HOW TO BUILD A NATIONAL SYSTEM FOR DECOMMISSIONING WASTE WITHOUT THE BENEFIT OF A SITE OR DEFINED FREE RELEASE CRITERIA: THE CASE OF FRANCE

J. Avérous, E. Chapalain
French Nuclear Safety Authority
Direction Générale de la Sûreté Nucléaire et de la Radioprotection
(Directorate General for Nuclear Safety and Radiation Protection)

ABSTRACT

Past experience in decommissioning in France has shown that a national system has to be put in place to deal with decommissioning, waste elimination and site cleaning up activities in order to allow a consistent, safe, transparent and industrially applicable management of these matters. A system founded on successive lines of defence has been put into enforcement, which does not involve any site nor waste liberation, as it is considered that the criteria associated are always prone to discussion and contradiction.
This system is based on the following concepts:

- "nuclear waste", waste prone to have been contaminated or activated, is segregated from "conventional waste" using a system involving successive lines of defence, and hence, building a very high level of confidence that no "nuclear waste" will be eliminated without control in conventional waste eliminators or recycling facilities ;
- "nuclear waste" is eliminated in dedicated facilities or repositories, or in conventional facilities under the condition of a special authorisation based on a radiological impact study and a public inquiry ;
- a global safety evaluation of the nuclear site is conducted after decommissioning in order to define possible use restrictions. In all cases, minimum restrictions will be put into enforcement in urbanisation plans to ensure sufficient precaution when planning future uses of the ground or the building.

This paper describes this global system in detail and shows that its inherent consistency allows it to be easily applicable by operators while achieving a high level of safety and confidence. It is now widely accepted by stakeholders.

The French Nuclear Safety Authority is now working to apply this methodology more widely to other nuclear practises like the waste management from medical, research and industrial activities, or from past or remediation activities.

INTRODUCTION

The rate of decommissioning in France is accelerating, as the first generation of power reactors will be actively decommissioned in the next few years. Experience has been gathered from past decommissioning activities and some current pilot decommissioning operations. The management of waste that is being produced while decommissioning nuclear facilities involves problems linked to radiation protection, but also to the social acceptability of the possible presence of artificial radionuclides in consumer goods if this waste is being recycled in the conventional industry. To respond to these preoccupations, an original system has been implemented in France.

THE REASONS LEADING TO A SYSTEM WITHOUT LIBERATION

The reliability of measurement and its applicability in a dismantling context

Experience has shown that systems relying only on measurements to determine whether materials are contaminated or not are susceptible to fail when applied to large quantities and kinds of objects, like the objects encountered when decommissioning a nuclear facility. The necessity to have a measurement system capable to treat large daily fluxes of different materials involves technological choices that do not allow a precise measurement to be made (such as low level measurements of surface contamination or mass contamination of each object). This type of methodology has led in the past, in several cases in France, to situations where objects had been released from regulatory control while presenting unacceptable surface contamination or mass contamination levels, mainly because these objects were hidden within a bulk volume of less contaminated material that had been subjected to a bulk radiological measurement.

Putting into question generic radiological impact studies of recycling within the conventional industry

In some countries, general clearance levels have been defined that allow to release slightly contaminated materials as conventional materials. These levels are defined according to studies taking into account scenarios of recycling of these materials, like metals or concrete materials, and taking a criteria of exposure of the order of 10 micro-Sv/y. However, these studies are generally based on cautious but average approaches that allow to define dilution ratios of these materials, as it is particularly the case for metal scrap. These dilution ratios are usually defined according to current national industrial practice, fluxes, and technologies. Hence, this type of approach is prone to discussion: practices and technologies are prone to change in the future; and special uses of these materials can lead in some cases to higher level exposures of individuals. There have been some cases in France where non-proper use of low-level radioactive materials has been put into evidence and has led to social rejection. Moreover, in some cases, industrial processes can lead to radionuclides concentration in some materials, like slag, that can lead to disposal or recycling problems.

Social acceptance

It is not the object of this paper to try to explain the origin of social defiance with regards to radioactivity content of consumer goods. In France, the regulator has nowadays to take note that the French consumer will not be willing to buy any good for which it cannot be certified that it has no added radioactivity, whatever the level of this radioactivity is. Obviously, this is not realistic, as natural radionuclides, and artificial radionuclides from past atmospheric weapon tests can be detected in our environment. However, there is a strong social aspiration that no added radioactivity should be traceable to decommissioning activities. Should there be a link established between the radioactivity content of a consumer good and nuclear activities, it always gives way to a social scandal. As an example, steel manufacturers are hence definitely not willing to mix scrap coming from conventional industries with scrap coming from the nuclear industry if they are not sure, with a high degree of confidence, that this last scrap is free from any artificial radioactivity.

Improving the safety of the system

As it is usual in the safety field, a good mean to improve the overall safety of a system is to provide several successive and independent lines of defence. Hence, a system was sought in which the line of defence consisting of radioactive measurement would be supplemented by another line of defence. In

order for the system to work properly, this additional line of defence has to be entirely independent from any measurement process.

DEFINING AND SEGREGATING "NUCLEAR" AND "CONVENTIONAL" WASTE

The preceding remarks have led to the implementation of a new line of defence, called "installation zoning".

Definitions

The objective is to achieve a segregation between "nuclear waste" (waste susceptible to be or to have been contaminated by radionuclides or activated) and "conventional waste" (waste that is not susceptible to be or to have been contaminated nor activated). Note that this distinction is made without using any screening level to distinguish between "nuclear" and "conventional" waste categories. The definition of "nuclear waste" is quite wide indeed and clearly contains a measure of precaution.

As we have already remarked that this segregation between "nuclear" and "conventional" waste has to be made without any measurement basis in order to provide a valid additional line of defence in the whole system, it was called upon other arguments to make this distinction. These arguments are:

- an analysis of the functions achieved by the materials within the facility, which determines if they can ever be contaminated or activated;
- an analysis of the past operating history of the facility, including incidents and accidents, in order to determine whether this material has served another purpose or could have been contaminated during an incident or an accident, which are situations in which the facility is operated beyond its normal operating boundaries.

It can be seen that these arguments are strongly linked to the physical position of the object or material in the facility, hence the discrimination between "nuclear" and "conventional" waste can be made on a geographical basis.

Zoning the facilities

It is required that the operators perform a "zoning" of their facilities to distinguish between "nuclear waste zones" and "conventional waste zones". This zoning shall be done only on a functional analysis and a historical basis, taking into account normal and incidental operation of the facility. Measurements are only accepted as punctual verification to check the zoning that is to be developed strictly based on a functional and historical analysis.

There are of course some rules concerning separations between "nuclear waste zones" and "conventional waste zones": these must be physical boundaries and any passage between these two types of zones has to be equipped with appropriate contamination detection instruments for people and objects, in order to prevent contamination dissemination within the facility and reinforce the functional analysis that had been done. The physical boundaries between zones have to be submitted to a regular check of their functionality.

The zoning of the facility should be the simplest possible; it should be compatible with ventilation design, radiation protection zoning, in particular in what concerns contamination dispersion. Transportation fluxes within the facility should also be taken into account.

Tags are to be put in place so as to enable quick identification of the type of waste zone in each part of the facility and sufficient formation of workers has to be enforced.

It is accepted that the border between "nuclear waste zones" and "conventional waste zones" be within the volume of concrete walls, if the operator can demonstrate that radioactive contamination or activation cannot physically exceed a given depth. This assertion shall be based on a physical model that has been extensively checked with experimental data and whose assumptions are thoroughly explicit in order to define its range of applicability. The depth of contamination or activation shall be adequately increased as a precaution in order to define the applicable depth of removal for the radioactive materials.

Measurement as an independent, additional line of defence

As a second line of defence, the operator has to define and justify measurement procedures whose goal is primarily to check that "conventional waste" isn't indeed contaminated or activated. Additionally, these measurement procedures can be used to characterise radioactive waste.

These measurement procedures have to be adapted to the kind of radionuclides susceptible to be present in the facility and to the kind of waste produced. The goal is to implement the best possible measurement procedures (i.e. the lowest levels of measurement) according to the best technologies available for the industrial fluxes and waste forms involved.

Any waste arising from a nuclear site shall be submitted to at least a bulk measurement as a precaution.

In general, a third line of defence is implemented which are the radiation monitors placed at the entrance of conventional waste eliminators, in accordance with general regulations for these facilities. However, at the moment, this disposition is not mandatory.

Quality assurance requirements

Implementation of the facility zoning and of the measurement procedures must be done in accordance with general quality assurance principles. In particular, non-conformities shall be identified and treated with due traceability. Procedures shall be defined concerning the decision to be taken in the case of the discovery of a problem with the facility zoning; sufficient care should be taken to rethink the zoning according to this element, and traceability of waste elimination should be sufficient so as to identify elimination sites of waste that should have been treated as nuclear waste.

Lines of defence balance

Defining a system in which two successive lines of defence are defined allows a certain flexibility as to the use of these lines in order to reach a given confidence level that "conventional waste" is indeed conventional. According to the confidence level which can be placed on the zoning of the facility, the amplitude of the measurement requirements can be adapted.

As an example, it is usually acceptable that waste coming from the site restaurant can be submitted only to a bulk radiological measurement with not too low a detection level. On the other hand, for objects or zones for which there is little confidence in the definition of past history, much stricter and complete measurement procedures have to be implemented in order to attain the same overall confidence level.
In a whole, the line of defence system allows more flexibility than a system based only on measurement.

THE NECESSITY AND THE DEFINITION OF A GLOBAL SYSTEM OF WASTE MANAGEMENT IF NO CLEARANCE LEVELS ARE IMPLEMENTED

On the necessity to define a global national waste management scheme

When implementing "nuclear waste" and "conventional waste" segregation without clearance levels, pathways of elimination or recycling have to be thought of in advance that take into account these features. Due to the necessity to attain sufficient volumes in order to render waste elimination facilities economically sound, it is necessary that they should be shared by several nuclear facility operators. Hence it is necessary to promote a global waste management scheme on a national basis that takes into account the waste types that have been and will be generated (giving way to a predictive national waste inventory), the annual fluxes, the sites of production, and hence devising the necessary waste elimination facilities in an effort to optimise available resources.

Case-by-case authorised conventional facilities for the elimination of "nuclear waste"

"Nuclear waste", i.e. waste susceptible to be contaminated or activated, can be treated or disposed of in conventional facilities, especially for very low level activities. It is required that, in this case, a special authorisation is to be granted to a conventional waste elimination or treatment facility, on the basis of an impact study by the operator of the waste elimination facility, taking into account the possible radiological hazard, and after a public inquiry. In France at the moment, two conventional facilities are thus authorised, one to treat slightly contaminated asbestos waste by vitrification (disposal will be made in a dedicated nuclear waste repository), the other to recycle U_3O_8 steel containers.

Dedicated facilities for the elimination of very low level "nuclear waste"

In order to eliminate the large amounts of very low level "nuclear waste" (VLLW) that cannot be eliminated in conventional facilities, a dedicated facility has been built. This centralised facility is designed on the basis of conventional hazardous waste repositories, as for VLLW, chemical hazard is shown to be as much of a concern as radiological hazard. This repository should be able to dispose of most of the volume of VLLW generated by decommissioning activities in the next decades. However, some operators are considering creating repositories on or near nuclear sites when the large volumes of waste generated make it uneconomical to transport the waste to the central VLLW repository.

However, from the regulator's standpoint, this VLLW repository should not preclude the development of other recycling and elimination pathways in conventional facilities, that should be developed by operators.

Implementation of global waste stream management to optimise waste management

The first basic way of not generating "nuclear waste" is of course to prevent waste from becoming contaminated. This is especially important for some special objects for which treatment and disposal poses technological problems leading to the use of specialised, dedicated facilities of which only a few exist in France. A good example is the case of phosphorescent lighting tubes. This has led some operators to implement special procedures involving wrapping the tubes in a plastic coating to prevent any contamination, and thus allowing these tubes to be disposed of in conventional facilities. This zoning methodology hence allows to separate a conventional waste zone inside the plastic coating and a nuclear waste zone outside.

In general, operators should be careful not to allow unnecessary objects to enter contaminating premises, like for example spare part wrappings and containers.

Economical considerations

The national system of radioactive waste management is being implemented is France, and hence, only limited feedback is available. However, it is believed that if operators succeed in bringing "nuclear waste" fluxes to the minimum due to optimisation, very low level waste elimination should not be very much more expensive than conventional hazardous waste elimination, with the advantage of no "nuclear waste" recycling within the conventional industry.

In fact, "nuclear waste" volumes can be held down thanks to careful delimitation of zones, clean operation of plants, and optimised application of zoning procedures. Recent experience shows that when decommissioning concrete walls, only about 10% to 15% of the concrete volume is to be considered as "nuclear waste", whereas the rest can be considered as "conventional waste", due to the limited diffusion of radiological contamination within concrete, even on a 50-year operation basis. The zoning limit is hence defined within the wall, at some determined depth. New design concepts should lead in future facilities to optimised, even lower, "nuclear waste" volumes, due to the use of special paints and dispositions avoiding extensive in-depth contamination.

MANAGING CONDITIONAL SITE LIBERATION

The technical and social necessity of applying minimum precautionary use restrictions on former industrial sites

Recent experience involving the nuclear industry as well as the conventional industry has shown the necessity to keep track of past uses of land and to at least define the minimum use restrictions when a facility handling hazardous materials has been occupying the site. This conclusion is based on technical considerations (how far can it be proven that a piece of land has been absolutely cleaned of all hazardous contaminants) as well as on societal considerations (cases when observation of a cluster of some sickness is automatically linked to past uses of the land, even if the link between this sickness and potential contamination cannot be proven).

Minimum precautionary use restrictions should include minimum measurement requirements when digging or performing any civil works (in particular digging and earthworks), and the prohibition of erecting buildings involving potentially more sensitive persons, like schools.

Of course, the application of these use restrictions has to be taken into account in the urbanisation plans of the vicinity in order to optimise land use.

Dealing with local waste repositories

Some operators envisage digging local repositories on the sites of their facility for such waste as conventional concrete, or even other more hazardous waste. These repositories have of course to be dealt with as any other repository of the same kind, including adapted post-closure surveillance and land use restrictions.

Other use restrictions

It is possible that some low chemical or radiological contamination remains in the ground, for which it is shown that it would not bring any advantage to treat it from an impact point of view, while it would be uneconomical and hazardous for rehabilitation workers. Moreover, the operator will often not leave the site completely free of any building, and very often would like to proceed with some non nuclear activities or activities that do not necessitate a nuclear facility licence.

It is hence necessary that the operator conduct a global safety assessment of the site before considering license termination, in order to take all these factors into consideration.

In these cases it is necessary to define adapted surveillance schemes and use restrictions in order to preclude future unwanted practices on the site. The operator's responsibility has also to be explicitly engaged concerning correct elimination of remaining structures and buildings if they may have been contaminated or activated.

APPLICATION OF THE WASTE AND SITES MANAGEMENT CONCEPT TO OTHER ACTIVITIES THAN DECOMMISSIONING

The concepts exposed above are readily applied to other fields than decommissioning. It is a regulatory requirement that "waste zoning" shall be the basis for the management of waste from the normal operation of nuclear facilities. In the case of other facilities (medicine, research, industry), the nuclear safety authority is considering implementing a similar regulation, in particular in the case of non-sealed source use, whether for normal operation or decommissioning.

In the case of the management of waste from an incident or accident, it is also required to use the methodology described above. However, some special aspects have to be considered in the case of site or soil contamination.

Cases of soil contamination have to be treated on a case-by-case basis, involving stakeholders, to define an acceptable end-state after decontamination. An optimisation process under a dose constraint is required. While implementing decontamination works, the methodology of "waste zoning" has to be enforced, segregating contaminated material from non contaminated with an approach based mainly on the original geographical situation of this material. In particular, in simple cases of small contaminated spots, it is required that the soil found contaminated in preliminary characterisation, plus a precautionary envelope of this zone defined by an arbitrary additional digging distance, shall be considered as "nuclear waste".

CONCLUSION: TOWARDS A SAFER, INDUSTRIALLY APPLICABLE, CONSISTENT SYSTEM WITHOUT LIBERATION

This paper shows how and why a specific system has been put in enforcement in France in order to ensure a safe and transparent waste elimination system for waste generated by nuclear facilities. This paper also shows that while not implementing any clearance level, on a technical as well as on a societal basis, it is possible to implement an industrially feasible system of waste management that can be widely accepted and hence enable extensive decommissioning programmes to be conducted by nuclear facilities operators. The fact that the system does not rely only upon measurements allows it also to be more suitable for the operational necessities of decommissioning. The issue of the site use restrictions to be imposed to a decommissioned site is quite new and is not totally implemented in French regulations yet; however, the main directions of future regulation are shown in this paper.

The need for a national waste management scheme is quite evident in order to optimise the use of the operator's and nation's resources in building large enough waste elimination facilities allowing economically sound investments.

It has to be stressed that the concept of successive independent lines of defence, so widely used in nuclear safety, is shown to be successfully used in the area of radiation protection in order to achieve a high level of confidence in the goal to be reached; such a concept could possibly be much more widely used in the radiation protection area.

The system described here implies some difficulties; not the least is that it is not implemented by neighbouring countries, which often have defined clearance levels. This should lead in the future to appropriate discussions at an international level in order to define common requirements in this field, but experience shows that it is a difficult subject.