and justification of the additional fixed safety margin;
- definition and justification of the clean-out depths chosen for each type of surface;
- justification of the implementation of the best methods and techniques for remediation and decommissioning within acceptable economic conditions, in accordance with article 8.3.2 of the order [3];
- special cases;
- protection of zones treated.

D- Description and justification of the second line of defence

- definition of the decision criterion chosen;
- type of measurement and sampling rate;
- measuring instruments and corresponding detection limits for the standard spectrum/spectra;
- expertise of the laboratory chosen for the measurement analysis.

E- Monitoring and processing of deviations

- definition of major deviations that may call into question the method used to assess physical activation and/or contamination phenomena;
- deviation processing methodology;
- monitoring of deviations.

F- Traceability

- management of clean-out operations;
- recording of final checks.

G- Administrative procedures for the downgrading of ZppDN to ZDC

H- Estimation of residual impact

- result, specifying the exposure scenario(s) adopted;
- chosen models and hypotheses.

I- Future of the waste generated (storage and chosen disposal route)

APPENDIX 2: Standard contents of post-operational remediation summary

The remediation summary presents the progress of the clean-out worksite, demonstrating that the clean-out methodology and the premises classification strategy (see §7) were followed during the operational phase. This summary supports the application for delicensing of the premises considered.

This independent document comprises:

A – Summary of the remediation methodology concerning the treatment, inspection and remediation objective defined according to the chosen surface classification

B- Summary of deviations from the remediation methodology or strategy (insufficiency of recommended treatment, measurements impossible, deviation from final expected status, etc.)

C- Summary of pertinent operating experience

D- Estimation of residual impact

- Result specifying the exposure scenario(s) adopted;
- Chosen models and hypotheses

E- Waste zoning plan at the beginning of the delicensing operations in order to identify the cleaned-out areas

F- An installation plan showing the pipes constituting the barrier for waste zoning and which carried liquid or gaseous effluents liable to be radioactive

For each of the areas concerned by the clean-out operations:

G- Presentation of the area

- Its location
- The history of activities which took place in it
- Waste zoning classification of the area during the decommissioning phase

H- Historical analysis

- Analysis of the risks associated with the activities previously listed
- Events which may have led to chemical or radiological pollution of the area
- Known radiological status before clean-out works

I- Civil engineering analysis

- General characteristics
- Inventories of equipment and structures present (e.g. holes, openings, duct penetrations, etc.)

J- Classification of surfaces

- Details of classification
- Justification of classification

K- Work performed

- Summary of treatments
- Justification of individual or particular treatments
- Deviations

L- Final inspection

- Summary of 1st level final inspections
- Summary of 2nd level final inspections

M- Methods used to guarantee radiological cleanness at the end of the work

Translation not yet validated

APPENDIX 3: Sheet summarising downgrading of an area previously classified as a nuclear waste zone

Area concerned (name and location):
Contamination/activation spectra considered:
Remediation objective(s) (in Bq/g and Bq/cm²):
Inspection (types of instruments, detection threshold, associated uncertainties, coverage):
Clean-out value(s) obtained (in Bq/g and Bq/cm²):
Location of any residual hot spots:
Radiological impact(s) and associated scenario(s) (in µSv/year):

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