Evolution and Major Turning Points of HLW Disposal Policy in Several Countries

Shigenobu Hirusawa,[1] Seishi Torikai,[2]
Neil J. Numark[3] and Daniel J. Moss[4]

1:Director 2:Scientific Consultant
Research & Development Div., the Institute of Applied Energy (IAE)
Shinbashi SY Bldg., 14-2 Nishi-Shinbashi 1-Chome, Minato-ku
Tokyo, 105-0003, JAPAN
1:hirusawa@iae.or.jp, 2: torikai@iae.or.jp

3:President 4:Director of Research
Numark Associates, Inc.
1220 19th St., NW, Suite 500
Washington, DC 20036
3:njnumark@numarkassoc.com, 4: dmoss@numarkassoc.com

Abstract-

The background situation and discussion of the evolution and major turning points of High-level Waste disposal policy in several countries were investigated, in order to extract key issues and lessons learned.

Also, the conditions preceding and following the major events were evaluated, tracing and analyzing the evolution and key issues of HLW disposal policy in each country, and we identified the major turning points, such as the ethical discussion in late 80's and new approach mentioned in RD&D Programme 92 in Sweden; the Waste Law of 1991 in France; the NWPAA of 1987 in US, etc.

Moreover, we examined the background of evolution and turning point in each country, and identified the key issues for HLW disposal policy. Based on the investigation, we extracted important common factors to promote HLW disposal policy, such as stepwise approach, reversibility/retrievability, third party's assessment, public involvement, etc.

I. HISTORICAL CHANGES IN GEOLOGICAL DISPOSAL (OVERVIEW-FOCUSING ON DISCUSSIONS IN INTERNATIONAL INSTITUTIONS)

The method to isolate and dispose of high-level radioactive wastes (HLW) deep underground was proposed in several research papers in 1950s.

In the United States, among defense-related wastes, so-called Highly Active Liquid Waste had been stored in tanks, and in 1955, a discussion on how to stably manage Highly Active Liquid Waste was held at Princeton. Based on results of this discussion and others, the National Academy of Sciences compiled and published a report entitled "The Disposal of Radioactive Waste on Land" in 1957. The report suggested that the most promising method to dispose of high-level radioactive waste in the future would be the emplacement of the waste in a rock salt formation.

In the 1960s, the research and development (R&D) made a full-fledged start, and in Germany, in-situ tests started at the Asse salt mine.

In the 1970s, R&D of geological disposal made great progress through intensified multilateral collaborative research and international joint R&D. In particular, the Nuclear Energy Agency of the Organization for Economic Co-operation and Development (OECD/NEA) was inaugurated in 1975, and the international joint R&D at the Stripa iron ore mine in Sweden (1977-1992), which started shortly after the inauguration, represented a typical example. From the 1960s through 1970s, R&D and data collection were performed progressively to obtain required geological disposal technologies and necessary data for safety assessment.

In the 1980s, in the wake of such progress of R&D, so-called feasibility studies were launched to evaluate the feasibility of geological disposal and clarify future problems in implementing geological disposal. Typical examples are KBS-3 in Sweden and Project Gewähr 1985 in Switzerland.

In the midst of such technological progress, a study from another aspect was proposed and made.

A report published by OECD/NEA in 1982 entitled, "Disposal of Radioactive Waste, An Overview of Principles Involved" stated the purpose and discussed those aspects which had not been clarified well up to then. The report showed the way to select radioactive waste management methods including HLW disposal and reiterated the rationality of final disposal of HLW into deep geological formation.

Through the progress of R&D by individual countries or within an international framework and the reconfirmation of the geological disposal concept among experts, from the late 1980s onward, movements toward the implementation of disposal operations were found in several countries.[a] Meanwhile, in the wake of geological disposal R&D progress achieved up to the mid-1980s, the International Atomic Energy Agency (IAEA) began to develop safety regulation policies and codes and standards required for the implementation of geological disposal. The IAEA Safety Series No. 99 of 1989 was the document compiled by experts to provide internationally agreed principles and standards of deep geological repository design for high-level radioactive waste disposal. It can be understood that a consensus was reached among experts that the basis to start out geological disposal operations was almost formed through R&D conducted up to then. This was also clarified by a collective opinion on long-term safety assessment compiled by OECD/NEA in 1991.

Meanwhile, environmental issues became prominent beginning in the 1970s and the same went for geological disposal. The public began to express concerns about long-term safety of geological disposal. In such time, specific preparations for geological disposal implementation actually began to proceed in some countries, but these preparatory activities immediately came to a standstill due to primarily a factor other than technical problems, i.e., difficulties to gain public consensus.

It is seen that such international situation was one of the factors leading to discussions and compilation of the collective opinion published in 1995 by OECD/NEA on environment and ethics in a report entitled “The Environmental and Ethical Basis of the Geological Disposal of Long-Lived Radioactive Waste”.

For implementation of such basic philosophy discussed and shown from such a broad viewpoint, there is a consensus among concerned parties that technical uncertainties should be eliminated gradually (stepwise)[b], and with concern for fairness among generations, geological disposal should take a step-by-step approach.

OECD/NEA’s Radioactive Waste Management Committee (RWMC), which has been focusing their activities on technological aspects, described in the report published in 1999 the consensus on geological disposal of long-lived radioactive waste reached among experts.

Based on such consensus and acknowledgement, RWMC indicated a broad range of fields, other than technical fields, as those to be strengthened in the future, and expressed its intention to strengthen its role as a bridge between individual countries.

Table 1. Brief History of Geological Disposal

date	Typical Cases
1950s	**Proposal of Geological Disposal** ・Paper in Geneva Conference, IAEA (1955) ・Princeton Conference, U.S. (discussions on disposal in the ground, in 1955) ・Report by U.S. National Academy of Sciences (NAS) (1957)
1960s	**Start of R&D** ・The Asse Mine in Germany (1965), etc.
1970s	**Start of International Joint Study** ・Inauguration of OECD/NEA (1975) ・Stripa Underground Laboratory, Sweden (1977-1992)
1980s	**Feasibility Study** ・KBS-3, Sweden (1983) ・Project Gewähr 1985, Switzerland (1985)
1990s	**Discussions on Ethical and Environmental Aspects** ・Preparation of a Collective Opinion based on results from workshops and discussions on ethical and environmental aspects of geological disposal, (1994-1995).
2000+	**Site Selection, Repository Construction and Implementation of Disposal Operations**

[a] For example, Sweden, USA, and Germany.

[b] Total System Performance Assessment (TSPA) method in Yucca Mountain Project, etc.

II. CASES OF PARADIGM SHIFT IN POLICY

As described in Section I, fundamental ideas of geological disposal appeared in the mid-20th century, and in the latter half of the century, R&D chiefly in technical fields advanced to implement waste disposal. Based on the R&D results achieved in this way, a disposal implementation program appeared in some countries. In some countries, the program advances smoothly; however, many countries bump against “a certain wall” during a phase in which they faced specific siting problems and experienced reviews and changes in ways to proceed with geological disposal or waste management measures. Section II focuses attention on the “turning point” experienced by individual countries in their geological disposal programs around the end of the previous century, explores the background, inquires what discussions were made, and traces courses derived from discussions.

Specifically, France, Sweden, Switzerland, Germany, the United States and Canada were selected for the research.

Due to the limitation of space, brief explanations of the experiences around turning points in the individual countries are described below. Furthermore, a summary table on those experiences is provided at the Table 2.

Evolution and main turning points in French HLW disposal policy were outlined, and the siting activities up to the moratorium in 1990 were evaluated, as were R&D activities around and following enactment of the 1991 Radioactive Waste Research and Management Law. The section on France also analyzed social, economic and political factors influenced the Bataille mission and the Granite mission.

A follow-up study was conducted on changes and main turning points of Swedish HLW disposal policy. We inquired about siting activities through the 1980s, development activities shown in RD&D Program 92, and subsequent program changeover.

Evolution of Swiss HLW disposal policy was outlined and a study was made on activities of EKRA (Expertengruppe Entsorgungskonzepte Radioaktive Abfälle), an expert group to assess options for L/ILW and HLW long-term waste management. EKRA was organized by the Energy Minister in June, 1999 to amend the Atomic Energy Act and to determine how to promote the Wellenberg project.

Evolution in German HLW disposal policy was outlined and research was made on general review by Akend (Arbeitskreis Auswahlverfahren Endlagerstandorte: the disposal site selection procedure committee), a radioactive waste final disposal site selection working group founded in 2000 by Germany’s Ministry for the Environment (BMU) triggered by the coalition government launched in 1998. The role of Akend is to prepare comprehensive procedures for final disposal site selection based on scientific norms.

Evolution in U.S. HLW disposal policy was outlined. Attention was focused on siting activities up to the Nuclear Waste Policy Amendments Act (NWPAA) of 1987, background and history of events after passage of the act, background of WIPP, and public comments on Yucca Mountain and WIPP.

Finally, cases in Canada were outlined, including analysis of R&D up to the beginning of 1980s, establishment of the Canadian Environmental Assessment Agency (CEAA), formulation of the environmental impact statement, the report by CEAA (and response by the government), and recent enactment process of commonwealth law.

III. WHAT CAN BE LEARNED FROM CASES OF TURNING POINTS

In Section II, several nations which experienced changes in policies or measures were selected from European and North American countries where high-level radioactive waste disposal is relatively advanced toward implementation, and situations and background leading to such changes were addressed. Section III abstracts key issues in discussions made at the time of such turning points and describes characteristics of individual countries. Based on the abstracted information, it shows the outcome of consideration on key points in discussions and consensus-building process common to those countries.

As stated in Section I, in the 1980s, methods to evaluate viability of the disposal concept and disposal safety were shown in some countries, and movements to shift from the R&D phase to the actual disposal operation phase appeared. In the R&D phase, science and technology groups mainly took an active part. When R&D covered no specific region or certain areas were studied on condition that no repository would be built there, no strained relations with the public took place over rights and wrongs of disposal operations. However, in the phase moving toward actual disposal operations, the public -- especially local residents -- became sensitive. For geological disposal, what comes after the R&D phase is typically detailed characterization on a specific site selected to evaluate the scientific and technological suitability for a geological repository. This is valid from a scientific and technological viewpoint, and scientific and technological groups may consider it to be “unexpected” when they face opposition from local community in this phase. The groups are making very serious efforts and it is natural that they assume the subsequent plans must develop. However, what is crucially lacking is to consider what impacts would be made on the region if underground research facilities were built there or the region were named as a candidate repository site. As to the possible reasons for objections from local community in the geological repository candidate site selection phase, the following list is based on the study of experiences in the aforementioned countries:

1) Concerns over fairness of the process (Are we the least lucky of all because of the imposition of a repository).
2) Validity of selection process (whether a broad technological study was made).
3) Candidate site selection led by science and technology groups, followed by announcement of decision ("Decide-Announce-Defend" approach).
4) Selection only from scientific and technological viewpoint.
5) Concerns over the disposal concept (anxiety about a repository left uncontrolled early).
6) Concerns over influences of a repository on a local community.
7) Concerns over safety of a repository.

Meanwhile, some countries asked the public to comment on the viability in the disposal concept phase, for example Canada. Based on knowledge obtained through R&D in laboratory and in underground research facilities, Canada built a disposal concept and held public hearings throughout the country with a focus on Environmental Impact Assessment (EIA), a preliminary survey of the safety, and received evaluation of the viability of geological disposal. In this example, the following points are given regarding the decision on geological disposal as a social matter:

8) Identification of important persons concerned and communication.
9) Concerns over the rigid disposal concept.
10) Concerns over disregarding other promising technological development

The item 9 involves a factor leading to disposal concept review including flexible selectivity by future generations, which triggered discussions by EKRA in Switzerland.

The item 10 is similar to an issue presented in a phase of investigation of new measures in France, which triggered broad discussions in society on options, including multiple options should be pursued in parallel with geological disposal R&D for the time being.

III. A. The Disposal Concept Involving Flexibility

The initial concept of geological disposal was to backfill a repository shortly after emplacement of waste and to isolate the site from the human environment on the basis of safety.

Until the 1980s when R&D by experts was dominant, such early isolation was acknowledged among experts as the disposal concept, and concrete R&D and candidate site selection started to implement geological disposal based on this concept. During this phase, protest campaigns by citizens took place in several countries, which led to the start of reconsideration of the plan.

In this phase, the discussion by many of the waste management authorities started from a viewpoint, "what is the desired judgement society should make on a problem with significant temporal and spatial uncertainties, like geological disposal?"

One of the strong arguments involved is how to demonstrate the safety of high-level radioactive waste disposal when potential risk lasts one to several thousand years. It is a matter of decision-making; what is the best choice for society on something whose safety we cannot demonstrate in the strictest sense? And the science and technology side seeks to solve it by designing adequate repository in deep geological formation with appropriate characteristics, emplacing wastes in it, and isolating it early. Against such ideas, the public has concerns over releasing control of wastes early without checking them; in other words, we might abandon countermeasures against uncertainties involved in the disposal system.

An idea emerged in Sweden (see KASAM, SKN, and SKB's RD&D 92) that a phase could be added to the disposal process so that limited demonstration becomes possible as in Swedish program, although it is inexact. This method is more flexible in that all of disposal is not decided in the beginning phase; rather, the safety of disposal is confirmed in a limited early phase and a decision is made again. It is to consider intergenerational waste management responsibilities, future options, and the balance. Specifically it proposes a step-by-step approach that decisions are made several times for public consensus. And discussions on reversibility are one of key elements in the approach--more specifically, retrievability of waste.

Today, after the turn of the century, it seems the stepwise approach becomes established as a general method as a result of past experiences in some countries. And some countries advocate considering reversibility or retrievability of wastes in their program.

In France, during the one-year moratorium, the parliament discussed how to proceed with waste management including high-level radioactive waste disposal. One of the important subjects was to review the irreversible process that was the concern of people. As a result, the Act on Waste Management Research (the 1991 Waste Act) embraced the promotion of geological disposal study including reversibility of process and/or retrievability of wastes.

For Sweden, people's concern over irreversibility is not noticeable from literature survey. However, in discussions by KASAM from late 1980s on how to proceed with disposal, they selected an improved method that, considering responsibilities of the current generation who plans disposal and options of future generations, enables future generations to select another way such as turning back.

For Switzerland, they considered that the HLW disposal site issue would come after solving the low and intermediate waste (I/LLW) repository siting problem. However, the I/LLW repository site selection problem did not go so smoothly due to opposition from the public. Because of this and possible influence of internationally developed discussions on reversibility, experts (EKRA) reviewed the radioactive waste disposal issue, the greatest challenge in revising Atomic Energy Act, and advocated the monitored long-term geological disposal concept that intends to promote the compatibility of disposal and reversibility.

For Canada, on public hearings held in the environmental impact assessment review phase, they respected opinions proposed by the interested parties and decided that the disposal concept would be discussed again mainly in a new body to be founded. The Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel reached the following recommendation:

"With regard to the AECL disposal concept, the Panel believes that better technologies for safe post-closure monitoring and retrieval must be developed and incorporated. These modifications would not only help provide the degree of security needed to earn public confidence; they would also satisfy the need to strike a balance between minimizing the responsibility placed on future generations and maximizing their choices."

For Germany, they see the selection procedure itself as a problem, and it is not easy to know to what extent the discussion on reversibility is dominant. In four countries excluding Germany, it is seen that the reversibility of disposal, a main concern of the public, is discussed at the turning point of policy or measures, and it is becoming a key element in subsequent policies or the way to proceed with disposal.

For radioactive waste with great uncertainties, it is natural to take it that reversibility (to put it plainly, whether we can retrace our steps) is a main concern of citizens when they face an issue with which they cannot have persuasive affirmation of long-term safety.

III. B. Sharing Problems -- Communication

This element is not reported so clearly as reversibility described in the previous section. However, for example, in the French case, the foundation of Local Information and Monitoring Committee (CLIS) for underground research laboratories (URLs) site selection after the turning point was an event not seen before the turning point. In the Swedish case, they got one step further. They took up a citizen-based decision-making style; the local municipality plays a central role in arguing rights or wrongs of acceptance of a research site and then decision is made (the Oskarshamn case). For Canada, AECL actively proceeded with study and practice for building social consensus even before the turning point. In the EIA review phase, a process was established in which more Canadian citizens participate (the environmental impact assessment process).

It can be said that almost all countries share a common understanding of going forward while talking with citizens. However, on that condition, this must be clearly shown in a concrete plan. Regarding this matter, it is not too much to say that just talking is ineffective if it does not involve any concrete implementation plan. An elaborated plan, competent people to implement it, and a system that can practice it effectively are needed.

III. C. Impasse of Site Selection Process Led by Science and Technology

This typically applies to the French case. Their selection method before the turning point was to establish scientific and technological criteria, select a site that meets the criteria, and then inform the local community of it. The Swedish siting method before the turning point was close to the French method. Obviously, protest campaigns took place in some municipalities and this hindered research in sites. SKB experienced a phase in which they had to change over to desk studies. In the German case, although protest against the Gorleben candidate repository site was not so intense as in France, the procedure of selecting the candidate site itself was seen as a problem in the wake of the inauguration of the coalition government. And today, after the lapse of a quarter century, they are discussing democratic site selection procedures again. In the Canadian case, disposal into crystalline rock in the Canadian Shield was established as a concept, and selecting a site in Ontario where many nuclear power stations exist was decided. To demonstrate viability of the disposal concept, underground facility was constructed near the site of Atomic Energy of Canada Limited (AECL) in Manitoba to proceed with the R & D activities. The results were compiled in Environmental Impact Assessment Report and public hearings were held all over the country with the public. After that, Environmental Impact Assessment Panel reviewed the assessment and the government drew conclusions on the environmental impact assessment. One of the government conclusions was that the disposal concept should be re-examined because, although the concept technically attained the level deserving evaluation, the social consensus was not reached sufficiently. In the Canadian case, although they did not have a site selection phase in the strict sense, they make it a rule not to enter a siting process as long as the public does not support the disposal concept. It was indicated that social consensus building activities by AECL were less sufficient compared to R&D.

As for four countries described here, although they had turning points at different times, they have common indirect or remote causes of the turning point, namely their siting process based on only scientific and technological examination reached an impasse. It is natural to take it that a municipality applying for public offering of a candidate facility site that involves safety issue lasting for millennia (to their remote descendants) may expect something favourable to their local community in return for facility construction. It is desired that advantages and disadvantages brought by the facility to the local community, i.e. social impacts, should be communicated honestly, and then a decision should be made based on full discussions by the local society. To that end, it is necessary that technical and other information needed for local residents to make their own judgements is disclosed, that the decision-making process is clear and open, and that the framework for discussions and decision-making that local residents can join in is in place. These are the basic principles of risk communication.

IV. CONCLUSION

The basic framework for promoting HLW repository project in JAPAN has been formulated by the "Specified Radioactive Waste Final Disposal Act" of 2000. Based on the legislation, the implementer, Nuclear Waste Management Organization of Japan (NUMO), was established and a three-step siting process was set up: selection of preliminary investigation areas, selection of detailed investigation areas and selection of a site for repository construction.

On 19 December 2002, NUMO officially announced the "Start of Open Solicitation for Volunteers for Preliminary Investigation Areas for a HLW Repository".

Through our study on the Evolution and Major Turning Points, we could learn valuable information and identify common factors for promoting repository projects in several countries' experience. At this moment, it appears from the study that a flexible decision-making system is recommended, which goes beyond the existing idea and policy, so that the project could be smoothly developed. The timeframe that must be considered is very long, and the policy should take account of the uncertainty associated with such a long timeframe.

REFERENCES

1.NAS/NRC, The Disposal of Radioactive Waste on Land, September,1957
2.OECD/NEA, Disposal of Radioactive Waste, An Overview of Principles Involved, 1982
3.IAEA, Safety Principles and Technical Criteria for the Underground Disposal of High Level Radioactive Waste, Safety Series No. 99, 1989
4.OECD/NEA, Disposal of Radioactive Waste: Can Long- Term Safety Be Evaluated? , An International Collective opinion, 1991
5.OECD/NEA, The Environmental and Ethical Basis of the Geological Disposal of Long-Lived Radioactive Waste, 1995
6.OECD/NEA, Strategic Areas in Radioactive Waste Management, 1999
7.Law No. 91-1381 of 30 December 1991 on Radioactive Waste Management Research, 1991
8.EC, Concerned Action on the Retrievability of Long-Lived Radioactive Waste in Deep Underground Repositories, 19145EN, 2000
9.KASAM/SKN, Ethical Aspects on Nuclear Waste, SKN Report 29, 1988
10.SKB, RD&D Programme 92
11.SKB, Clase Thegerstrom, The Swedish Approach to Spent Fuel Disposal-Stepwise implementation and the Role of Retrievability, 1997
12.EKRA, Disposal Concepts for Radioactive Waste, Final Report, January 2000
13. AkEnd, Site Selection Procedure for Repository Sites, Recommendations of the AkEnd, December 2002
14.BfS, Jahresbericht 2000
15.Nuclear Waste Policy Amendment Act, 1997
16.US.NRC, NUREG/CR-6513: High-Level Radioactive Waste Program Annual Progress Report Fiscal Year 1996
17.U.S.NRC, Issue Resolution Status Report Key Technical Issue: Total System Performance Assessment and Integration, September 2000
18.US.NRC, 10 CFR 63, Disposal of High-Level Radioactive Wastes in a Proposed Geologic Repository at Yucca Mountain, Nevada, Final Rule, November 3, 2001
19.NAS/NRC, One Step At a Time, 2000
20.AECL, Environmental Impact Statement on the Concept for Disposal of Canada's Nuclear Fuel Waste, AECL-10711, COG-93-1, September 1994
21.CEAA, Federal Environmental Assessment and Review Process, Report of the Nuclear Fuel Waste Management and Disposal Concept Environmental Assessment Panel, February, 1998

Table2 Experience around turning point in the individual countries (1/2)

	1. France	2. Sweden	3. Switzerland	4. Germany
Turning point	1989-1991	1987-1992	1998-2000	1998-2002
Background leading to turning point. Main factors.	➢ Science-and-technology-led site selection process. ➢ Typical DAD approach. ➢ Consequential vigorous opposition.	➢ Science-and-technology-led site selection process. ➢ Establishing the concept（KBS-3）in an early stage. ➢ Protest against laboratory site survey and boring survey. ➢ Suspension of field survey.	➢ Active promotion of R&D. ➢ Low and intermediate level wastes disposal site problems ➢ The HLW disposal site issue is not urgent. ➢ Amendment of Atomic Energy Act (argument on rights and wrongs of future nuclear energy development).	➢ Early establishment of the geological disposal concept (in 1960s). ➢ Implementation of in situ testing. Assignment of Gorleben candidate site and commencement of research. ➢ Start of the coalition government in the autumn of 1998.
Characteristics of situation at turning point	➢ Efforts toward solutions led by Parliament and the members. ➢ Legislation of a new bill considering public opinion. ➢ Turning back from the selected research site phase to the concept study phase.	➢ Review of the comprehensive approach for the management of long-lived radioactive waste led by the government including broad sectors in society. ➢ Formulation of RD&D Program 92 by SKB, an implementation body. ➢ The process advances with no major regression.	➢ The disposal concept was almost established through accumulated R&D. But it started examination going back to assessment of the waste management concept. ➢ It encouraged public debate on radioactive waste management issues. ➢ Proposal of the monitored long-term geological disposal concept that intends compatibility of disposal and reversibility, and recommendation on study of involved monitoring and retrieving wastes.	➢ Review of site selection procedures. (Was the selection of Gorleben valid from scientific and social viewpoints?) ➢ BMU founded Akend, the site selection procedure committee.
Topics of development after turning point	➢ Starting construction of Bure underground laboratory ➢ Siting of underground laboratory in granite region was deadlocked by local resident opposition. ➢ Full-fledged review of retrievability by the National Assessment Committee.	➢ Objection expressed in two northern municipalities on detailed research. ➢ Six municipalities including Oskarshamn and Osthammar agreed on feasibility study. ➢ Oskarshamn and Osthammar decided to accept site characterization.	(Atomic Energy Act is being revised)	➢ Akend recommendations in December 2002, titled “Site Selection Procedure for Repository Sites” ➢ “To develop a traceable procedure for the identification and selection of a site for the disposal of all types of radioactive waste”
Characteristics of policy changeover	Large-scale changeover after facing blocking by force. Turning back to the concept study phase.	Changeover by (calm) discussions based on experience. Subsequent development looks almost good.	Changeover within the framework of nuclear policy discussions.	Indication of changeover in conjunction with government and policy changes.

Table2 Experience around turning point in the individual countries (2/2)

	5. United States	6. Canada
Turning point	1982-1987	1989-1998
Background leading to turning point. Main factors.	➢ Early proposal of the geological disposal concept (originally they regarded salt-layer as promising, and later widened scope.) ➢ Conducted wide-area research ➢ Review in IRG ordered by President Carter. ➢ Legislation of the Nuclear Waste Policy Act of 1982 (NWPA). ➢ Budgetary problems over implementation of site characterization in multiple sites (budget cutback).	➢ Early establishment of the geological disposal concept (the Hare Report, 1977) ➢ Protest movement in some regions including Ontario. ➢ Indication of insufficient social consensus through review of EIA.
Characteristics of situations at turning point	➢ NWPA established procedures of selecting three candidate-sites, doing characterization on those, and finally selecting one. Only Yucca Mountain was selected due to political factors.	➢ Social consensus in the disposal concept was their goal. ➢ Implementation of nation-wide hearings on EIA. ➢ Collection of various opinions raised in the hearing stage. ➢ Scientific study on EIA and negative assessment by the government. ➢ The government reported that social consensus was insufficient.
Topic of development after turning point	➢ Under Energy and Water Appropriation Act of 1997, DOE prepared Viability Assessment of a Repository at Yucca Mountain in 1998. ➢ A report by General Accounting Office in December 2001 indicated nearly 300 pending issues. ➢ In 2002, NWTRB brought out various-level merits and demerits of the disposal system proposed by DOE in a letter addressed to Congress. ➢ In 2002, Secretary of Energy (DOE) recommended a site to President and President conveyed his assent to Congress. ➢ Yucca Mountain was selected as a candidate disposal site through the congressional authorization.	➢ Canada approved Bill C-27, "Long-term Management of Nuclear Fuel Waste" ("Nuclear Fuel Waste Act") and established future directions.
Characteristics of policy changeover	The method to select one from multiple sites was changed, and a candidate site was singled out politically.	Sociological studies were made; however, the government concluded they were insufficient. Moderate changeover centered on the environmental impact assessment.