

KEY PERFORMANCE CRITERIA AFFECTING THE MOST THE SAFETY OF A NUCLEAR WASTE LONG TERM STORAGE : A CASE STUDY COMMISSIONED BY CEA

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ABSTRACT

As part of the work scope set in the French law on high level long lived waste R&D passed in 1991, CEA is conducting a research program to establish the scientific basis and assess the feasibility of long term storage as an option for the safe management of nuclear waste for periods as long as centuries. This goal is a significant departure from the current industrial practice where storage facilities are usually built to last only a few decades. From a technical viewpoint such an extension in time seems feasible provided *care and maintenance* is exercised. Considering such long periods of time, the risk for Society of losing *oversight and control* of such a facility is real, which triggers the question of whether and how long term storage safety can be actually achieved. Therefore CEA commissioned a study (1) in which MUTADIS Consultants (2) and CEPN (3) were both involved. The case study looks into several past and actual human enterprises conducted over significant periods of time, one of them dating back to the end of the 18th century, and all identified out of the nuclear field. Then-prevailing societal behaviour and organizational structures are screened out to show how they were or are still able to cope with similar *oversight and control* goals. As a result, the study group formulated a set of performance criteria relating to issues like responsibility, securing funds, legal and legislative implications, economic sustainable development, all being areas which are not traditionally considered as far as technical studies are concerned. These criteria can be most useful from the design stage onward, first in an attempt to define the facility construction and operating guiding principles, and thereafter to substantiate the safety case for long term storage and get geared to the public dialogue on that undertaking should it become a reality.

INTRODUCTION

The 1991 law created the opportunity to explore the *long-term storage* concept as a new option for the management of the waste until a decision is made regarding its final disposition. CEA has defined *long term storage* as a storage system that has the potential to last a few centuries and to achieve a high level of protection for the waste, the people and the environment throughout the period considered. Provisions for re-handling the waste at any given time while transferring only a reasonable burden to future generations are included. Time related phenomena like metal corrosion, material degradation, effect of temperature load on engineered structures, etc, have been studied through R&D work in an attempt to better understand the time limiting factors for structural components and to identify technical responses to achieve passive safety for the duration envisaged. If technical people are likely able to design installations which could last longer this, however, does not preclude monitoring and maintenance operations and, therefore, provisions for human interventions must be considered. The ability to envisage a steady and efficient human response to storage problems or emergencies as they may arise in the future is essential. How Society may be able to remain structured, organized and emergency-readied in the coming decades or centuries ahead to effectively keep up with the necessary safety control and performance of such a

facility must be addressed. For instance, a lack of maintenance of the ventilation system, be it passive and only relying on natural ventilation, could turn into a severe safety event.

CEA, therefore, decided to explore societal conditions underlying a set of past and still on-going human activities. Four of them were selected as case studies on the basis of their respective regulatory and institutional regimes and stakeholders' involvement at national or international levels. The cross analysis of all cases together leads to the formulation of criteria which could either promote and sustain people's *oversight and control* or, if not met, contribute to disruption and failure. Each case depicts a situation where people's *oversight and control* either failed or was successful to some extent:

- old underground cavities left behind by past quarrying operation: risk created by the presence of underground cavities left empty and unmapped underneath Chanteloup-les-Vignes, a small town nearby Paris, and the city of Paris in France ;
- underground quarrying activities under a new regulatory regime: similar risk, however managed under a more recent regulation ;
- the legacy of the iron ore mining activities in the Lorraine region of France: risk of surface disturbance, disruption in real estate properties, damage to groundwater ;
- UNESCO: mechanisms designed and implemented for the preservation of World Heritage sites ; the particular case of the Angkor site in Cambodia.

STUDY HIGHLIGHTS

Old Underground Cavities

A large part of the city of Paris is built above large underground cavities from which dimension stones were produced. This resulted in sudden collapse of buildings in the 18th century, which precipitated the creation of a special corps, the Inspection Générale des Carrières (IGC) (4). This corps has been operating ever since to prevent and mitigate that risk in a very efficient way with no interruption in that service including during wartime and social unrest. A similar organisation was put in place more recently to manage similar risk elsewhere (Chanteloup-les-Vignes) with limited success. Key points underlying the success obtained within the boundaries of the city of Paris are among others:

- high accumulation of real estate property value per square metre constructed,
- real estate market regulation which implies that any transaction must undergo the IGC risk check procedure and ground reinforcement recommendations including their implementation if necessary,
- Paris is the country capital city and is where governmental bodies are located,
- a very great number of stakeholders since each individual living in Paris is one of them,
- although IGC is not a regulatory body, failing to meet its recommendation for ground reinforcement would have the real estate owner face legal action should an accident occur.

Property value seems to be the driving force that makes the IGC operation successful. IGC is well known and perceived as a very useful body by stakeholders. At Chanteloup-les-Vignes, the magnitude of property value at risk is quite different (individual houses versus historic apartment buildings in Paris). A national regulation put in place recently to prevent human accidents in the event of a ground failure had a large part of the town centre declared a dangerous zone which made the property value plummet and the real estate market freeze in that area.

Underground Quarrying Activities Under a New Regulatory Regime

This case focuses on ground disturbance prevention mechanisms that are available through the regulatory regime implemented more recently. Cavities must be back-filled shortly after mining is over and money

for future mitigation is being accumulated in a special fund. Mapping of the mined zones is mandatory, records are maintained and made available. Permits are issued for limited periods of time and must be renewed at the operator's request. Specific dispositions regarding the decommissioning of the mined lands are enforced like the obligation to produce an environmental impact assessment ahead of time. The mining operator would be held responsible should a problem occur even after the land was sold to a different user.

Key points are:

- prevention mechanisms backed up by technical responses such as back-filling, mapping, special fund,
- maintenance of knowledge: record keeping,
- clear identification of responsibility,
- licensing mechanisms that trigger a regulatory review of the risk management performance on a regular basis.

However there is always potential for conflicts between various users and stakeholders regarding the future land use of mined areas often regarded as unique development opportunities. Real estate pressure for new land may exist creating a threat for the future.

The Legacy of Past Iron Ore Mining Activities in The Lorraine Region

The State was, quite often in the past, the one institution in control of the legislative power, the ownership of the ore-bodies, the regulatory decisions and the mining operation through state owned companies. Local people living on the mines, the only employment opportunity at their disposal in their vicinity, were used to a long-established relationship with the management people of the operating companies essentially based on confidence. Upon closure of the mines the risk situation was assessed to be under control, therefore care and maintenance was not deemed necessary. A few years after ground movements occurred creating significant loss in real estate property, damage to groundwater and distrust, a long lasting detrimental effect. At the same time, neither was it possible to gather relevant data to identify areas at risk nor to quickly mobilize expertise to overcome the situation. Actions taken by local authorities were successful and resulted in the creation by central Government of new multi-stakeholders entities with the mandate to rebuild lost knowledge and expertise and conduct remedial actions. This also entailed the development of spin-off businesses from newly acquired expertise.

Key points are:

- an activity controlled in many aspects by only one stakeholder, the State,
- failing technical assessment of the potential evolution of the mined areas,
- a one-way relationship creating a state of dependence between State entities and the population, therefore putting social *trust* at risk,
- failing record keeping and expertise,
- a strong local movement to take over the failing State responsibility,
- economic development,
- implementation of a new decision making process involving many stakeholders.

UNESCO : Mechanisms Designed and Implemented For the Preservation of World Heritage Sites

The UNESCO study showcases the involvement of various levels of stakeholders to achieve the common goal of preserving special places in the world because they are of particular significance to human beings.

As a result they deserve to be recognised and are declared World Heritage sites to be put under the control and oversight umbrella of member states who are willing to participate in that undertaking. The sharing of

that preservation goal, established as a philosophy among participating nations, seems to be the easiest part of the task. Difficulties usually arise when dealing with national and local interests combined. Each stakeholder must be recognised and respected for what it represents and therefore specific mechanisms are designed to promote each level of responsibility making sure that local sustainable development can be achieved as a result of implementing the preservation process.

UNESCO has only one role : that of facilitating that process. Drawbacks, often in the form of tourism pressure, must be overcome. New jobs and spin-off businesses can be created from new local needs : maintenance and reconstruction of monuments, tourism, craftsmanship, artists, etc. Countries participating in the UNESCO World Heritage (5) programme are all able to get involved in some way to help a failing partner at any level. In return, this may also foster the development of new expertise in the helping country resulting in a network of combined interests world-wide. Key points are:

- networking between interested partners at various levels, institutions, local, national and international, which creates redundancy in the sustainability of the caring approach and favourable conditions to also preserve relevant knowledge,
- sustainable development as an objective to foster local interest and involvement (to get people involved in a win-win approach),
- however not a 100 % fail-safe system : the BUDHA statues in Afghanistan went destroyed.

This example of world-wide networking activity, applied to the preservation of unique places which embody what is considered by human beings their own World Heritage, must be kept in mind. Such an approach could serve as a management system that has great potential and can produce sturdiness, redundancy, early warning, etc, all attributes that are very precious in the context of the safe management of nuclear waste and particularly when considering the long periods of time during which safety must be guaranteed.

KEY PERFORMANCE CRITERIA TO PROMOTE SUSTAINABILITY IN PEOPLE'S OVERSIGHT AND CONTROL

Eight performance criteria, which could influence and sustain *people's oversight and control* have been identified through a cross evaluation of all case studies and are listed below.

- sharing of roles and responsibilities between multiple partners who are all interested parties

Partners can be identified at various levels, local, national or international. The implementation of the World Heritage Convention shows that the sharing of responsibilities at various levels provides some assurance that some level of *control and oversight* can be maintained even if one level were to fail. This requires however a clear identification of each partner's role.

- expertise must be available at all times and stakeholders must be able to mobilize it

Expertise cannot be reduced to record keeping alone. It must be alive and passed from generation to generation. IGC for instance has more than 200 years of experience. Worth mentioning is the enduring ability of carpenters' or stone-cutters' guilds to effectively maintain and pass their craft-man skill to the next generation. Satisfactory economic environments can foster expertise sustainability.

- multiple sources of sustainable expertise

This can work in multiple ways to either help prevent risk or recognize a situation as potentially holding severe risk in order to take relevant action. Expertise was a matter for concern for local people in Lorraine

when the mines shut down since the only information available was state-owned. Involvement of local people in the expertise building process can help in constructing action lines that best address stakeholders' concerns.

- the recognition of a common goal established and shared within a network of local, national and international interested parties, therefore creating a patrimonial link between them and what is at stake

This can take many aspects, for instance the shared interest in the preservation of the real estate property value in Paris, of the World Heritage sites or the management of collapsing ground areas. The *safety* of a long term storage could be the goal to share in the case of nuclear waste.

- local sustainable economic development

Economic development is the natural link between people which creates shared interests and fosters oversight and control. It also gives the economic means to act. World Heritage towns like Luang Prabang in Laos and Chinon in France develop local skills in architecture, town development planning or heritage conservation to link the protection of their historical monuments with economic sustainable endeavours.

- financial, legal and institutional structures

Very many organisational systems exist within the society matrix. Underlying financial, legal and institutional structures can be custom designed to address specific long term aspects and are of paramount importance in the prevention of risks. Availability of sufficient funds to implement remedial action can stop or limit the risk. Clear roles and responsibilities set in law or regulation can avoid hesitation, confusion or lack of action. For nuclear waste the primary issue is : whose ownership for the waste to day and in the future?

- stepwise decision process

This mechanism provides the opportunity to set times at which certain issues are to be re-examined. If various stakeholders are given the opportunity to intervene in the making of the agenda to be discussed it is then unlikely that a serious concern be forgotten.

- redundant record keeping

This can be achieved by keeping records in various places, local, national or international or/and by different institutions, and also by keeping expertise alive so that information recorded can be understood and used efficiently to address a particular situation.

CONCLUSION

However, none of these criteria can work separately. Combined together as a mix, they could become additional and essential design criteria for future storage systems. Long term storage can therefore be a management scheme, safe, useful and appropriate for human beings to use provided they are aware of and willing to cope with the associated potential risks, understand and manage them and indeed implement necessary care and maintenance in a sustainable way.

REFERENCES

- (1) – The study report is entitled “Réflexions sur les critères de performance d’un entreposage de longue durée vis-à-vis des risques d’oubli ou de délaissement temporaire” – 2001. Authors are : G. Hériard Dubreuil, S. Gadbois, Th. Schneider and C. Schieber. The report has not been published yet.
- (2) – MUTADIS Consultants : a French consulting and research group on the governance of hazardous activities and particularly involved in the EU programs, notably in the field of radioactive waste and public dialogue.
- (3) – CEPN : (Nuclear Protection Evaluation Centre) a non profit organisation, created in 1976, to establish a focus for the development of principles and methodologies to assess and manage health and environmental impacts pertaining to the nuclear fuel cycle and for the optimisation of radiation protection.
- (4) – H. Le PAS DE SECHEVAL, “L’Inspection Générale des Carrières : 222 ans de gestion de l’après carrière, responsabilité et environnement”, Annales des Mines – Janvier 1999.
- (5) – <http://whc.unesco.org/nwhc/pages/home/pages/homepage.htm>