Working paper

Swedish Nuclear Waste Management on the Move: From the Finnish Uptake of KBS-3 to the Rise of SKB International

(WP 2 – Topic: Technology Transfer)

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Date of issue: 01/05/2014
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1 Introduction

The ambition of this case study is to use the example of the Swedish Nuclear Fuel and Waste Management Company (SKB) and their KBS-3 method for the geological disposal of spent nuclear to discuss the contemporary internationalization of nuclear waste management. This process of internationalization is evident in the formation and growth of the free-standing enterprise SKB International (SKB IC) aiming to commercially exploit the experience and know-how gained by SKB through their co-ordination of the Swedish nuclear waste management system since the 1970s. Originally established as a section for international contacts and cooperation within SKB, the formal separation of SKB International from SKB in 2001 marked a significant move towards the formation of an expanded international market for consulting and technology transfer services in radioactive waste management.

SKB started out life in 1972 as SKBF (the Swedish Nuclear Fuel Supply Company). However, by the beginning of the 1980s, SKBF’s nascent concern with innovation in nuclear fuel supply (KBF-kärnbränsleförsörjning) had been overtaken by a new imperative for achieving nuclear fuel safety (KBS-kärnbränslesäkerhet) (Anshelm 2006:chp.3; Sundqvist 2002:chp.4). Initially, this prioritized pursuit of KBS by SKBF was proposed to incorporate the international reprocessing of Swedish spent nuclear fuel the residual elements of which would be subject to geological disposal subsequent to their repatriation. However, by 1984 when SKBF officially became SKB, the pursuit of KBS became lastingly tied to the direct geological disposal of Swedish stocks of spent nuclear fuel without reprocessing after a period of interim storage in a central national facility (Sundqvist 2002: chp 5; Elam and Sundqvist 2011: 253).

Therefore, by 1984 and the introduction of the Swedish Act on Nuclear Activities, SKB’s KBS programme had become an emblematic example of a new global concern with the national programming of nuclear waste management. In subsequent decades, the apparently definitive character of the Swedish national programme of nuclear waste management has been maintained and upheld thanks to the uncommon resilience and durability of the KBS programme (Elam and Sundqvist 2011). However, as will be discussed in this paper, the growing international reputation and stature of the Swedish nuclear waste management system has come to be accompanied by its creeping internationalization. Arguably, Swedish nuclear waste management only remained a more genuinely national programme during the years after 1980 when it was directly implicated in a phase out of nuclear power in Sweden by 2010. After such plans for an early phase out were abandoned during the course of the 1990s, so SKB’s KBS programme has gradually come to resemble a Swedish incubator spawning the technical experience and know-how allowing for the creation of an expanded global market for nuclear waste technology and management services. As SKB’s KBS programme has won a reputation for technological leadership and international best practice in relation to the manifold challenges of managing a nuclear waste management programme, so it has become not only a programme to imitate but also one to turn to as the commercial supplier of proven technology and know-how.

Internationalisation can be treated as both a process of technology and knowledge transfer on the one hand, and a process of commercialisation on the other. As will be discussed, SKB International implies a new set of arrangements allowing for market creation and the commercialisation of long-term national investment in nuclear waste management.

After briefly outlining further the historical background to the formation of the Swedish nuclear waste management system and the special division of responsibility between state and industry enshrined in its programmatic formulation, the creeping internationalization of the KBS programme...
will be addressed in two stages. First, the transfer of KBS-3 technology for the direct disposal of spent nuclear fuel to the Finnish nuclear waste management programme during the 1980s and 1990s will be discussed as initiating the internationalization of the Swedish programme. At that time the power company Teollisuuden Voima (TVO) started to use the KBS model as reference concept in its nuclear waste plans. However, this straightforward import of KBS-model to the Finnish nuclear waste management gradually changed towards collaboration as the nuclear waste management agency Posiva assumed the role of a co-developer and creative modifier of Swedish designs. As TVO had paid to become involved in the development of the Åspö Hard Rock Laboratory in Sweden at the beginning of the 1990s, money from the Finnish nuclear waste management programme also later paid for access to Swedish know-how regarding welding technology (Kojo and Oksa 2013). However, by the end of the 1990s, SKB and Posiva more closely resembled technological partners closely collaborating in the further development of KBS technologies of encapsulation and disposal. The balanced and collaborative nature of their relationship has evolved further as their joint research centring on the Åspö HRL and SKB’s canister laboratory in Oskarshamn has been supplemented by the SKB’s open access to the extensive bedrock investigations being carried by Posiva in the Finnish rock characterization facility Onkalo after construction began in 2004.

The second stage in the creeping internationalization of the KBS Programme will be discussed in relation to the formation of SKB International as commercial entity founded upon, but strategically separated from, the Swedish nuclear waste management system. In this context KBS technology as it has been jointly adopted and developed in Sweden and Finland is presented as tried and tested technology available for licensing after having been ‘extensively peer-reviewed internationally’ (www.skb.se/international). By claiming to represent and enshrine international best practice both in terms of technology and programme management, stretching to models for local stakeholder communication and dialogue, SKB International is interested in marketing its ability to assist national programmes worldwide in reducing both the costs and risks of nuclear waste management. Furthermore, by taking advantage of the technology and services SKB International has to offer other national programmes are argued to be capable of resourcing the reputational capital that SKB has succeeded in steadily accumulating over the decades. In this way, enlisting SKB International in your national programme is presented as a means to strategically enhance confidence in the nuclear waste management solutions different national programmes are pursuing. In discussing the growth of SKB International special attention will be paid to the relations formed with the Nuclear Decommissioning Authority (NDA) in the UK. It is argued that the clearly stated ambition of the NDA to reduce costs and timescales for the implementation of geological disposal through technology transfer are directly compatible with SKB International’s ambitions.

Based firstly on document analysis this study also draws on a limited number of interviews with key figures. Three interviews were carried out during April-May 2013; with Kjell Westerberg, Vice President of SKB International; Ann McCall, UK representative office SKB International; and John Mathieson, Head of International relations at NDA.

2 KBS Technology Transfer to Finland – A Partnership Between TVO, Posiva and SKB

As a precursor to the rise of SKB International, one can see the transfer of KBS technology to Finland as a forerunner to contemporary developments. In similarity to the Swedish laws it was required by the Finnish government that the nuclear power companies should have a solution to the nuclear waste issue. However, the two power companies TVO and Imatran Voima (IVO) did not collaborate in
SNF management like the Swedish power companies before Posiva was established in 1995. Although the main line of the Finnish nuclear waste policy regarding SNF was based on reprocessing and shipping the waste out of Finland during the 1970s and 1980s, the IVO and TVO had company specific policies. IVO shipped spent fuel produced in the Loviisa Soviet type NPP units to the Soviet Union and to Russia in 1981–1996. The contract was signed at the governmental level in 1969 (Sandberg, 1999). TVO’s search for a waste solution started in the late 1970s. TVO was guided towards reprocessing by the Finnish nuclear waste policy decisions issued in 1978 and 1983, but the company was also considering direct final disposal. As TVO took responsibility for developing a solution they were criticized for having insufficient expertise and knowledge (Kojo and Oksa 2013). One of the immediate answers to this problem was to gain knowledge and experience from overseas. The Swedish KBS-concept had already in 1977 been adopted as a reference model in Finland by TVO due to Sweden and Finland’s similar geological conditions. However, the relations were intensified during the 1980’s, when TVO initiated a more focused collaboration as a way to benefit from the Swedish experience and to communicate more frequently. The collaboration between SKB and TVO gained momentum in the late 1980s with the Finnish search for possible methods and solutions.

Consequently, what was initiated as information-exchange and frequent communication became in a stepwise fashion a programme of joint-development between the Swedish and the Finnish nuclear waste management agencies, both in terms of research and development as well as the implementation process. The informal cooperation of a group called the Crystalline Group in the early and mid-1990’s ended up in collaboration on research into crystalline bedrock, and along with the joint Project Alternative Systems (PASS) project during the early 1990s substantial research collaborations and technical development evolved between Swedish and Finnish nuclear waste management agencies (Kojo and Oksa 2013). TVO also gained access to SKB’s hard-rock laboratory that was under development in Äspö through payment of a fee for privileged access and utilization. However, from the late 90’s both R&D and implementation of geological disposal have evolved into a matter of close collaboration for SKB and the Finnish waste management agency Posiva founded in 1995. Thus, the KBS-programme has evolved into a matter of mutual concern and benefit for Swedish and Finnish nuclear waste management both in regards to joint research and technical development. Research is also planned in accordance with a shared budget, so that both SKB and Posiva are able to benefit from each other’s research efforts and share responsibility for research spending (Interview Kjell Westerberg Vice President SKB International 2013).

Hence, the KBS model has not only been transferred to Finland, it is also continuing to evolve through this collaboration as the two national programmes build upon a shared and co-evolved technological platform. Especially Posiva has however argued that there is no such thing as a national program or solution, just company-specific activities. The enterprise cooperation between SKB and Posiva has been inscribed into the KBS-model through what was formerly seen as a joint-development between the Swedish and the Finnish programs. However, the question is whether such a pattern of transfer resulting in joint development will arise again, or if international relations and nuclear waste management technology transfers will take other forms in the future. Kjell Westerberg of SKB International sees a difference emerging today given SKB’s technical concept is now is treated as more fully developed and as possible to offer for commercial contract and licensing.
3 The International Regime of National Responsibility

With the first wave of nuclear power development from the 1950s to the mid-1980s, spent nuclear fuel was broadly conceived as a resource. Nuclear fuel supply and the development of a global nuclear reprocessing industry were closely connected and the import/export of spent nuclear fuel was rather extensive (Lidskog and Andersson 2002). In Sweden, there were contracts signed both with the UK Atomic Energy Authority and with French Cogema for the reprocessing of spent Swedish nuclear fuel between the years 1969-1978 (KSU analysgrupp 2005). The question of spent nuclear fuel has been formed as a national and international question in relation to the nuclear safety and safeguards against nuclear weapons on the one hand, and on the other hand in relation to the potential gains of international cooperation, such as economies of scale and co-ordinated development.

What followed though was a shift from an international pattern to a national pattern of organization for spent fuel management broadly reconceived as a task of nuclear waste management. Despite the global configuration of nuclear cycles, nuclear waste management has been firstly subject to national programming. The 1968 non-proliferation treaty (UNTS 1970/1968) recognizes the inalienable right of all sovereign states to develop and use nuclear energy for peaceful purposes. What is stepwise emerging is a national control and responsibility over the management of spent nuclear fuel (Cramér et al. 2007; Stendahl 2009). Thus, one of the elements in the national responsibility is the agreement on national sovereignty over nuclear activity.

In Sweden national responsibility emerged through a number of steps even though it was not defined as a principle at first. A foundation for the subsequent Swedish national responsibility is also the initial structure of nation state authority for all nuclear power generating activities specified in the first law on atomic energy (SFS 1956:306). A second element of national responsibility has been the government driven requirement for active nuclear waste management as a regulation covering all civil nuclear activity. The commissioning of new nuclear reactors is subject to certain conditions and stipulations, and it was in relation to these governmental controls that specific conditions for the safe management of nuclear waste were set in 1977. These were first and foremost a demand upon industry to "demonstrate how and where a totally safe end-disposal of non-reprocessed used waste can be materialized" (Prop 1976/77:53§2).

The structure of responsibility was further elaborated in 1981 when accountability was more clearly specified (SFS 1981:669). This was however still before any principle of national responsibility had been clearly expressed. The law in 1981 did however put more emphasis on industry as both practically and financially accountable in the management of its nuclear waste. Together with overarching state responsibility for guiding nuclear waste management policy, the relation makes a foundation for the Swedish model of long-term nuclear waste disposal (Prop. 1980/81:90 bilaga 1 s. 319).

National responsibility was defined as a principle more clearly in 1984, when it was stated that “the essential principle for Swedish proceeding should be [...] that each country takes full responsibility for the nuclear waste created within the country” (Näringsutskottets betänkande1984:85:NU30 s 67) (citerat i Cramér 2007). This proclamation was given legal status by a collection of different laws and most significantly by legislation prohibiting the disposal of other nations’ waste in Sweden (prop 1992/93:98 s 29 f) (Ktl § 5 a). However, the Swedish principle of national responsibility is not a very rigid one in legal terms and can even be interpreted as more of a proclaimed political intention (Cramér et al. 2007:38). This also makes it flexible in its character and function – adaptable to changing political circumstance.
However, there is also the distribution of responsibility between state and industry, which in Sweden was formed mainly around the responsibility of reactor owners with the over-arching powers of direction placed in the hands of government. The division of responsibility between state and industry was set in the late 70s and early 80s at a time when energy production in Sweden was mainly owned by the state, which blurred the distinction between industry and the state in terms of responsibility (Cramér et al. 2007:17). The responsibilities were divided so that the nuclear industry was reviewed every third year by the authorities, but in relation to a joint steering between the industry and civic bodies. Thus, industry was formally separated from the state, but there were in practice close relations between industry and state due to state ownership of the nuclear industry. The division of responsibility is similar to that under new public management, i.e. a market-like structure between principles and agents in which public bodies are procuring services from private bodies under surveillance and control according to certain measures (Lane 2000).

The producer’s responsibility was accentuated through a modification of the law on financial structures for nuclear waste management (SFS 2006:647), which further strengthened the division of state and industry as principal and agent. SKB is a separate joint stock company owned by the nuclear power industry, but they receive their funding from the nuclear waste fund. In the official report preceding the law of 2006, there was a concern with protecting the state against financial risks, which thus accentuated SKB as an actor with interests separate from the state (SOU 2004:135-136). The law on financial structures is one of the pillars forming the principle of national responsibility and the financial means are not supposed to fund SKB’s private commercial activity or commercial involvement in the nuclear waste management programmes of other nations. This provides a background to the creation of SKB International – or might even be seen as the rationale for this institutional innovation given that the Swedish nuclear waste fund is delimited to national concerns.

National responsibility as an international regime is an arrangement in which responsibility follows from nationally taken decisions about nuclear power. However, as responsibility stems from the national level, it also constitutes a principle of non-solidarity between nations when it comes to managing each other’s waste or any sharing of intellectual property (Cramér 2007). One can of course argue that national responsibility for nuclear waste was something of an anomaly already from the beginning, thinking about how nuclear fuel cycles otherwise remain indisputably global transboundary affairs. The transportation chain includes the mining for uranium, enrichment and fuel production, and for example in the case of Sweden, fuel pellets are imported into Sweden while fuel elements are exported out of the country.

Resembling the technology transfer from Sweden to Finland, bilateral and international collaboration now seems to be a matter of methods and knowledge being shared and/or traded across borders. The line is thus being drawn between the distribution and marketing of methods for nuclear waste disposal as opposed to the actual shipping and international transfer of nuclear waste itself. However, this does not answer the question of how we can expect the internationalization of nuclear waste management and geological disposal technology to develop in future.

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1 This is logically true, but there are of course empirical contraries, for example the relation of SKB(F) and TVO in the late 1970s.
4 The Emergence of SKB International – From Cooperation in the Stripa Project to Commercial Contracts

Like many other nuclear waste organisations, SKB’s activities were of an international character already from the outset, as they have been linked to global nuclear fuel cycles and to international fields of knowledge and expertise. SKB was originally a Swedish nuclear fuel supply company (SKBF) before it was forced to abandon innovation in this field to become a nuclear waste management company obliged to develop an entirely safe solution to the nuclear waste problem as a matter of national responsibility (SOU 1976). SKB began to address this new company mission by bringing together existing technical and geological knowledge - not only domestically from within Swedish industry, but also drawing together expertise from an international network. They turned to people with expert skills from different field in an effort to channel forces into a method and model that was to be known as KBS (Interview Kjell Westerberg Vice President SKB International 2013).

The “Stripa project”, conducted between 1980 – 1992, was an international research cooperation concerning geological disposal. The project was initiated as a joint project by 9 member countries of the OECD-NEA, and was managed by SKB. The in situ experiments (conducted in underground conditions) were carried out in the Stripa mine in the middle of Sweden. SKB, at that time SKBF, leased the mine in 1976 and initiated experiments. A few years later, in 1978, an OECD-NEA conference was held in Ludvika not far from the Stripa mine. It was then that the first proposals of the project were officially discussed, and the seminars to come, two in 1979, decided on the Stripa project to be organised in relation to the mine, with SKB(F) managing the project and joint funding thorough OECD-NEA. Thus in retrospect, this project can be seen a forerunner to SKB’s role as initiator and facilitator of transnational networks and international cooperations in geological disposal.

One can see the continuation and expansion of SKB’s international networks in the reports from Äspö hard rock laboratory established in Oskarshamn in 1995. Between the years 1992-1998, SKB formed bilateral agreements with a large number of organisations including Nirex (UK), Posiva (Finland), ANDRA (France) and AECL (Canada) (SKB 1992-1999). Ann McCall, a Vice President for SKB International (Interview 2013), who previously held a senior position within the disbanded UK nuclear waste management body Nirex, describes the Swedish Äspö Hard Rock laboratory as a leading international meeting place for representatives from different national programmes. She describes it as an important centre for information exchange between about different programmes and projects.

As relations with other national programmes have expanded an international department eventually was formed within SKB in order to deal professionally with the co-ordination of these contacts (Interview Kjell Westerberg Vice President SKB International 2013). It was this department within SKB that in 2001 was established as a separate wholly-owned joint-stock company; SKB International. As already mentioned, SKB’s work is financed by the Swedish nuclear waste fund (Kärnavfallsfonden), and therefore guided by legislation saying that money from the fund cannot be used to directly enhance the development of any other nation’s nuclear waste management plans - there must be a clear mutual benefit for SKB (SFS 1988:1597, SFS 2006:647). SKB are re-negotiating these conditions when creating SKB IC as a mediating body reflecting that they see themselves as having more to offer others than to receive from them through international exchange.

However, SKB still remains an active part of different collaborative projects exchanging knowledge and expertise on a non-commercial basis. These projects have been firstly about technology
platforms and different forms of bilateral relations on the one hand, but a question of competition and market-like procedures as well. The 6th Framework Programme CATT\(^3\) (2007) project was an explorative venture with an aim to establishing co-operation over implementation of geological disposal within the European union. The intention of the CATT-project was rather simple; trying to explore the cost reduction potential for national nuclear waste management through future co-operation and technology transfer between the waste disposal programmes of different countries, and for that purpose the project identified potential “Donor Member States” and “Recipient Member States”. The purpose was to investigate possibilities for transfer from member states with advanced disposal concepts to member states that may not be able to develop their own disposal solutions due to lack of finance, technical know-how or expertise. As part of the CATT-model, the donor-states are expected to “survey the market for available technologies” and the transfer model “can be (simply) conceptualised as a straightforward purchaser-vendor relationship” (ibid:12). This articulates the theme of competition as part of the process, without however discussing any other implications of commercialisation and market-like procedures in general.

Work aiming for the further development of collaboration on a European level was continued with the CARD-project (Project and Technology Platform in the Field of Geological Disposal of Radioactive Waste) between 2006 and 2008. The general theme of the project was collaboration and co-operation, but it was however stated as the specific aim of the project to “assist Europe to compete efficiently in the development of advanced and complex technologies” (my emphasis) (CARD 2008:25). Even though the final report does not point out any driver for “external competition” (i.e. from outside European context); the vision of a collaborative platform is on the one hand a question of shared RD&D (Research, development and demonstration), and on the other hand the expected benefits from competition. Thus, a new combination of competition and cooperation is expected from the process, and that is matter that raises new questions about what happens when concerns over profit and market shares enter more strongly into the nuclear waste management field.

The European technology platform (IGD-TP) was launched in 2009, and this is specifically aimed at implementation of geological disposal. It is therefore, “no longer just research, but research into implementation; it’s how to get things moving into that next stage”, as expressed by John Mathieson (Interview John Mathieson Head of international relations NDA). The goal of the IGD-TP is to proceed to license the construction and operation of geological disposal (Euratom 2009). The themes of “joint-work” and opportunities for “co-operation” are stressed in the IGD-TP special report of 2012., and as the platform is focused on implementation it does also emphasise a need to “facilitate access to expertise and technology” (Euratom 2012:9). Thus, a multilateral platform can appear to be the way forward in the quest for best practice of geological disposal, but with a fairly ambiguous distinction between collaboration and competition.

Along with these different collaborative research projects where SKB is an active participant, their experience and established technical know-how has put them in a position where many actors have a direct interest in their work. While the owners of SKB are constrained from gaining commercially from company activities, SKB International is still able to access staff and experts from SKB on contract. Through such arrangements, the commercial activities of SKB IC are conveniently detached from the national waste fund through a defined rate per hour for the different kinds of competence SKB can supply (Interview Kjell Westerberg Vice President SKB International).

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\(^3\) CATT = “Co-operation and technology transfer on long term radioactive waste management for Member States with small nuclear programmes”. 
SKB and SKB IC’s approach to international collaborations is characterized by the ambiguity between voluntary sharing and forums on the one hand, and proper commercial agreements as part of a business case on the other. Thus, SKB’s participation doesn’t seem unconditional when it comes to collaborations such as the IGD technology platform or the CARD-project. While cooperation and international sharing is considered positive and something SKB promotes, such collaborations are undesirable for SKB if they become channels for shared technology instead of commercial arrangements:

When there is one nation, or a couple of nations such as Sweden and Finland that have come very far, then you cannot just require those countries to provide all that they know, to let others more or less build up something from our stuff without paying for it. So, we are going to provide on a commercial basis...we are participating in these co-operations, but when it comes to a matter of profoundly technical details then we are not just going to divulge it free of charge (Interview K.Westerberg 2013)

So, if collaboration might come to the point of contracts for technology transfer then the company and their owners also do see the potential of commercial profits. Get-togethers and communication are on the one hand important in themselves but there are on the other hand restrictions about surrendering intellectual property. Commercial activities could not be advanced if SKB were to be forced to disclose whatever they develop; and as such SKB International is of great importance because it has a different status as a company. Moreover, parallel to working with the platforms, SKB and SKB IC have been focused on bilateral relations and associations with other national programs. One of these connections that has been developed over a long period of time is with the British programme of nuclear decommissioning.

5 Restructuring the UK High-Level Nuclear Waste Programme - Towards International Best Practice

Nuclear power was pioneered in the UK during the 1950s. However, like in many countries the question of nuclear waste management has not been successfully addressed and the UK programme has a history of many failed initiatives and suspended time schedules for given plans. The Royal Commission on environmental pollution was the first authority to demand a response to the nuclear waste issue, which led to the establishment of RWMAC (Radioactive Waste Management Advisory Committee) (Kemp 1992). Technical knowledge and capabilities were however understood as of overriding importance for a successful programme with less attention given to questions of public acceptance, communication and participation (Aterthon and Mathieson 2007). In 1997, it was stated in UK Parliament that the “UK [deep disposal] programme has stopped dead in its track” (Mathieson 2010) and in 1999, the House of Lords Science and Technology Committee acknowledged a failure of the closed, expert-dominated process (Mackerron and Berkhout 2009).

As a response to this situation, the MRWS-programme (Managing Radioactive Waste Safely) started in 2001, with demands for heightened transparency and public consultation. The programme was also followed up by the creation of the NDA (Nuclear Decommissioning Authority), which marked a turn towards clear targets to decommission and a remaking of the British programme (Secretary of State for Environment 2008).

However, what also changed from 1997 was the work with international relations. The restructuring of the UK programme evolved with reference to how things were being done in other national programmes and through international outlooks into the relative success and failure of other
programmes (see for example NIREX 2004:annex 2). The Committee on Radioactive Waste Management (CORWM) aimed already in 1997 to gain from looking into other programmes at a time when many programmes had suffered setbacks, such as Canada’s failure that was examined as part of the international outlook. The Committee also tried to understand why the Swedish programme appeared more successful than the British and what lessons could be learned (Interview John Mathieson Head of international relations NDA 2013).

The outlook into international practice came with an ambition for structural change within the UK programme stimulating an interest in identifying global best practice in the field (CoRWM 2006). It was at this time that a report by JRC (Joint Research Center – European Commission) identified the term Best Available Technology (BAT) as an “emerging issue” for the field of geological disposal (Falck et al. 2009). The concept itself is expected to create a needs-driven rather than a vendor driven process, and to safeguard for best engineering and safe methods. However, the safety case is also considered capable of “optimisation”; a cost-benefit analysis of available options and an ambition to optimize safety within set financial limits. The BAT-approach was brought into the UK implementation phase as it was introduced and adapted as a concept in reports from NISDF (Nuclear Industry Safety Directors Forum) (2010) as well as NDA (2010).

With the creation of NDA there was a more distinct focus on strategies for how to work with international relations and also to find best practice by the involvement of different actors. International cooperation and contracts were now more fully accepted as of potential benefit to the UK disposal programme and the possibility of technology transfers was discussed (Kelly et al. 2009). In NDA strategy reports international affairs are divided between relations and formal contracts. The relations are bilateral agreements with different waste management organizations around the world with whom NDA exchanges information and strategies, but which does not bind actors to any firm commitments and does not “relate to commercial income” (NDA 2011:6). The commercial contracts are different because they bind actors to actually providing goods and services as a contractual commitment. The purpose of bilateral relations should however also be, according to Mathieson at NDA, some sort of business case. The so-called international relations as well as the commercial contracts converge in a quest for finding different components that can form a successful UK programme, as it is stated by Mathieson:

…the law which sets us up, is to get to do things under best practice, and included in that would be best international practice. And so the point with international collaboration is you don’t want to spend what is, at the end of the day the taxpayer’s money, on reinventing wheels. One of the ideas behind international collaboration is to understand what others are doing, or have done, and in return to get them to understand what you have done; to give them access to your intellectual property, expertise and best practice, and if these exchanges then can be developed into commercial contracts then that is good for everybody (Interview John Mathieson Head of international relations NDA 2013).

So, what international collaboration comes down to is the overall aim to collaboratively agree upon what constitutes best practice in nuclear waste decommissioning and disposal and collectively converge upon this standard. Commercial contracts guiding collaboration coincide with the maturation of this process as international consensus over best practice emerges after a period of more informal and open communication of knowledge and information. Many different actors such as consultant firms, waste management organisations and implementing contractors, along with the experience and knowledge of each of one of these, might in the end compose the “UK programme” (Interview John Mathieson Head of international relations NDA). To “do things under best practice” is
a matter of adopting practices that are not entirely novel and to procure techniques that have been tested by others; all according to an overall aim to reduce risks and costs for the UK waste management.

5.1 Applicability and Adaptation

Another aspect of the relation between SKB and the UK decommissioning programme is the question of whether there in practice could be a similar transfer of the KBS-3 model as has already occurred to Finland. There are different views and dimensions to this question. The UK doesn’t yet have a site, and without a site there is no certain type of bedrock chosen, so the geological conditions are still unclear and hence also any specific technical concept. KBS-3 is developed according to the conditions of crystalline rock and the question is whether the conditions might be similar enough for a technology transfer to be feasible (Interview Ann McCall UK representative office SKB International; SKB International 2012). What is also subject to examination is whether the model can fit UK conditions and really bring down costs, or if it would be very difficult to adapt thereby at risk of increasing rather decreasing costs.

In order to assess the potential for technology transfer, SKB IC have, through the help of experts from SKB, attempted to calculate the UK applicability of their model and have presented the results in the report “SKB Technology Transfer – Identification and quantification of potential benefits” (2012). The calculations include for example estimates of how the different materials potentially can be used in different types of rock, and the estimated applicability is presented in percentage terms, such as 80-90 % overall applicability for higher strength rock, while it is only 20-30% for evaporates (SKB International 2012:61-62).

SKB describes their technical concept as a rather robust model – ‘a solid core of engineering that can be more or less adapted to different environments and contexts’ (Interview Kjell Westerberg Vice President SKB International). However, the model must also be flexible in relation to a new place and setting, such as the social/legislative context, the wide range of different wastes, and the wide range of different types of geology:

*There may be other demands from the authorities, or different demands in relation to geology...that the geologic conditions are different and so on...and to begin looking into that. Then you have agree to something like ‘those different changes needs to be introduced’. And after that there is the idea that customers should be able to construct this by themselves or within their chain of supply, but also with our help and support. Because then when the adaptation is carried out, they should basically be able to do things by themselves...but with us all along sitting in the backseat so to speak (Interview K.Westerberg 2013 Vice president SKB IC/Technology).*

Thus, when SKB are considering technological transfer, they are estimating applicability on the one hand, and the work of adaptation on the other. As both these elements actually requires action, it entail certain kinds of active intervention rather than a passive “transfer”. The transfer thus requires a sophisticated strategy of enrolment by SKB, partly because the adaptation requires their continuous participation, partly because KBS-3 is under development. SKB IC consider the work of adapting their concept a top priority, even though they recognize that they cannot take full responsibility for the implementation. Thus, a questions remain concerning how transfer and adaptation can be managed in scale and scope over what sort of time frame. Transfer seems to be
more of a continuous process and relation rather than the straightforward movement of technical objects, also given the continuous development of KBS-3 that is still taking place in Sweden and Finland.

SKB IC (interview) also emphasises that they never can come from out of context as ‘foreigners’ and expect to fully understand the new setting. The efforts required for adaptation must be worked out and accomplished through local representatives. Technology transfer is thus not a matter of certain techniques to be transported from one setting to another, but bits and pieces that will be rearranged according to a process of social as well as technical problematization - a process acclimatizing and adapting KBS-3 to its new surroundings.

In the SKB International report on transfer, they consider KBS technology of great potential value as it could potentially reduce uncertainties and costs for the UK programme. Great emphasis is thus given to the engineered core of KBS-3 and a “delivery” of KBS-3 is the technical answer to the problem of nuclear waste, and the components of SKB’s technical concept are described according to their performance such as the encapsulation and barrier system. The performance of key technical elements is detached from other areas such as “society” and “economics”, and SKB’s methods are portrayed as bringing down uncertainties related to “technology”. The technical systems are however also part of the answer to problems of “society”:

> If the KBS-3 technology is imported and is 80–90% applicable to the UK needs then the uncertainties associated with “Technology” should be significantly reduced. [...] The acceptance-related risks, or the uncertainties related to “Society”, should also be significantly reduced based on the technology having been widely reviewed and having reached an advanced stage of local community approval and gradual Government encouragement (SKB International 2012:94).

For the UK programme there is an clear ambition to resource some of SKB’s reputational capital, and SKB views their relations with the UK as confirming their high status in the field as well. However, attempt to draw upon and expand reputational capital is also to incur a new reputational risk, and SKB does also comprehend and recognize major hazards related to a further international transfer of their model. To miscalculate structures and details of another geology and a new social context might create unexpected and unwelcome effects and problems:

> Potential adverse risks could include a perception amongst stakeholders in the UK that the technology is being made to fit where it is not necessarily the best option. For SKB, being involved in a process at the early stages of siting with potential for adverse media coverage, could potentially affect the SKB programme. Such risks need to be carefully managed (mitigated) by both parties in connection with cooperation on technology transfer (SKB International 2012:94)

Thus, the ability to define and separate technical aspects from other kinds of social and political involvement is here considered a rather difficult task. If the concept and technical features are misunderstood, it might create a new reputation/image of an inadequate KBS-3 model. Moreover, another context might require the reworking of certain understandings of the technical and social dimensions of KBS-3 – dimensions which hitherto have been possible to present as purely technical.

The way SKB’s concept is communicated and put into a presentable format is fashioning technology transfer as a robust concept made up of elastic components. As, such the concept itself is understood as a core surrounded by flexible components that can help to fit the technology into a
new context. It is however not clear where to draw the boundaries of robustness and flexibility. How does such flexibility relate to the robustness of the engineered solution, and can there really be a line drawn between technology transfer as a delimited project and relations and involvement as part of a continuous process?

5.2 The Transferability of Public Confidence?

SKB’s KBS-3 method emerges out of and research, development and demonstration project showing safe geological disposal of spent nuclear fuel to be within technological reach. Such powers of demonstration are also part of interest to the NDA and the British programme. SKB have also demonstrated how an implementer can establish and maintain constructive relations with local communities participating in a repository siting process. The NDA consider it particularly an asset that SKB have worked at full scale integrating community/local stakeholder relations with the further confirmation of technological solutions:

...showing people a copper canister is very, very important for them to be able to show exactly what it looks like...and also just taking people into a repository environment like Aspö in Oskarshamn or SFR at Forsmark, to show people what size things would be underground...to show that things can work underground...and that it's not rocket science, it's simple tried and tested technology. It's building up confidence like that...and I said we are looking at how the communities interact with the implementers...how that can be done and how that can be successful [...] So we like to communicate our links to Sweden to show our communities how community-interactions overseas work, just to show examples of how good relationships can be successfully built up (Interview John Mathieson Head of international relations NDA).

Without doubt, the municipalities of Östhammar and Oskarshamn have had a profound impact on the development of the nuclear waste issue in Sweden and their involvement is seen by actors such as the NDA as of broad international significance. As the two communities have volunteered to participate in the siting of a KBS-3 repository, it has not just heightened the credibility of this solution in Sweden, but has also raised its profile internationally demonstrating on a more global scale a potential method for handling nuclear waste safely.

Apart from mitigating risks and costs, SKB IC points to their ability to reduce uncertainties and unforeseen delays given the fact that the Swedish programme has accumulated much experience and is in a later phase than the UK programme (CoRWM minutes 2011). The expression “Transfer of confidence” is used in the sense of following automatically as “an inherent part of the KBS-3 technology associated with the SKB and KBS-3 brands” (SKB International 2012:82). Ann McCall, UK Vice President of SKB International, adds that transfer of confidence follows with the opportunity for people to see technical progress, and the possibility of finding ‘a willing community’. Therefore, the transfer of confidence builds on a combination of acquired knowledge, ‘not reinventing the wheel’-opportunities, and the possible to draw on the stocks of ‘reputational capital’ that SKB currently holds internationally in the field of nuclear waste management.

In a NDA report from 2013 a more explicit strategy for technology transfer is outlined as central to the task of managing UK radioactive waste safely. The objective for transfer is firstly stated as “to improve confidence in the UK programme using evidence and demonstration that geological disposal is being implemented overseas” (NDA 2013:19). In the report a clear definition of technology transfer
is provided as “the assignment of technological intellectual property, developed and generated by one organisation, to another, through legal means such as technology licensing” (ibid:1).

The construction of narratives and framings (cf. Yannick Barthe 2009) of SKB’s work are integrated with the demonstration of something more than just drawings and papers, and SKB has displayed the work of laboratories and the putting together of an integrated concept (CoRWM minutes 2011; Interview Ann McCall UK representative office SKB International). Thus, since SKB has the role of provider of confidence, they can through SKB International reinvest their reputational capital as a new form of venture capital for establishing a new market in confidence for geological disposal solutions.

6 Conclusions

This case study has focused on the internationalization and marketization of nuclear waste management, and the detachment of SKB International as a commercial spin-off from the established Swedish programme for geological disposal.

The formation of SKB IC has enabled SKB to move beyond the national responsibility under which the company was first created, but which have also established the reputation of the company. National responsibility pushed SKB into the innovation of geological disposal on behalf of the nuclear power industry. The key to success has been the way SKB’s historical role has been structured and supported by the public authorities extending to the participation of particular local municipalities. It is under this public control, auditing and support that SKB and the KBS-model have been able to win public confidence and a good reputation. These values of confidence and credibility have been taken from the national project to an international market of characterised by demands for corporate responsibility. Thus, the core of the model is not merely the technological solution, but the structure of accountability established through Swedish nuclear waste management which is as much a central component of the KBS-3 solution as the copper canister.

6.1 Boundary Work and Flexibilities

However, as SKB are starting to partially detach themselves from the national structure within which KBS technology has been nurtured so they there is a need for flexibility as well as remaining clear cut boundaries. In order to be geographically flexible, the technical solution needs to be divorced from detailed geological conditions or a unique location. KBS-3 technology has come to be recognized as a system of engineering expertise and flexibility due its multi-barrier system. However, talking in terms of problematizations, the formulation of problems hangs strictly together with ways to address the problem, and thus the identification of certain expertise as legitimate or not for the task of nuclear waste management (cf. Yannic Barthe et al. Forthcoming; Callon and Law 1986). The geographical flexibility of the KBS-3 technology is very much a matter of engineering expertise and a technical answer to the problem of nuclear waste management.

Moreover, as the model has developed in the Swedish/Finnish context it has been characterized by certain social/political settings, but as SKB are to carry the model overseas the technical aspects need to be detached from the existing social settings. For the purposes of technology transfer the KBS-model is portrayed as a unit of stable methods and techniques, highlighted as a technological answer to a question of nuclear waste management. In order to uphold the vision of a transfer – something
transported from one setting to another - the technological model is separated from its relations to a particular public sphere. Further necessary boundary work relates to the protection of intellectual property underlain by an expansive process of public review through which KBS-3 technology has developed hitherto and achieved the status of a mature and advanced solution. If SKB are both to give their technology a commercial value, there must be a tension if they as well want to sustain the model of transparency and public reviews. This tension relates to the one of international projects as both collaborative and competitive.

Finally, there is a need for a boundary to be drawn between SKB, as a company taking corporate responsibility on national level, and SKB International as a commercial actor on a transnational market. As noted above, SKB IC was created as a mediating body. According to Swedish law, SKB are not allowed to develop technology for other nation’s waste programmes but are obliged to use means from the fund for the Swedish waste management and only for that. Thus the boundary between SKB and SKB IC is significant, but such a boundary will only withstand by a continuous work to organizationally separate the companies.

6.2 Technology Transfer as a Process – Nuclear Waste Management as a Market

The pursuit of technology transfer across borders assumes that the state of technological solutions is more or less constant, even when travelling across national borders. However, the transfer of the KBS-model is a bit messier than this. What can be taken overseas is KBS-technology as an answer (or part of an answer) to other nations’ problems and demands for nuclear waste management. However, as SKB claim themselves their role is as much a matter of confidence-building as geo-engineering.

Thus, SKB International needs to be visible and active in both the distribution and implementation of the KBS model if it is to successfully travel further out into the world. A combined active and passive role is called for as expressed for example in the notion of SKB International maintaining an earlier mentioned ‘backseat’ role during technology transfer to the UK.

The active role of SKB International in relation to the NDA, implies a redrawing of the traditional lines of responsibility that have defined the KBS project since its inception. From the very beginning, KBS technology has evolved in accordance with a specific division of responsibility, central to the Swedish programme. The KBS solution is thus both an engineering solution as well as a technology of accountability.

KBS-3 is being put in motion as a method, but SKB International is also becoming involved in transferring the style of institutional arrangements that were established within the Swedish model during the late 1970s and consolidated during the 1980s under the new Swedish law on nuclear activities. As SKB was once set up and responsibilized with delivering nuclear waste solutions nationally, it may find itself made contractually responsible for delivering solutions overseas, and become part of process creating new principal-agent style relations on an international basis. Through such expansion and commercialisation of nuclear waste management, the international search for best practice potentially becomes an international market of methods and technologies for geological disposal.
7 References


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