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THOUGHTS ON RETRIEVABILITY

EXECUTIVE SUMMARY

- Juin 1998 -

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A. MOTIVATIONS FOR RETRIEVABILITY

The problem of the retrievability of nuclear waste disposal covers all the technical and administrative measures providing the possibility, if we so wish, to retrieve safely the material considered as waste, with a clear benefit for society. This advantage can be based on scientific and technological progress (for example advances on transmutation that would lower the potential harmfulness of long-life high-activity radionucléides), on an evolution of the economy (energetic value of waste), on safety considerations (wrong initial assessment of the risk detected through permanent control) or ethics (not imposing our choices to future generations). As early as the debate on the 1991 law, the concern to start on nothing that could be irreversible had appeared, therefore opening the door to the idea of potential retrievability of disposal and effective retrieval of the packages placed in this disposal facility. The same concern can be seen in the report written by Deputy Christian BATAILLE (20th December 1993) which attaches importance to retrievability plans, which provide a " scientific as well as a moral guarantee ".

Scientific and technical discussions compare the advantages and the respective fields of application of long-term surface or sub-surface interim storage, and those of reversible or not geological disposal, or also the types of barriers best adapted to ensure safety under any circumstances. However, it appears that the most sensitive area of the debate is not situated between these various technical concepts. Indeed, these are all likely to be conform with the regulation existing in many countries, therefore they can be granted an agreement by the safety authorities responsible for its application. The first motivation for retrievability emerges mainly from the debate between a " scientific and technical " position, and an " ethical " therefore a " political " position. Nothing will be acquired as for the final fate of nuclear waste until the community is firmly convinced of the quality and the strength of the solutions chosen. The mission of mediation led by the Deputy Mr. Christian BATAILLE and the Prefect Mr. Jacques MONESTIER worked in that direction. In parallel, the Commission Nationale d'Evaluation (CNE*) made an effort to be as transparent and as informative as possible, during the public presentations of its annual report as well as during its contacts with the local information bodies established by law. The CNE presented a first approach on retrievability in its report N° 3. It is within the continuation of this approach that the present report attempts to propose orientations acceptable by stages. Today, we have enough time at our disposal to reach social acceptability concerning the technical options of final waste management, when the Parliament will be stating on the building of permanent structures in 2006. If this decision is positive, the realization, then the exploitation of these structures will represent about 70 years, thus offering extra time to make a decision on the required level of retrievability.

B. SCIENTIFIC AND TECHNICAL ASPECTS OF RETRIEVABILITY

The technical motivations to ensure retrievability suggested by one or several actors of the law, either scientists or industry people, encompass progress in sciences, the protection of man or the evolution of the economical environment.

The results expected from transmutation (area 1 of the 1991 law) could justify the retrieval of high-activity, long-life waste, to lower its harmfulness. The evolution of the economy of the various primary energies, combined to important improvements in the fields of reactors and corresponding cycles could lead to the retrieval of non-reprocessed irradiated fuels – which are not called " waste " in France – to extract residual plutonium and uranium from them. Other technical developments which are not easily predictable to date, in industrial or medical fields, could also favour the search of elements contained in glass packages and in non-reprocessed fuels (platinium family and others metals for fuel cells which are clean energy converters, radionucleides for medical applications, etc….). We can wonder, however, if it would not be better to produce them " de novo " rather than retrieving and opening old waste packages, with the risks involved.

Finally, technical motivations do not exclude the case when a failure of disposal safety is suspected, but it is clear that, if there is the slightest doubt on the assessment of the risk connected to a disposal project, it is imperative not to use that structure to dump nuclear waste.

Discussions have clearly outline three essential elements which we need to know in order to have a well thought-out waste management according to a reversible approach, and which we lack in a fair proportion :

* National Assessment Committee

a - The effective inventory of radionucleides, often demanded by the CNE, a first version of which is promised for the end of 1998 ; it would allow to distinguish more clearly the waste for which the concept of retrievability would be hardly justified for technical and economical reasons. To date, we really have at our disposal only the volume of waste produced by specification categories, but without any precise reference as to the radioactive and chemical content. It would be advisable to speed up the inventory process.

b - Packages which would be placed in a storage and possibly retrieved after a certain time : nature of the containers and supercontainers ; their geometry, thickness, high, diameter, mass and composition are essential characteristics to assess their durability and the necessary handling to retrieve them. There again, considering the information given, it is a deficiency pointed out by the CNE reports ; this deficiency is one of the elements which have induced specific instructions from public authorities in 1997 on the area 3 of the law.

c - Engineering concepts (mining, if it is a geological disposal) including in particular the general architecture of the structure, the handling technique of the loads and the filling of the pits, silos or cavities, which will both have to comply with the constraints related to the nature of the radionucleides, the characteristics of the different conditioning matrices and of their containers ; this problem will be applied to all interim storage or disposal facilities (surface, subsurface, deep underground).

We can see that the writing of the inventory and the definition of the containers are, among other things, questions which require the quickest answer possible , even if these have no direct link with the current demands concerning the setting up of underground laboratories. The engineering concepts will, of course, have a determining influence on the proposals which will be presented in 2006 to the public authorities to allow one or several disposals.

In any case, reversible storage will have to ensure a long-term safety which cannot be less than for an irreversible disposal. Criteria's to be followed will be the same : absence of radionucleide dissemination, radioprotection, guarantees against human interference and malevolence, as well as against the proliferation of nuclear weapons if large quantities of plutonium were placed there, then the longest possible subsequent confinement. The whole project must represent a fair position vis-à-vis present and future populations, and maintain costs which ensure the competitivity of nuclear industry. Several solutions can often meet each of these criteria's, and the best for one criteria is not necessarily the same one for the others. Examining the retrievability of a disposal cannot be separated from interim storage considerations, even for the sole retrieval of packages. We can then envisage the following situations which make optimisations possible :

- Surface or sub-surface[1] long term interim storage, which is the simplest, perfectly reversible, but which finishes necessarily into waste retrieval,

- geological storage convertible into geological disposal called “ reversible ”, with various degrees of retrievability, decreasing according to the barriers that are established at the level of the cavity, the secondary or the main gallery, and finally the pit or the access gallery from the outside ; as the barriers are put into place, retrievability which is easy during the filling operation, becomes a public works exercise if filled and sealed up cavities need to be reopened. If the whole site has been abandonned, retrieval is a mining concern,

- Geological disposal called “ irreversible ” in which, however, package retrieval will be possible after closing the site, but it would be very heavy : it would call upon classical mining techniques all the time the integrity of the packages would be kept, and upon advanced techniques if the integrity of the packages were not assured any more. As an example of mining engineering, the mining methods authorized for the Canadian Cigar Lake ore deposit which is particularly rich in uranium, show that we can extract highly radioactive substances from underground with automated mining techniques, even in an environment where the level of radioactivity does not allow direct access to man.

The economic factor of this options will have to be taken into account and an estimate of the costs for the various retrievability steps will have to be established.

C. PERCEPTION AND REPRESENTATION OF THE ROLE OF RETRIEVABILITY

The protection of man and the rights of future generations are at the heart of the worries expressed by part of the public in favour of retrievability. The concern to give these generations the free choice to place waste into final disposal or to retrieve them, is associated to the will not to leave the burden of this problem to these generations, in other words to give them an acceptable solution, if they have not found a better one, without imposing it on them in a final way. The technical motivations mentioned earlier, are considered to be derisory by

[1] The word subsurface is used in this text to describe structures situated at a low depth (ten meters or so under the surface of the earth), galleries dug across a hill or a mountain for example, allowing access through an horizontal or not very steep way.

some extreme points of view. As one of the participants said during an audition, retrievability aims at avoiding " God's judgment : you have made a serious mistake, and it is irreversible ! "… The experience of the surface storage in the the Manche disposal center outlines the fact that retrievability is only possible when it is defined from the start, particularly when the retrieval of " off-standard " waste, as described in the TURPIN Commission report, is practically impossible. For "off-standard" waste the recovery give up after cost-benefit analysis.

In the face of these positions, the main motivation for retrievability changes in nature. Before anything else, it is a question of maintaining the possibility of a repair action if the observed evolution of the waste or of the environment showed that the engineers had gone the wrong way, following a bad assessment of the risks. With this pattern, the analysis does not just concern a link-up between waste/physical and chemical mecanisms/action on biosphere and man/cost-efficiency of the solutions/decisions, but involves a second cycle which takes into account the representation of danger by the public and the reading of situation, as well as the various requirements concerning the long-term waste management which derives from it. Beyond a mere communication strategy, the circulation of honest, transparent and accessible information plays then a leading role. The feedback of the representation of danger and of its consequences from the public to the decision-makers is done through elected representatives and local authorities that can be consulted as well as associations. This should in fact help improving technical projects.

The concern about future generations is a question of ethics which is certainly essential for everyone and is separate from the economical situation or even from the choices of society. However, we must be aware of various often forgotten aspects. Indeed, the accumulation of measures taken to ensure long-term safety for an irreversible disposal, represent as many added obstacles to retrievability. An irreversible disposal, as such, forces one to keep track of it, to avoid any regrettable incident such as a drilling that could go through it. Finally, we must be aware that, in case of a deep change in society, we must avoid having a disposal, the closure of which may have been postponed, that could be an added source of risks, for a society that could have lost the know-how to deal safely with it.

One of the propositions stated concerns a deep storage, convertible into disposal (reversible geological disposal) : The architecture is the one of a permanent structure , the partial then total closures occur after a long enough time of observation. At any time, we can interrupt the process and retrieve the packages fairly easily. This incremental approach allows a probationary phase for an operation which has never been carried out yet, in other words it allows certain guarantees. Today, in this hypothesis, it is only necessary to decide on the experiments to be carried out in underground laboratories and to organize the debate to prepare a difficult decision which will have to be taken by one of the future generation. In this solution, the duration of retrievability, and therefore the time limit for making a decision, should not be too long (hold of the packages in an oxidizing environment, prolonged maintenance and watch, mechanical hold of structures and supporting systems, dewatering, political or social hazards which are unpredictable over a long period of time).

Conversely, long-term waste interim-storage in surface or subsurface structures have the advantage of being simple, it does not require an immediate decision about the future, but forces to deal one day with the problem of permanent disposal ; it entails an obvious extra-cost since a second investment is necessary, and it means that the responsibility of the decision is handed over to future generations.

The choice on retrievability and on the processes retained will have to be made for the elaboration of the draft bill which will be submitted to the Parliament in 2006. Final disposal provides the first best technical guarantees for safety, in the present state of knowledge ; however, once it has been abandoned, it evolves away from any sort of control. But technical safety is not enough if the public does not give its trust or support. The fear of an " immediate irreversible decision " would rather lead to devoting more time to better establish the quality of the site through observing its functioning over a long period of time and, therefore, to better inform the public. For this, the time before making a crucial decision, must be fairly long, but limited to a few decades. Increasing observation time, keeping the public informed of the results and thus improving the perception of the problem ; developing a step by step approach which, in view of the results at each step, could gradually win social acceptance, seems to be the best approach. Retrievability being thus prolonged, even if the retrieval of packages becomes less and less probable, would nevertheless allow an action if an essential (technical or non-technical) element had been forgotten.

D. CNE PROPOSITIONS

Besides, since the Government's demand focuses, in this particular case, not only on an assessment but above all on a reflexion on retrievability, the Commission thinks it would be desirable to include in its conclusion suggestions concerning the various categories of waste and general studies.

The 13th July 1992 law on industrial waste disposal shows that eliminating waste by abandonning them in storage can only concern ultimate waste. A contrario, any material that can be upgraded must go to interim storage. Everything must be done to lower the polluting and dangerous aspect of ultimate waste.

Upon this basis, the Commission reminds that the measures taken to ensure retrievability must not impair the safety of storage and that the implementation of retrievability cannot be envisaged indefinitely but can be renewed by well defined periods of time.

In this context :

1 - Used nuclear fuels clearly are a material which can be potentially upgraded , are therefore suited to interim storage ; long-term surface or subsurface gallery storage seems best adapted to the will to maintain the possibility of retrieving these materials to upgrade or transform them.

2 - B waste are clearly ultimate waste : chances to get any upgradable substance out of them seem inexistant ; their activity is moderate ; therefore they are suited to a final in-depth disposal, if they are in accordance with the specifications, as is stated in the 1991 law. The technical conditions are easy since they do not present any thermic problem. This implies that the waste packages but above all the man-made barriers and the geological barriers ensure long-term safety. Conversely, on the surface, the risks of a rapid return to the biosphere and human interference do not provide the same long-term guarantees of safety. B waste that do not comply with the specifications will have to be set against the standards after an appropriate storage, if necessary.

3 - Glass, which are highly radioactive, also contain potentially upgradable or transmutable substances ; but their retrieval is far from being easy. Whatever the outcome of feasability studies and the interest of such a retrieval, a fairly long period of surface interim storage is required for them to “ cool down ”, a period that should be exploited to carry out complementary investigations of a scientific and economic nature. Glass which are presently stored within the compound of reprocessing plants could stay there during definite and possibly renewable periods of time. To date, the period is 50 years for La Hague plant.. Once time has elapsed, either research on the area 1 is going to be successful and the decision to retrieve will depend mainly on economic considerations, or, if the research has not been successful, final disposal will be the solution of reference for their elimination.

4 - Finally, it is important to also examine the case of burnt fission products[2] which are produced during the first phase of vitrification. Studies are to be carried out to determine in which conditions and in what state easier to retrieve than glass, they could be put away waiting for an industrial implementation of separation and transmutation (area 1). If it is successful, this new strategy could bring a significant contribution before disposal, to the characteristic of retrievability as far as the management of the first part of the cycle is concerned.

Depending on the choices of interim storage or disposal facilities, two safety barriers play a very different role :

- In surface or subsurface interim storage, *the geological barrier* does not play a role any more, except that it offers in the case of subsurface a cheap material to ward off any human intrusions, falling of planes, earthquakes even : geological formations then play the role of " cost-free concrete ". Confinement is solely ensured by the *container* which must be of a very high quality ; considering the small quantities concerned (some thousands tons), this situation seems to us to be the best one for irradiated fuels – off the pool – and possibly glass packages (C-* waste) we can reasonably think that such a containerization would be feasable, without any major obstacle. This is not the case for B waste*.

A preference is expressed in favour of underground galleries with one exit only, on the side of a hill or a mountain, like in the structure project prepared by the NAGRA for Wellenberg (Switzerland) : lorries and wagons can have level access to the main gallery, the geological environment means that we have at our disposal the passive protections mentioned earlier. Retrievability is simple since vehicles and handling machines can enter the disposal site.

This situation seems to us the best one for irradiated fuels – off the pool – and possibly C waste.

- In depth *the geological barrier* plays a specific role around the supposedly reversible disposal during its exploitation phase (50 to 70 years) and irreversible later. According to the RFS III.2f, it must be able to form a barrier by itself that can prevent radionucleides from reverting to man and the biosphere. This situation seems to us the best one for B Waste : These represent very large volumes, with very different packaging, or even waiting to be packed. In total, their storage previsions are assessed at about 135 000 m3, 50.000 m3 of which are planned for the year 2020. The vaste quantity and the diversity of B waste leaves little hope to have them placed in long-life *containers* in order to install them in surface or

[2] The Commission adopts the idea suggested here by Professor CASTAING during the last meeting which he

subsurface. The geological barrier (for example clay) is bound to play here the most important role."”

Moreover, we could imagine a “ wrapping ” for the containers, likely to prolong their life time by delaying interactions between possible underground waters and concrete or tar works of the matrice.

As it has been previously stated, the Commission considers that the retrievability of such a disposal will always remain possible ; but it recommends that its design should make the implementation of retrievability as easy as possible, without reducing in any way the intrinsic safety of the disposal.

In any of the cases envisaged, numerical modelling will play a central role, because of the impossibility to experiment over long periods of time. It is therefore recommended to pay a very special attention to the fields of soundness, strength of models, as well as the values of the parameters which will be used.

In the same way, it will be necessary to carry out studies on risk assessment, safety engineering, combined to any disposal development project, to demonstrate that the technical devices necessary to retrievability over a few decades do exist, and justify the robustness of the solutions at each step and at each level. These studies would ensure that the disposal project has no critical characteristic which could go against retrievability ; if they are done with the required transparency, they would provide the public with a clear representation of the means available to protect man and the environment.

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