

International workshop on Record Management and Long-term Preservation and Retrieval of Information regarding Radioactive Waste

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International workshop on
Record Management and Long-term Preservation and
Retrieval of Information regarding Radioactive Waste

Preface

This report compiles the presentation and discussion at the International Workshop on Record Management and Long-term Preservation and Retrieval of Information regarding Radioactive Waste held by RWMC(Radioactive Waste Management Funding and Research Centre, Japan) and SKB(Swedish Nuclear Fuel and Waste Management Co.) in Rome on January 27-28, 2003.

RWMC has been aiming at providing information for the government and related bodies to utilize in formulating programs as a component of the institutional control concerning geological disposal. In this study, we've considered " Who, How long, For whom, What kind of records should be preserved. And How?" Furthermore, in order to show the technical possibility of long-term record preservation, we developed the new record preservation method called LASER-GLYPH using sintered silicon carbide thin plates and engraving their surface by the laser marking system.

The objective of this workshop is not to reach official consensus, but to inform each other on the present status concerning record preservation. Twenty-three experts from 12 countries, IAEA and OECD/NEA participated in the workshop and discussed on this issue.

The main points of discussions were as follows,

- Regulations regarding "Knowledge Management" not fully developed in most countries.
- Motives and key issues are slightly different between the programs.
- Systems for identifying important knowledge/records/documents are developing and are in some countries in the stage of implementation.
- "Knowledge management" is an important field for all programs and needs further attention (visions-policy).
- The development on technical media continues (and will continue).
- The question on the need for international archives has been raised and several views have been expressed. This question has to be discussed on a regular basis since repositories for LLW and ILW are implemented and plans for implementing repositories for HLW are well under way in some countries.
- Early actions on knowledge management issues will improve the possibilities for future generations to make informed decisions regarding radioactive waste issues.

To within a year or two have an international expert meeting for compiling the changes from the current established baseline as presented at this Rome workshop, preferably such a meeting should be anticipated held by an international organization such as IAEA and OECD/NEA. Clarification of remaining issues would be another task for such a meeting. At the next meeting it might also be considered to broaden the discussion by also inviting other stakeholders. Views from other industrial fields might also be a good approach to get a perspective on relevant measures for the future.

All presentations in the Workshop were distributed to the participants as electric files in CD-ROM. In this report, we attached only RWMC's presentations.

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1. The Workshop

1.1 Opening of meeting

The workshop started with a presentation round with all session around the table. Mr *Ken Bragg* from IAEA noted *the blend* of people from different areas present - from technicians to archivists - which he thought would stimulate the discussions throughout the workshop. Mr Bragg stressed a shift in focus within the field “practical reality applications”, i.e. serious decisions by governments to do something in reality for the record keeping needs for the future.

He also pointed out that the context (on record keeping and retrieval) of information might and probably will change with time – how do the process/system on “knowledge management” adapt to such changes?

The questions to keep in mind when working in this field are:

- What are we practically doing today on “Knowledge Management” – can we do more?
- Why are we doing these measures and for whom?
- What are the vision and the philosophical intent?

Mr *Takao Tsuboya* from RWMC gave a presentation on the background for the workshop. He stressed that a passive safety system needs to be prepared. Record preservation will constitute an important part of institutional control of future geological repositories.

Future institutional control is foreseen to consist of a social side and a technical side. In Japan the start has been to look at the technical side. The implementation phase of a geologic repository for HLW in Japan started in year 2000 and now the most important issue is to obtain public trust and confidence for the waste management programme. One element to build such trust can be to ensure that the information on the repositories will be kept in a good way.

RWMC described that the main objectives of record preservation are preventing future generations from unintentional access to the repository, and providing future generations with information necessary for decision-making on the repository. Therefore record preservation is to be considered to be a very important part of future institutional control. He also quoted the IAEA TECDOC-1097 report where it is stated that a record management system may be a good way to communicate information to future generations.

RWMC’s record preservation study aims to inform governmental bodies regarding “Knowledge Management” issues. This work can later be used when programs for developing institutional control components are formulated. Important questions right now are: “Who? How long? For whom? What kind of records and how?”

As a technical issue a new media type has been developed - the LASER GRYPH record preservation method. In this method the valuable information is laser engraved on thin plates of sintered silicone carbide.

1.2 Nordic study of record keeping

Mr *Mikael Jensen* from SSI, Sweden, gave a presentation of the KAN 1.3 study.

This study was a common Nordic study regarding how to deal with information on radioactive waste repositories and the information transfer to coming generations. The workgroup that conducted the study consisted of Governmental bodies, Universities, Archives in the Nordic countries and implementers of systems for taking care of radioactive wastes. The goal was to form a common Nordic view on these issues.

Information conservation – Why, What, How, When? This will serve as a base for proper future decisions in regard to unintentional/intentional intrusion.

Stakeholders - which are the interest groups? Which system and vision are used to determine what information to preserve? To understand the general background information you must also have an understanding of the context and the reasoning behind the decisions taken.

A few conclusions in the KAN 1.3 study:

Data on repositories must contain information on

- Geographic location (community, county board, authorities).
- Layout and design (SKB, authorities, repository).
- Source term (High level waste, LLW and ILW).
- Safety analysis (SKB, authorities, repository).

Data characteristics on the information to be preserved:

- Overall relatively small volumes of data.
- Only small additions to the database are made each year.
- A lot of the information is on digital media.
- All information has been saved/no culling has been made.

Archives – After the repository has been closed the information shall be preserved as long as possible. Archiving aims at reaching physical, logical and technical durability.

The case studies of the KAN 1.3 project show the German Landesarchiv despite several war times have suffered few losses. The Vatican archive has been moved several times and has been subject to attacks on several occasions throughout its long history. Still, however, a large part of the original documents remains intact.

The KAN-study concluded that for archives a summary and duplication strategy is recommended: A “Primary Information Set” – consisting of originals regarding research, safety assessments, operation issues etc – can be collected.

Second and Third Level Information Sets” (summaries and conclusions/copies of important parts of the “Primary Information Set”) are to be placed regionally, nationally and/or internationally – e.g. a summary of 1-10 volumes with references plus duplicates of valuable information.

An idea could also be that countries could “exchange archives” to ensure physical distribution of the information sets.

Only Finland so far has a law specially demanding delivery of a well structured archive after that the deep repository has been closed.

Summary

- There is a need for information conservation regarding HLW repositories for at least 1000 years.
- A multi component strategy is recommended for information conservation (Archives, Markers and Information in society).
- Paper and microfilm are today State-of-the-art of durable information media.
- Magnetic and optic media are excellent for producing durable information sets, but are not durable themselves.
- For archives a summary and duplication strategy is recommended. Creation of Second and Third Level Information Sets to be placed regionally, nationally and/or internationally.
- Some simple marker systems should be considered.
- For information conservation regarding nuclear repositories worldwide, an international archive would be valuable. The working group recommends that such an archive be formed.

1.3 Presentation by Mr. Ken Bragg, IAEA

New ideas related to the transfer of information and the use of contextual frameworks as they apply to radioactive waste management was discussed by Mr *Ken Bragg*, IAEA.

The problem is that institutional control will put a burden on future generations, which might not be acceptable.

Every generation should be able to

- Make conscious and active decisions.
- Take necessary technical actions to mitigate any dangers or hazards.

To make sure that the above options are valid the relevant information has to be transferred to the coming generations.

The transfer of the contextual framework is very important. This can be done through a Framework database (meta data with links) on the Primary databases, where the ability to make intelligent searches is a fundamental issue. Multiple links will decrease the risk that the information can't be accessed and ensure that the information is widely accessible.

The Contextual framework concept can give answers to many questions: Who generated the information and for what purpose? Why has action x been carried out? This kind of information will mirror the time in which the actions were done – hence a context is formed.

Mr Bragg suggested the evolution of a “multiple archive concept” as earlier taken up in the KAN 1-3 study. IAEA could have a leading role in such a development. An IAEA archive would need:

- Support from the participating states.
- That it would constitute a substantial project with long term funding.

The initiative must in any case come from the member states and not from IAEA.

Knowledge Management is another important issue – people in the industry are aging and it is important to bring the collected knowledge on radioactive waste management to the young generation

1.4 OECD/NEA study

Dr *Claudio Pescatore* from OECD/NEA referred to the report “Future Human Actions at Disposal Sites” from 1995. This report focused on geological disposal.

Dr Pescatore stressed the importance of bringing the knowledge of the context behind all information collected.

He then put the question: When do we need record preservation?

Activities plus institutions require records. Therefore as long institutions exist we need records.

Why do we need preservation of records?

- Mitigate human intrusions.
- Deep repository is passive safety. The existence of records gives further safety.
- We must not deprive future generations the possibilities to make informed decisions.
- Control requires records.

How could we do this?

- Conservation of records.
- Information in society [compare with KAN 1-3 conclusions].
- Durable media – Paper 100 years; microfilm 100-200 years; magnetic disc – very few years. This leads to the conclusion that we should consciously duplicate our information.
- Memory in society.

Communication issues:

- Records are not useful if no one is aware of them.
- Information has a tendency to degenerate and migrate.
- Information should be kept simple.
- Mark out the geographical locations of facilities on maps.

Long-term preservation issues:

- The preservation should be constantly monitored and be kept state-of-the-art.
- There must be a legal framework to support the preservation.
- The National archives must be part of the systems.
- There should be references on the intranet..

Conclusions:

- Actions on preservation are mainly to prevent human activity at the sites.
- There should be clear requirements on retrieval of information from the systems created.
- There should be monitoring requirements on the status of the preservation systems.

1.5 US studies regarding marker systems

Professor Stephen Hora from University of Hawaii at Hilo presented work made at Sandia National Laboratories for the US Department of Energy. There were two studies involving panels of experts:

- Four teams of experts addressed future inadvertent actions that might violate the repository.
- Two teams of experts created marker systems as a defense against these intrusions.

The first study found a number of activities that might influence a repository in the future:

- Drilling or mining.
- Future expansions of the repository.
- Injection disposal wells.
- Archaeological investigation.
- Dams.
- Underground weapons testing.
- Weather modification.
- Irrigation.
- Tunneling.
- Water wells.
- Other scientific investigations.

The markers expert teams had experience on:

- Language.
- Materials.
- Architecture.
- Astronomy.
- Social Science.
- Semiotics.

In the marker system study the design basis for the markers were that they must be effective in warning potential intruders and that they would have a durability of about 10,000 years. They should also form a redundant system.

Professor Hora showed a number of different suggested marker designs and discussed different levels of the information that might be displayed on the markers.

1.6 RWMC study on record preservation

RWMC has made a study on the Record Preservation for HLW Geological Disposal –Significance, Methods and Technical Feasibility. This study was presented by Messers.*Jin Ohuchi*, and *Kazutoshi Sugiyama*, RWMC and *Professor Nozomu Matsubara*, University of Tokyo. The presentation was divided in the following parts:

- Part-1...Significance & Requirements.
- Part-2...Robust system & durable technology.
- Part-3...Examples of Long-term Record Preservation in Japanese History.

Mr Ohuchi presented the Part-1, Suggested system for long-term preservation of information in Japan.

A study has been done by RWMC through discussions at a Technical Committee with experts from the following disciplines:

- Social science / statistics.
- Journalism.
- Information system.
- Archives.
- Philosophy / semiotics.
- Archeology / cultural anthropology.
- Material science.
- Nuclear engineering.
- Expert of geological disposal.
- Implementer of geological disposal.

The goal of the work has been to provide a menu for the government and the related bodies, such as implementing entity and municipalities, to realize their record preservation system.

In the group they studied the significance of record preservation for geological disposal and clarified the requirements and adaptable elements for designing a robust record preservation system. "Record preservation" in this study covered in a broad sense record keeping, retrieving documents, communication by markers & monuments, etc.

The reason for the study was that:

- Long-term preservation of information is a legal requirement in Japan.
- Prevent future generations from unintentional access to the repository.
- Provide future generations with information necessary for their own decision-making on the repository.
- Confidence building ...the achievement of "intergenerational equity" by choosing technologies and strategies which minimize the resource and risk burdens passed to future generations by the current generations which produce the wastes. (OECD/NEA, 1995).
- Meta signal to the current generation:
... "Do our best" for the future generations might be the conscious message to the current generation to implement geological disposal.

The Japanese programme to achieve a robust and redundant system comprises:

- Classify the society models.
 - Ability of understand preserved information.
- Investigate the historical & current record preservation and extract elements.
 - Clarify adaptability of elements for requirements of each society model.
- Strengthen robustness & redundancy.
 - Durable recording technology etc.
- Design in trial a record preservation system.
 - Integrate elements to meet the requirements.

Integrating several adaptable elements would impart redundancy to communicate to the future generations and also impart robustness to maintain the overall function even though partial damage, thus resulting in a flexible preservation system adaptable to future changes of society.

Mr Sugiyama presented the Part-2, technical basis of long-term preservation. Of special interest has been recording media of which material and recorded characters has long-term durability, and is independent on the environment where it is stored. Silicon carbide was found to have the hardness, density, engraving capabilities etc that would be interesting for a recording material. The conclusion was that Laser engraving technology on SiC plates can be used for documentary records and even face plates of future monuments etc.

Professor *Nozomu Matsubara* presented the Part-3 on the examples of long-term record preservation in Japanese history. There are many historic records and monuments from Ancient in Japan. Especially old documents have remained since 8th Century or older ages, and combination of Japanese paper and Chinese ink has had superiority as long-term media for documents. He explained that current Japanese generation could understand the Chinese message engraved on the discovered iron sword from 5th century.

1.7 Presentations from different countries

Presentations were given from the different countries regarding their Record Management Systems, the possibilities and ideas/plans/actions taken for long-term preservation and retrieval, considered marker systems etc.

1.7.1 France(Phillippe Raimbault, DGSNR)

Preservation of information on waste disposal have been considered in France in two areas:

- For licensing the Centre de la Manche(CSM) to enter the surveillance period after completion of its operational period.
- For regulatory guidance regarding the development of deep disposal of high level and intermediate level long-lived waste.

For CSM, the information has been preserved in duplicate at CSM and the suburbs of Paris. Detailed information on the disposal should include :

- information on the different components of the disposal and their emplacement (structures, cover, water collection and drainage system) ;
- data concerning the waste inventory, the waste characteristics and its location in the disposal structures ;
- data concerning the monitoring of the site and its environment ;
- data concerning past incidents, detected defects and the associated maintenance operations.

For geological disposal, Basic Safety Rule, RFS III.2.f, issued in June 1991 by DSIN. The basis of this regulation is that protection of people and the environment be provided against risks associated with the dissemination of radioactive substances in all the situations considered without depending on institutional control which may not be guaranteed beyond a limited period of time. Retrieval was not considered in that rule.

It is considered that memory of the repository will be kept for 500 years making inadvertant intrusion in the repository area extremely unlikely. This memory will depend on the durability of the measures implemented :

The surface markers have been the subject of some development in France in the framework of the NEA Working Group on the Assessment of Future Human Actions at Radioactive Waste Disposal Sites which produced a report on the subject in 1995.

Surface markers may consist of solid constructions designed to last many thousand of years and be interpretable by future societies, or may consist of simple fences and warning signs having a lifetime of only some decades. Some people have argued that, far in the future, the message concerning the hazard associated with the repository might not be properly understood, and that markers may stir up

curiosity and incite people to perform underground exploration and thus increase the risk of human intrusion.

In France, a novel type of marking system was proposed. Markers should not be located directly above the repository but at some distance, like 10 to 20 km away, in order to limit the risk of intrusion due to curiosity by people unaware of the risk but still informing people about the location of the repository if they can appreciate the risk.

1.7.2 UK(Ian Upshall, NIREX)

A study of the issues concerning the preservation of information and records relating to radioactive waste was undertaken by Nirex between 2000 and 2002 with a view to providing the basis for discussion and as input to the development of a national radioactive waste information management strategy.

Organisations responsible for the safe management of radioactive waste in the United Kingdom have long recognised the importance of preserving information about radioactive waste. Current regulation regarding the management of waste-related records is principally focused on safety and environmental imperatives. However, in order to meet our aspirations to enable future generations to safely manage our radioactive waste and to inform the decision making process, we have to carefully consider the long-term value of all related information.

The development of a national radwaste information management strategy should take due cognisance of the objectives and characteristics of existing ‘local’ systems developed for operational needs. •

A robust information management system will include the identification of threats to long-term access and implement appropriate measures to counter these threats. These measures will include a combination of appropriate media, controlled environments, planned migration, clear accountability, preservation of meta-data and agreed system objectives.

The British Radwaste Information Management System (BRIMS) offers a tool for the long-term management of radioactive waste information the development of which has been focussed on the need to maintain access to data. Further development of the system is to take place that will ensure it becomes the recognised standard providing a reliable source of strategic information on which future waste management activities in the UK can be based.

1.7.3 Spain(Jose Antonio Gago, ENRESA)

The rationale of record preservation are 1) intentional or involuntary human intrusion in the repository, 2) needed for confidence building and public acceptance.

In Spain, all existing standard requirements for nuclear installation only touch the “philosophical” aspects and do not explicitly cover the closure and post-operational phase

The most critical aspects for record keeping are:

- Repository location
- Source terms and contents
- Conceptual and “as-built” design. Layout
- Background material, including rationale
- Preserving the information in the long-term

1.7.4 Switzerland(Anne Claudel, NAGRA)

Law valid for organisations to whom the government has delegated some of its activities 1) Any information which might be useful from an historical, juridical, social, economical, political or cultural

point of view should be archived. 2) Archives can be managed by the organisation or transferred to the Federal 3) Archive The Federal Archive has guidelines for document classification and archiving.

In Swiss Nuclear Safety Inspectorate, Guideline R-21: Protection Objectives for the Disposal of Radioactive Waste is following,

“ It is [...] to be assumed in the safety analysis that future generations will not take measures to protect themselves from the exposure to radionuclides released from the repository. The applicant should, nevertheless, take measures to preserve information on the repository, including its location, design and wastes which have been emplaced. This is intended to reduce the likelihood of an unintentional intrusion into the repository“

In Swiss New Nuclear Energy Law, although it is under discussion, there are some articles concerning record preservation.

- Art. 37, Documentation requirements: Repository layout, waste inventory as well as a complete set of safety-relevant information gathered during the monitoring phase
- Art. 39, Post-closure safety: The Federal government is responsible for the preservation of information regarding the waste as well as the repository and the surrounding area. The government may forward information to other countries or international organisations. It can prescribe the use of markers.
- Art. 40: Geological data gathered during site investigations and repository construction should be forwarded to the Federal government upon request.

The current situation of information Management at Nagra are following;

- Key processes are documented
- Relevant and up-to-date information is registered and filed
- Relevant information is indexed to allow for easy retrieval
- Information is available to all who require it during the projects
- Information can be reused for later projects
- Sensitive documents are marked accordingly
- Obsolete documents are marked accordingly
- Documents are safely archived over prescribed time periods
- At present: pre-operational documentation

The important issues of record preservation are fall into two types, one is information management issue and the other is knowledge management issue.

- Information management
 - selection policy
 - information access: terminology, classifications
 - organisation of project documentation
 - physical preservation of information
- Knowledge management
 - exhaustivity
 - continuity

1.7.5 Belgium(A Berckmans, NIRAS)

Preservation and retrieval of information is part of Knowledge Management System (KNM), and now it is at start-up phase.

General objective of KMS are following;

- Structure all acquired & still to acquire knowledge
- Archive & create cost effective multilevel access
- Assure QA/QC
- Use narrative / learning approach
- Strive to transparency & traceability
- Software vendor as independent as possible
- Strive to multi-disciplinary integration

Future plan of KMS is following;

- 2003
 - Develop strategic implementation plan
 - Start communication with stakeholders (scientists)
- 2004-2005 :
 - Implement infrastructure
 - Test pilot project
 - Communication effort / motivate culture change
- 2005-2010 :
 - Recover past
 - Implement day-to-day use

1.7.6 Hungary(Milhaly Nagy, PURAM)

In July 1997, Act CXVI, legal base of radioactive waste went into force. PURAM (Public Utility for Radioactive waste Management) was established as management entity of spent nuclear fuel and radioactive waste by government. The operational records of radioactive waste are preserved and the annual report has been published. The issue of record management is to establish the national archives.

1.7.7 Italy (Anselmo Farina, APAT)

The Computerized Inventory on Radioactive Materials, named SIRR, is a project aiming to create an inventory that may support the institutional activities of the APAT as nuclear Regulatory Authority in Italy.

The SIRR allows to follow the history of the radioactive waste by recording any eventual transfer, treatment, conditioning process. It is possible to recover all the history of a particular waste.

Until now the problem of keeping data for a long term is not yet considered because the rule of APAT is to follow the present inventory and to keep the information of the recent past. The important task of record keeping for long time it will be considered in a much more detail when an organisation responsible for RW management and disposal will set up.

The problem of the record management and long-term preservation and retrieval of information regarding radioactive wastes disposal was considered in the technical standard UNICEN 202 (2002) "Information management system for the disposal of Cat. 2 packages " issued by UNI (Italian Agency for Standardization).

This technical standard focuses the following topics:

- Identification of the data that have to be kept

- Indexation, traceability and retrievability of the data
- Classification and the service life of the records
- Support (medium) of the data
- Protection of data from damaging environment
- Control of the access to the data
- Periodical duplication of the data

1.7.8 Canada(Ken Bragg, IAEA)

The Canadian studies focus on institutional control and information transfer to coming generations. To maintain long-term safety there must be some form of institutional control.

A multi-disciplinary group was formed containing historians, anthropologists, economists, archaeologists etc. The group concluded that there is no proof for the effectiveness of institutional control. The future effectiveness depends on the survival of institutions and/or bureaucratic functions. Passive institutional control will generally outlasts active ones.

The recommendations from the group were:

- Develop case studies.
- Design long-term institutions to look after radwaste facilities.
- If institutional controls are to be relied upon, provide information of the institution exercising the controls.
- Put information on waste facilities on national topographic mapping databases and link to international map publishers.

1.7.9 Netherlands(Maarten de Vos, COVRA)

In Netherlands archive law regulates the governmental report will be preserved at least for 100 years. No specific regulations for record preservation of radioactive waste exists. The record of GKN (shut down NNP) was handed over to National Archive institute (30 years, 1966-1997)

All radioactive waste data has been preserved on paper and digital from 1982.

In 2003, “archive policy” project will be set up. Task of the project is to create management system and the period, record type and methodology will be discussed.

1.7.10 Japan(Jin Ohuchi, RWMC)

In June 2000, a law relating to final disposal of specified radioactive waste was officially announced and implementing entity and fund managing entity was established.

In December 2002, the implementing entity NUMO (Nuclear Waste Management Organization of Japan) started selection of preliminary investigation areas.

Record preservation on geological disposal was specified in specified radioactive waste act, and METI (Ministry of Economy, Trade and Industry) are responsible for eternal record preservation on geological disposal.

RWMC's record preservation study aim to provide information for government and related bodies to utilize in formulating programs on the record preservation.

1.7.11 Sweden(Ann-Mari Ekendahl, Per-Olof Lindberg, SKB)

In Sweden, the record preservation of nuclear facilities are implemented based on a rule regulating the record management and preservation.

The new project “A 100K” started in 2002. The objective of the project is integrating the information of waste management of SKB (confirmation, preservation and searching) and establishing the knowledge management system.

2. Discussion

Mr *Torsten Eng*, SKB, Sweden started the discussion showing some observations from the presentations from the different countries:

- Regulations regarding "Knowledge Management" not fully developed in most countries.
- Motives and key issues are slightly different between the programmes.
- Systems for identifying important knowledge/records/documents are developing and are in some countries in the stage of implementation.
- "Knowledge management" is an important field for all programs and needs further attention (visions-policy).
- The development on technical media continues (and will continue).
- The question on the need for international archives has been raised and several views have been expressed. This question has to be discussed on a regular basis since repositories for LLW and ILW are implemented and plans for implementing repositories for HLW are well under way in some countries.
- Early actions on knowledge management issues will improve the possibilities for future generations to make informed decisions regarding radioactive waste issues.

The general discussion followed the following lines:

There was a question if there is a general need for an international consensus on how to address the knowledge management issues. Some standards exist (UK1097/10 and UK1097/22) and could be developed further. The meeting concluded that all programs could benefit from such documents but that it is still very early in the process and it is not an urgent need. A lot of knowledge is also to be collected from other types of industrial activity – i.e. chemical industry etc.

It was pointed out that a narrative component would be a good complement to the (passive) archives. This would enhance the possibilities to transfer the knowledge on the contextual issues to future generations.

There was a consensus on the principle that we have to "do our best". We need a good management system, but before that we should have clear goals. Safety requirements come first. We have technical documents but we should have requirements to follow. The "Knowledge Management" idea can be a question for future evolving organisations (can be part of their mission).

Each country needs a "guidebook" on how their "Knowledge Management" system works. When travelling you often use some "guidebook" to learn from experienced people how to get around, where to find restaurants and interesting spots etc. The same is valid for a "Knowledge Management" system.

To make a "Knowledge Management Guidebook" you must first have a knowledge base to build on (preferably an archive) and *not* with just information on the operators. The regulators information systems must address this issue as well! What we would need to develop this idea further would be to have some discussions on the content list in such a "Knowledge Management Guidebook".

International expert meetings to discuss these issues were suggested.

Mr *Takao Tsuboya*, RWMC, pointed out that discussions on an international archive would be very interesting.

The issues on "Knowledge Management" should be addressed in the reports on the "International Convention on Radioactive Waste". Each country that has ratified this convention is presently writing this report.

Dr *Claudio Pescatore* stressed that an international archive should be requested by the big organisations and countries. Knowledge Management is a major interest with a large set of potential customers. It can be used e.g. passing on knowledge during reorganisations and in long-term management of information.

Regarding the time schedules and scope of future discussions the meeting concluded that the “Knowledge Management” issues should be divided into manageable parts and future needs. Since our organisations change with time it is important that we start these discussions now. We must show what the requirements are for information and knowledge management.

Mr *Torsten Eng* referred to the Swedish experience in the repository siting process where not only technical issues have been discussed but also the possibilities for future generations to take informed decisions and actions. The Swedish siting process has surely benefited from these discussions.

Who would pay for the long-term preservation? The meeting concluded that we would actually save money by building up good archives – money is not (or should not be) an issue! The cost for record keeping is very small, but the issue of responsibility is important and the stakeholders will all agree that these questions are important.

Regarding marker systems there were several different views among the different countries. Several thought these questions lies to far ahead to be discussed at this point. Even if we cannot reach a consensus we should at least have some international discussions on these issues in the years to come.

Prof *Stephen Hora* said that the multifunctional group on marker systems in the US had been regarded as a controversial initiative - but it had come up with a lot of good ideas!

Regarding an international standard he thought there is a timing problem since the different programs are at different stages.

Chairman Prof. *Nozomu Matsubara* thanked everybody, especially Mr Eng, Mr Bragg and Mr Jensen – the latter especially for the visit to the Vatican Library.

He then concluded that it is important that we see these questions from society’s point of view, and we should address the questions of how to

- Construct archives – internationally and nationally.
- How to pass on information in the long-term perspective.
- Continue to discuss our common interests.

3. General conclusions from all presentations and discussions

After the workshop, Mr. Tsuboya and Mr. Eng discussed on general conclusion of the workshop as follows;

- 1) The general understanding and implementation of “Knowledge Management” systems are quite shallow in many countries. All countries have some form of archives but they are often not taking into consideration the need for conveying the contextual framework together with the “normal” documents and records.
- 2) Good archives are important for:
 - Future generations.
 - To assess the long-term safety of the systems we are constructing today and then make informed decisions.
 - To mitigate human intrusion scenarios.
 - To raise the possibility for retrieving the waste (for whatever purpose).
 - Present generation.
 - To document and assess the potential repository sites in a structured way.
 - To have arguments for the decision on geologic disposal as the preferred alternative for radioactive waste.
 - To have in the archives all information necessary for all involved stakeholders (waste management policy makers, implementers, regulators, politicians, societies, neighbours, etc) to discuss important items.
- 3) The robustness of the “Knowledge Management” system is very important.

Regarding the archives we must be looking at both hardware and software to utilize the recorded information as applicable and effective.

- The key subjects in software are:
 - i. Who is the responsible organisation today and in the future?
 - ii. How long shall the institutional period be?
 - iii. How long should we aim at the longevity of the technical systems we are constructing today?
 - iv. What contextual framework do we want to transfer to future generations?
 - v. How do we create redundancy systems?
 1. Local archives?
 2. Regional archives?
 3. International archives?
 - The key subjects in hardware development are:
 - vi. Development and implementation of durable media.
 - vii. Document preservation measures.
 - viii. Markers.
 - ix. Renewal of important information on “old” and rapidly aging media.
Measures to mitigate losses in our decaying heritage of information.
- 4) Next steps for discussions.
 - To within a year or two have an international expert meeting for compiling the changes from the current established baseline as presented at this Rome workshop, preferably such a meeting should be hosted by an international organisation (type IAEA or OECD/NEA). Clarification of remaining issues would be another task for such a meeting. At the next meeting it might also be considered to broaden the discussion by also inviting other stakeholders. Views from other industrial fields might also be a good approach to get a perspective on relevant measures for the future.

4. Acknowledgement

We would like to express special thank to Mr Eng and SKB staff for contribution for planning and organizing the workshop. And we also thank the all participants for active and informative discussions.

Appendix 1 Participants

Record Management and Long-Term Preservation and Retrieval of Information regarding Radioactive Waste

Country	Name, Organisation	E-mail address
Japan:	Nozomu Matsubara, the University of Tokyo Takao Tsuboya, RWMC Jin Ohuchi, RWMC Kazutoshi Sugiyama, RWMC Hitoshi Kageyama, Mitsubishi Materials Co Kenichiro Sugita, Mitsubishi Co. Masahide Nakamura (IAE)	nmatsubara@k.u-tokyo.ac.jp Tsuboya@rwmc.or.jp Johuchi@rwmc.or.jp sugiyama@rwmc.or.jp kageyama@mmc.co.jp kenichirou.sugita@mitsubishicorp.com nakamura@iae.or.jp
Sweden	Ann-Mari Ekendahl, SKB Per-Olof Lindberg, SKB Torsten Eng, SKB Mattias Hammarlund, SKB Mikael Jensen, SSI	skbae@skb.se skbpol@skb.se torsten.eng@skb.se mattias.hammarlund@skb.se mikael.jensen@ssi.se
France	Phillippe Raimbault, ASN	philippe.raimbault@asn.minefi.gouv.fr
Italy	Anselmo Farina, APAT	farina@apat.it
USA	Stephen Hora, University of Hawaii at Hilo	hora@hawaii.edu
Switzerland	Anne Claudel, NAGRA	anne.claudel@nagra.ch
Belgium	Dr A Berckmans, NIRAS	a.berckmans@nirond.be
UK	Ian Upshall, Nirex	ian.upshall@nirex.co.uk
Spain	Jose Antonio Gago, ENRESA	jgab@enresa.es
Hungary	Milhaly Nagy, PURAM	milhaly.nagy@rhk.hu
Netherlands	Maarten de Vos, COVRA N.V.	mdvcovra@zeelandnet.nl
IAEA	Ken Bragg	K.Bragg@iaea.org
OECD/NEA	Claudio Pescatore	claudio.pescatore@oecd.org

Appendix 2 Programme of Workshop

Record Management and Long-term Preservation and Retrieval of Information regarding Radioactive Waste.

Rome, Italy, January 27-28, 2003

Hotel Crown Plaza Rome-St Peters, Via Aurelia Antica 415.

January 27, 2003

SESSION I

Chair: Mr Ken Bragg, IAEA

Co-chair: Dr Mikael Jensen, SSI

- | | |
|-------|---|
| 13.00 | Welcome. (Chairman) |
| 13.10 | Background for the workshop (Takao Tsuboya, RWMC, Japan) |
| 13.20 | The Nordic KAN 1.3 study (Dr Mikael Jensen, SSI) |
| 13.45 | New ideas related to the transfer of information and the use of contextual frameworks as they apply to radwaste management (Ken Bragg, IAEA) |
| 14.15 | The OECD/NEA report " Future Human Actions at Disposal Sites" and later developments (Claudio Pescatore, OECD/NEA) |
| 14.45 | The US studies regarding marker systems (Prof. Steve Hora, University of Hawaii at Hilo) |
| 15.15 | RWMC's study on the Record Preservation for HLW Geological Disposal – Significance, Methods and Technical Feasibility - (Jin Ohuchi, Kazutoshi Sugiyama and Nozomu Matsubara, RWMC and the University of Tokyo) |
| 15.45 | Coffee |
| 16.30 | Discussion on technical issues and future actions regarding international archives and/or other joint international actions on preservation and retrieval of information regarding radioactive waste. |
| 18.00 | End |
| 19.30 | Dinner |

January 28, 2003

SESSION II

Chairman: Prof. Nozomu Matsubara, the University of Tokyo

Co-chair: Mr Torsten Eng, SKB

09.00 Presentation from the different countries regarding their Record Management Systems, the possibilities and ideas/plans/actions taken for long-term preservation and retrieval, considered marker systems etc.

France

UK

Spain

Switzerland

Belgium

Hungary

Italy

Canada

Netherlands

Japan

Sweden

Each country is asked to give presentations 10-20 min on the present status on the above mentioned subjects. If possible, presentations from both the regulator(s) and the implementers from a specific country would be appreciated.

12.00 Lunch

13.30 Continuation from the morning session

15.00 Summary and conclusions

17.00 Bus to the Vatican Library

17.30 Study visit to the Vatican Library (presentation on history and visit to the reading rooms and conservation area)

About 19.00 Bus back to the Hotel

End of workshop

Appendix 3 Announcement

Record Management and Long-term Preservation and Retrieval of Information regarding Radioactive Waste.

Workshop to be held in Rome, Italy, January 27-28, 2003
at Hotel Crown Plaza Rome-St Peters, Via Aurelia Antica 415.

Background:

To ensure that future generations have a proper freedom of action for intentional intrusion in a repository for nuclear waste, for whatever purpose, the knowledge of the repository should be kept as long as possible. To inform each other on the present status regarding these issues, the societal needs, laws and regulations, policies, present documentation systems, procedures and measures to ensure information transfer, search for important documents, possibilities of making information summaries etc, this workshop is held.

There are several reasons to create this baseline at this point in time. One is that the question on retrievability of waste from repositories and what this would mean in demands on information transfer is becoming more and more important in several waste management programmes. Another is that regulations on the handling of information regarding waste repositories now are issued or under development in some countries. To get an overview of the overall situation and to further develop the thoughts and actions in this area, a workshop with broad international participation from institutions, which have studied or are studying this issue, would be interesting.

The Radioactive Waste Management Funding and Research Centre (RWMC) in Japan have brought up the original initiative for the workshop since they in Japan today have an intensive discussion regarding confidence building. RWMC has an ongoing discussion on the technical issues regarding long term record preservation, and has developed a durable media using silicon carbide which might give a possibility to preserve records for more than thousand years. Since we know that the topic of long-term preservation and retrieval of information are also discussed in a number of other countries it might be very timely to have a joint discussion on the issue of long-term preservation and retrievability of information.

Program for the workshop

January 27, 2003

SESSION I

Chair: Mr Ken Bragg, IAEA

Co-chair: Dr Mikael Jensen, SSI

- 13.00 Welcome. (Chairman)
- 13-10 Background for the workshop (RWMC, Japan)
- 13.20 The Nordic KAN 1.3 study (Dr Mikael Jensen, SSI/Torsten Eng SKB)
- 13.45 New ideas related to the transfer of information and the use of contextual frameworks as they apply to radwaste management (Ken Bragg, IAEA)
- 14.15 The OECD/NEA report " Future Human Actions at Disposal Sites" and later developments (Claudio Pescatore, OECD/NEA)
- 14.45 The US studies regarding marker systems (Prof. Steve Hora, University of Hilo, Hawaii)
- 15.15 RWMC's study on the purpose, methods and technical issues of long-term record preservation (RWMC)
- 15.45 Coffee
- 16.30 Discussion on technical issues and future actions regarding international archives and/or other joint international actions on preservation and retrieval of information regarding radioactive waste.
- 18.00 End
- 19.30 Dinner

January 28, 2003

SESSION II

Chairman: Prof. Nozomu Matsubara, University of Tokyo

Co-chair: Mr Torsten Eng, SKB

- 09.00 Presentation from the different countries regarding their Record Management Systems, the possibilities and ideas/plans/actions taken for long-term preservation and retrieval, considered marker systems etc.

Finland
Germany
France
UK
Spain
Switzerland
Belgium
USA
Japan

Sweden

Each country is asked to give presentations 10-20 min on the present status on the above mentioned subjects. If possible, presentations from both the regulator(s) and the implementers from a specific country would be appreciated.

12.00 Lunch

13.30 Continuation from the morning session

15.00 Summary and conclusions

17.00 Study visit to the Vatican Library (presentation on history and visit to the reading rooms and conservation area)

about 19.30 End of workshop

Logistics:

The workshop will be held at Crown Plaza Rome-St. Peter's, Via Aurelia Antica 415, Rome. Telephone +39-06-66420. Fax: +39-06-6637190. **Please make your own room reservation before December 15 with reference to the name of the workshop.**

Room rate is 155 Euros/night breakfast included (single room) and 175 Euros/night for a double room. Each person will also have to pay a **conference fee** (for 1 lunch and 3 coffee breaks, other conference services etc) of about **50 Euro** in total . This payment will be on your hotel bill when checking out. If you are staying at another hotel in Rome you will have to pay this fee separately to the conference hotel.

If you have not yet done so - please **send as soon as possible your notification of participation** (a form is attached) in an e-mail to Torsten Eng at SKB on address: torsten.eng@skb.se . The deadline for this notification is December 15, 2002.

Some written material, OH-series etc regarding

1) the papers in Session I

2) the presentations in Session II

must at the latest at January 10, 2003 be sent to Torsten Eng at the above mentioned e-mail address. A CD-Rom with all the presentations is intended to be produced for distribution at the workshop.

Posters are welcome but a special poster session is not scheduled. If you have a poster, please notify Torsten Eng at the above e-mail address to make sure that sufficient space is available in the conference room.

1. Background of the workshop

Takao Tsuboya, Radioactive Waste Management Funding and Research Center (RWMC)

1.1 Institutional control

RWMC (Radioactive Waste Management Funding and Research Center) has been studying on the issue of record preservation of HLW geological disposal since 2000 commissioned by the Ministry of Economy, Trade and Industry. Record preservation is positioned as an optional institutional control of geological disposal. It is recognized that geological disposal of high-level radioactive wastes based on passive safe concept of isolating waste safely from human's living environment over a long period of time without relying on any human institutional control (OECD/NEA, 1982). However, in order to implement geological disposal in society, various options which complement this passive safe concept would be required to be prepared. These options should contribute the present generation who can ask for decision-making of acceptance of repository sites and implementation of waste disposal to accept the geological disposal system. An institutional control consists of social side and technical side. As far as technical issue is concerned, post-closure monitoring, retrievability of waste packages and record preservation attract attention (IAEA, 1995).

1.2 Current Japanese situation regarding HLW geological disposal

The year 2000 was an epoch making year for waste management history of Japan. In late 1999, the Japan Nuclear Cycle Development Institute, JNC compiled and published a series of technical reports so called H12 reports described in the scientific and technical basis for the geological disposal in Japan based on extensive research works during past 25 years. The Specified Radioactive Waste Disposal Act legislated in June 2000. The act specifies the overall implementation scheme and the three steps disposal site selection process with transparent ways, and defines the role and responsibilities of the Government, the disposal implementing organization (NUMO), the waste funding management organization (RWMC), and owners of power reactors. Thus the RWMC has two quite difference missions of research studies and funding management.

Accordingly, Japan opened the door to an implementation phase at the year 2000 from a scientific and technical research phase. In December 2002, NUMO announced the "Start of Open Solicitation for Volunteers for Preliminary Investigation Areas (PIAs) for a HLW Repository". It is no doubt that the most important issue of the implementation phase will be how to obtain public decision and public confidence with geological disposal technology.

1.3 Current situation of record preservation in geological disposal program of Japan

As mentioned above, Japan went into the new stage towards implementation of geological disposal and incorporation of record preservation, as part of institutional controls into geological disposal plan will be discussed from now on. The word "Record preservation" are shown on not only Specified Radioactive Waste Disposal Act but also some documents from governmental organization, such as Atomic Energy Commission and Nuclear Safety Commission of Japan(*). According to these documents, the objective of the record preservation is preventing future generations from unintentional access to the repository. Therefore, the record preservation is considered to be the policy of the institutional control which naturally needs to be adopted by management of HLW.

(*) Described record preservation in official documents. (Tentative translation)

- "The Ministry of Economy, Trade and Industry shall permanently retain the records submitted in accordance with the provision of the preceding clause." (The Specified Radioactive Waste Disposal Act, 2000).
- "... institutional controls such as land use restrictions and preservation of records are considered to be effective for further reducing the possibility of any unexpected contact between the repository and human beings." (The basic Policy of Safety Regulations for the Disposal of High-Level Radioactive Waste (The first-stage Report), 2000)

1.4 Previous discussions regarding institutional controls and record preservation

At the place of an international argument, since the 1980's, the role of institutional controls measure in disposal of radioactive waste was appeared in international documents(OECD/NEA, 1982). In 1987, KASAM held a seminar " Ethical Aspects on Nuclear Waste. Some salient points discussed at a seminar on Ethical action in the face of uncertainty" (KASAM, 1988) and summarized the result of an argument. In 1994, OECD/NEA held a workshop "The Environmental and Ethical Basis of Geological Disposal: Collective Opinion of the NEA Radioactive Waste Management Committee"(OECD/NEA, 1995). At the workshop, intergenerational and intergenerational equity concerning disposal of radioactive wastes was discussed and collected the opinion of final disposal from environmental and ethical point of view.

As far as record preservation is concerned, Scandinavian countries had discussed in KAN-1.3 in 1993. The report described that the current generation is required to preserve the information of disposal facility so that future generation can access and use it.

Almost same time, in the United States, SNL report addressed the information communication by markers and monuments for reducing the possibility of unintentional access to WIPP underground repository by future generations.

In 1999, IAEA published the technical report "Maintenance of Records for Radioactive Waste Disposal, TECDOC-1097". In the report, the record management system was discussed for communicate important information to future generations.

1.5 RWMC's record preservation study

RWMC's study aims to provide information for the government and related bodies to utilize in formulating programs as a component of the institutional control concerning geological disposal. In this study, RWMC considered " Who, How long, For whom, What kind of records should be preserved. And How?" Furthermore, in order to show the technical possibility of long-term record preservation, we developed the new record preservation method called LASER GRYPH using sintered silicon carbide thin plates and engraving their surface by a laser marking system. I am pleased if this technical topic will contribute to activate discussions among participants.

1.6 About this workshop

I wish to thank for cooperation of the SKB staff, especially Mr. Torsten Eng. Furthermore, it is thankful to Mr. Ken Bragg of IAEA, Dr. Mikael Jensen of SSI, Professor Nozomu Matsubara of the University of Tokyo, and Mr. Torsten Eng of SKB who had the chairperson's duties taken over. The workshop is participated by over 20 experts from eleven countries and two international organizations. Today, I have really recognized that this issue is important and highly concerned.

In session II of tomorrow, there are presentation from representatives from participant's countries. I hope we will be able to exchange precious information.

The objective of this workshop is not to reach official consensus, but to inform each other on the present status concerning record preservation. But, I wish to give direction toward next step, for example, opportunity to discuss record preservation sponsored by international organization, holding workshop by rotating host country, and discussion including archivist, historian and sociologist. Furthermore, we have possibility to hold seminar or workshop in cooperation with related academic society

Discussion we have made will be reported as part of our technical report. This report will be available to the public, so if you have any inconvenience to disclose, please tell us or give instruction us when checking draft report.

I hope succession of your presentation and intense discussion will be made during next two days.

References

The Japanese Law (2000):The Specified Radioactive Waste Final Disposal Act.

Nuclear safety Commission of Japan (2000): The Basic Policy of Safety Regulations for the Disposal of High-Level Radioactive Waste (The first-stage Report).

IAEA (1999): Maintenance of Records for Radioactive Waste Disposal, TECDOC-1097.

KASAM (1988): Ethical Aspects on Nuclear Waste. Some salient points discussed at a seminar on Ethical action in the face of uncertainty in Stockholm, Sweden. September 8-9, 1987. SKN Report 29.

Nordic Nuclear Safety Research Project KAN-1.3 (1993): Conservation and Retrieval of Information – Elements of a Strategy to Inform Future Societies about Nuclear Waste Repositories.

OECD/NEA (1982): Disposal of Radioactive Waste, An Overview of the Principles Involved.

OECD/NEA (1995): Environmental and Ethical Basis of Geological Disposal: Collective Opinion of the NEA Radioactive Waste Management Committee.

Sandia National Laboratories (1993): Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant, SAND92-1382.



Background of the workshop

January 27, 2003

Takao Tsuboya
Radioactive Waste Management
Funding and Research Center
(RWMC)

January
2003
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1



Role of institutional controls

- 1) **It is recognized as geological disposal of high-level radioactive wastes being a passive safety method of isolating waste .**
- 2) **In order to implement geological disposal in society, various options which complement this passive safety system are need.**
- 3) **These options should contribute the present generation who can ask for decision-making of acceptance of repository sites and implementation of waste disposal to accept the geological disposal system.**

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History of Final Disposal of HLW in Japan

- 1976** Geological disposal study was started.
The study was performed mainly by geologists.

- 1989** Multi-barrier system development was officially confirmed.
The study was accelerated by participation of scientists and engineers from various fields.

- 1992** Technical feasibility of safe geological disposal of HLW in Japan was clarified.
Interim report known as H3 was submitted to JAEC, and opened to the public by PNC.

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(continues)

- 1995** JAEC started high level discussion on social and economic aspects as essential for realization of HLW disposal.
(Recommendations were compiled in 1998)

- Key message to the public** was that they were expected to pay more attention to final disposal of HLW as their own issue.

- Key message to authorities** was that they had to make every effort based on ethical aspects such as minimization of burdens on future generations, inter- and intra-generational equity.

- Transparency and disclosure of information** are fundamental principles in all processes of repository development.

- The report gave incentives to introduce new legislations in order to secure the waste disposal fund, establish implementing entity, and develop transparent site selection processes.**

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(continues)

1997 Specification of H12 report was issued by JAEC.

The report was required to demonstrate the technical reliability on geological disposal in Japan.

The report was also required to provide the technical basis for the selection of potential disposal sites and the formulation of safety standards.

1999 The H12 report was submitted.

The H12 project to establish technical basis for HLW disposal in Japan was compiled, submitted to JAEC, and opened to the public by JNC.

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(continues)

2000 Epoch-making year for waste management measure in Japan.

New Act, "The Specified Radioactive Waste Final Disposal Law", was passed in the Diet (May 31)

- Overall implementation scheme and three steps disposal site selection process with transparent ways were clearly specified.
- NUMO as implementation entity was established (October 18)
- RWMC was designated as waste disposal fund management entity (November 6)

The first document on safety regulation framework was completed by NSC (November 6)

2001 The Government was reformed (January 2001)

The policy making role on final disposal of radioactive wastes from nuclear power generation was unified to the Ministry of Economy, Trade and Industry (METI), successor of MITI.

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Current Japanese Situation on Record Preservation

1) The Specified Radioactive Waste Final Disposal Act (2000):

METI shall permanently retain the records submitted in accordance with the provision of the preceding clause.

2) Nuclear Safety Commission of Japan(2000):

Institutional controls such as land use restrictions and preservation of records are considered to be effective for further reducing the possibility of any unexpected contact between the repository and human beings.

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Previous discussions regarding institutional controls and record preservation

1) **OECD/NEA (1982)**: review of the philosophy underlying the technical approach to the disposal of radioactive waste.

2) **KASAM (1988)**: the responsibility to future generations.

3) **OECD/NEA (1995)**: inter-generational and intra-generational equity.

4) **KAN-1.3 (1993)**: to establish a common Nordic view on information communication.

5) **SAND92-1382 (1993)**: permanent markers of WIPP

6) **IAEA (1999)**: record management system.

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RWMC's record preservation study

■ Objectives

- To provide information for government and related bodies to utilize in formulating programs on the record preservation as a component of the institutional control measure.

■ Development of the new record preservation method by using:

- Material **LASERGLYPH** on carbide (SiC) thin plates
- Technology: engraving by laser marking system

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About the workshop

■ Objective of workshop is:

- not intend to reach official consensus,
- but to inform each other.

■ Expected next step (for examples):

- opportunity to discuss sponsored by international organization,
- workshop by rotating host country,
- discussion with experts in the area of archives, historian, and sociologist, etc..

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RWMC's Study on the Record Preservation for HLW Geological Disposal

- Part-1...Significance & Requirements
- Part-2...Robust system & durable technology
- Part-3...Examples of Long-term Record Preservation in Japanese History



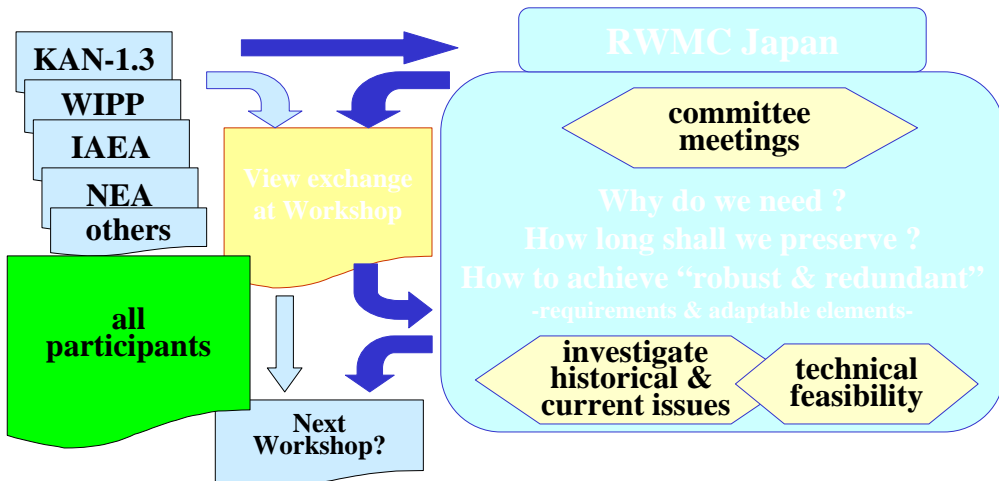
Jin OHUCHI and Kazutoshi SUGIYAMA

Radioactive Waste Management Funding and Research Center (RWMC)

Nozomu MATSUBARA

The University of Tokyo

Scope of RWMC's Study





Fields of Technical Committee Members

- social science / statistics
- journalist
- information system
- archivist
- philosophy / semiotics
- archeology / cultural anthropology
- material science
- nuclear engineering
- expert of geological disposal
- implementer of geological disposal



Goals

- Aiming at providing **a menu** for government and the related bodies such as implementing entity and municipalities to realize their record preservation system
 - Studied **significance** of record preservation for geological disposal and clarified **the requirements and adaptable elements** for designing robust record preservation system
 - “Record preservation” in this study **covers widely** record keeping, retrieving documents, communication by markers & monuments, etc.

Why do we need Record Preservation ?

Purpose

- prevent future generations from unintentional access to the repository
 - ...basic information on the existence of repository
- provide future generations with information necessary for their own decision-making on the repository
 - ...more detailed & related information

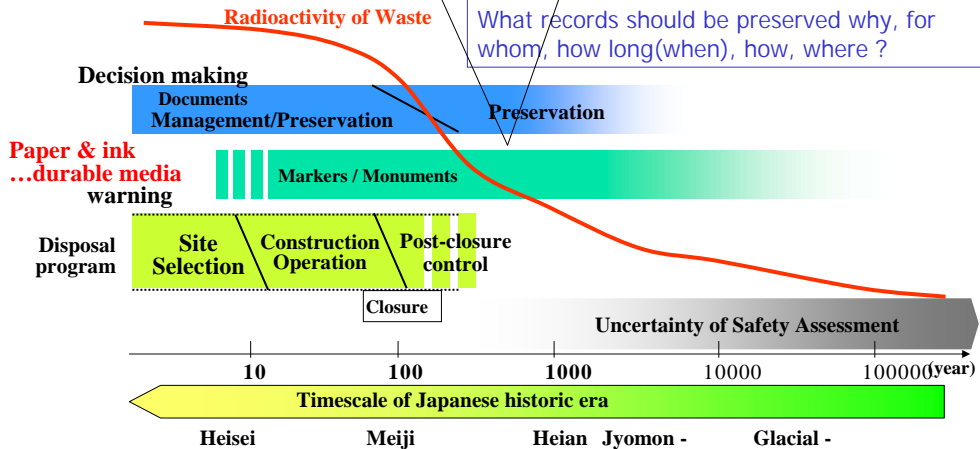
Why do we need Record Preservation ?

Significance

- **confidence building**
 - ...the achievement of “**intergenerational equity**” by choosing technologies and strategies which minimize the resource and risk burdens passed to future generations by the current generations which produce the wastes. (OECD/NEA, 1995)
 - **meta signal** to the current generation
 - ...”Do our best” for the future generations might be the conscious message to the current generation to implement geological disposal.
- **legal requirement in Japan**

Future generation's decision-making
...re-use of the site, re-assessment, removal of HLW, etc.

How long shall we Preserve Records ?



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7

Our Approach to Robust & Redundant

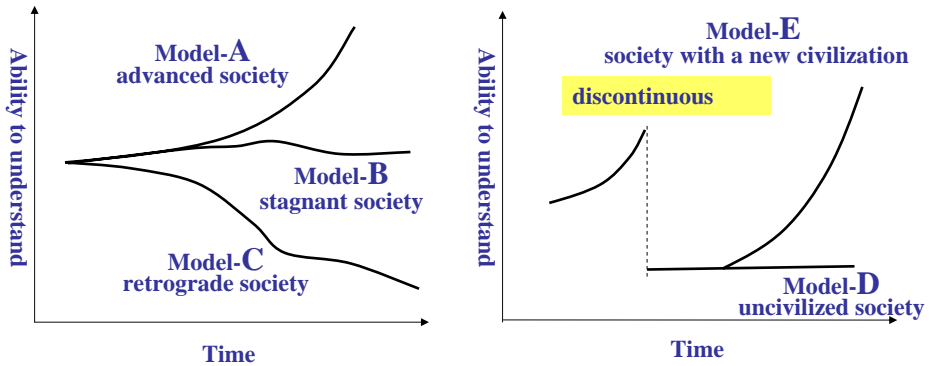
- Classify the society models
 - Ability of understand preserved information
- Investigate the historical & current record preservation and extract elements
 - clarify adaptability of elements for requirements of each society model
- strengthen robustness & redundancy
 - durable recording tech.,etc.
- Design in trial a record preservation system
 - integrate elements to meet the requirements

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Five Society Models



Description of Society-Models

-- from the viewpoint of record preservation and communication --

Society model	technology	Record management	Intelligence / language	culture
A	<ul style="list-style-type: none"> Superior Advanced and stable information network system 	<ul style="list-style-type: none"> Well organized International archives 	<ul style="list-style-type: none"> Superior Possible to understand present language 	<ul style="list-style-type: none"> keen awareness of record preservation Fast renewal of society
B	<ul style="list-style-type: none"> Comparable 	<ul style="list-style-type: none"> comparable Archives 	<ul style="list-style-type: none"> Comparable Possible to understand the present language 	<ul style="list-style-type: none"> Comparable
C	<ul style="list-style-type: none"> Inferior Information network system is not expected 	<ul style="list-style-type: none"> Not be expected 	<ul style="list-style-type: none"> Inferior Impossible to understand the present language 	<ul style="list-style-type: none"> Inferior Strong influence of religion
D	<ul style="list-style-type: none"> Not be expected 	<ul style="list-style-type: none"> Not be expected 	<ul style="list-style-type: none"> Impossible to understand the present language 	<ul style="list-style-type: none"> similar to prehistoric times
E	<ul style="list-style-type: none"> different from now 	<ul style="list-style-type: none"> different social systems from now 	<ul style="list-style-type: none"> Impossible to understand the present language Psychological or nonverbal symbols may be decoded 	<ul style="list-style-type: none"> different values

Investigate Historical, Archaeological and Societal samples



Ancient document



Ruins



Rosetta stone



Japanese old writings

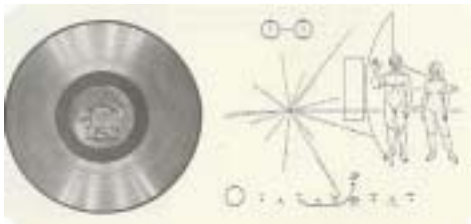


Keeping system of documents

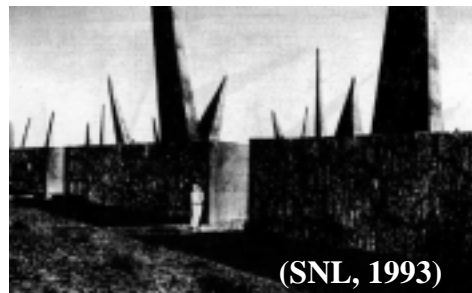
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Investigate Symbols & Psychological consideration



Search for Extra terrestrial Intelligence (NASA)



(SNL, 1993)

(concept by Michael Brill and art by Safdar Abidi)



DANGER
POISONOUS RADIOACTIVE ♣ WASTE BURIED HERE
DO NOT DIG OR DRILL HERE BEFORE A.D. 12,000



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Investigated Samples to extract Elements for meeting Requirements

- **Historical & archeological record preservation**
 - Documents...Old Testament, Relics, Legends, Japanese ancient writings, Old records of Korean Dynasty, etc.
 - Monument/symbol, buildings, etc.
- **Current Record preservation**
 - Repository...IAEA-TECDOC1097, SAND92-1382, KAN-1.3
 - Social system...Census, cultural properties protection, documentary records preservation, etc.
- **Related technologies**
 - Information system, paper & microfilm, metallic & inorganic materials, communication & psychological consideration, etc.



Extraction of adaptable Elements from historical & current issues

- **Documents**
 - Preserved...durable media & preserving environment, manuscript copying for future generation, preserving at different places, recognized value, etc.
 - Lost ...change of social & national system, war damage, etc.
- **Remains**
 - Preserved...durable materials such as rock and brick, written in ideograms and/or plural languages, etc.
 - Lost...destruction / robbery due to racial / religious confrontation and difference of values, re-use, removal, etc.

Adaptability of Elements for each Society Model... clarified

Adaptability

**

*

none

elements		society model									
		A		B		C		D		E	
D: document, M: markers & monuments		D	M	D	M	D	M	D	M	D	M
recording media	paper	**		**		*					
	film	**		**		*					
	electronic / optical media	**		**							
	natural rocks		*		**		**		**		**
	engineering materials		*		**		**		**		**
where to be preserved	regulatory body	**		**							
	geographical survey institute	**		**							
	district legal affairs bureau	**		**		*					
	national & international libraries and records	**		**		*					
	IHLW repository site	**	**	**	**	*	**		**		**
	every parts of the world										**
preservation system	extraterrestrial, space station										**
	social system	**		**							
	education system	**		**							
	relay system	**		**	**	**	**				
	maintenance during post-closure control		*		*						
expression form	durable markers & monuments						**		**		**
	current language	**	*	**	*	*				*	**
	mathematical expressions	*		*		*					**
	charts	*	*	*	**	*				**	*
	drawings		*		**	*			**	*	**
others	summarized message				**	**		**	*	*	*
	idiomatic symbols		*		**	*					*
	classified information -decision making-	**		**							
	classified information -warning-			**		**					
	dispersion of preservation	*		**		**				**	*
physical media as markers	information system	**		*							
	physical media as monument		*		**						
	physical media for communication				**						
physical media as markers					**		**		**	*	

Rome V

Robust & Redundant...case studied

- Integrating several adaptable elements would impart **redundancy** to communicate to the future generations and also impart **robustness** to maintain the overall function even though partial damage, **thus resulting in a flexible preservation system adaptable to future changes of society.**



Summary of Part-1

- **Significance...re-confirmed**
 - Why -decision making & warning
for confidence-building & legal requirement
 - How long
-several hundreds to a thousand years (documents)
more than a thousand years
(markers & monuments + SiC documents?)

- **Requirements**
 - Historical and current issues ...investigated
 - Requirements & applicable elements ...clarified

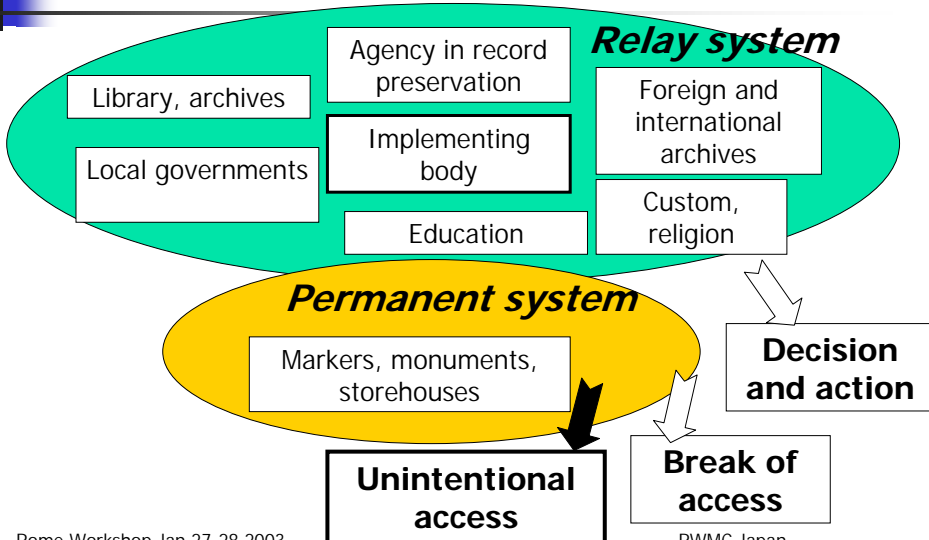


Part-2...Robust system & durable technology

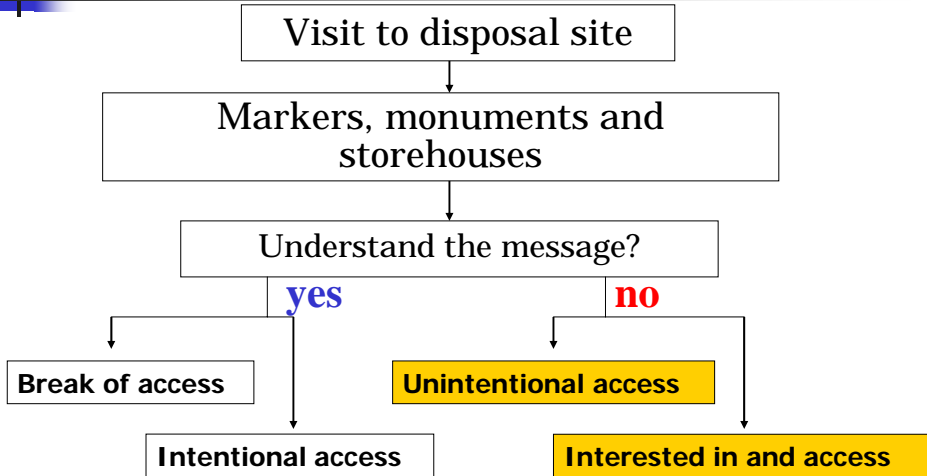
Relay system & permanent system

- **Relay system:** by which the record is kept, renewed and communicated through generations within social system.
- **Permanent system:** by which the record and information are kept and communicated by using durable recording methods such as markers and monuments.

Scenario of future generations' information retrieval and decision



Scenario in permanent system

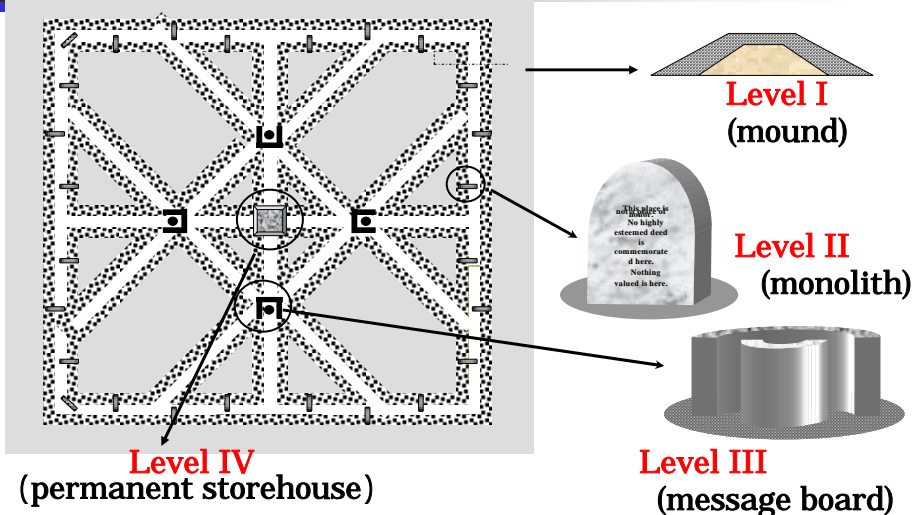


Classified level, contents and preservation methods

Objective of Record Preservation	Level Classification and Contents ^(*)		Preservation Method
	Level	Contents	
Prevention of Unintentional Access to Repository	I/II	1. Information to be encountered first "Something artificial exists around here and it represents danger."	↑ Markers, monuments ↓
	III	2. Information necessary after the danger is perceived "High-level radioactive waste exists" "It exits deep under the ground nearby." "More detailed information exits"	
Future Generations' Decision-making	IV	3. Detailed information written records, tables, figures, maps, etc.	↑ ↓ Documentary record
	V	4. Further detailed information	

^(*) Referred to SNL, 1993 etc.

Arrangement of markers, monuments, and permanent record storehouse



Rome Workshop Jan.27-28,2003

RWMC Japan

Development of durable recording media



Engineered materials
(metals, ceramics)

Rome Workshop Jan.27-28,2003

RWMC Japan



Comparison of recording media

Materials	Durability of recording media		Required technology level for recognition
	Estimated life time	Dependence on preserving environment	
Digital media	several decays	high	high
Paper and film	several centuries - millennium	high	low
metal and ceramics	more than thousand years	low	low



Purpose of development

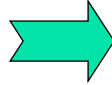
Technical basis of long-term preservation as one of options

- Recording media of which material and recorded characters have:
 - long-term durability, and
 - independency on stored environment.

Laser engraving – long-term preservation of documentary archives-



Documents on paper/film ...



Documents on durable media

Hardness of materials

Materials	Vickers hardness
Stainless steel	330
Quartz	800
Zirconia	1300
Alumina	1600
Silicon nitride	1600
Silicon carbide	2500
Diamond	8500

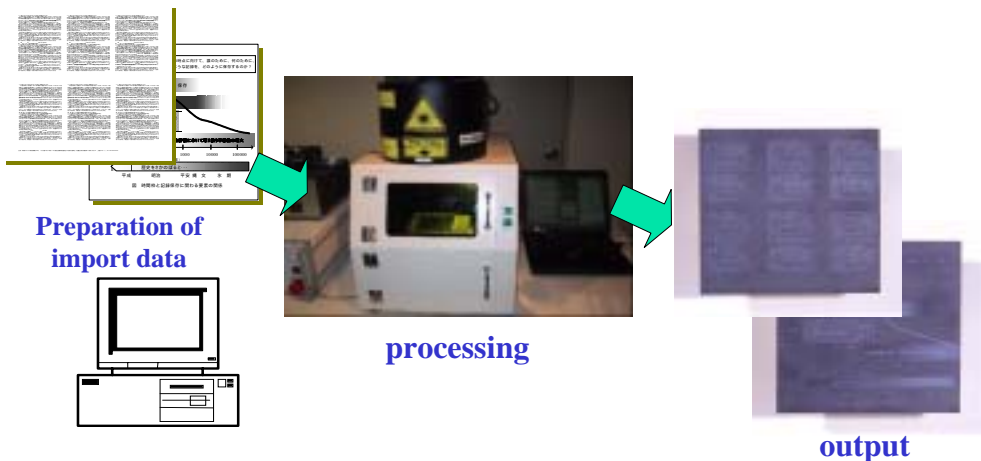


Density of materials

Materials	Density (mg/m ³)
Hastelloy C22 (Ni-base alloy)	8.7
Alumina sintered compact (Al ₂ O ₃ 99.9%)	4.0
Zirconia sintered compact (ZrO ₂ 94.7%)	5.5-6.1
Silicon carbide sintered compact (-SiC 98%)	3.2



Engraving process



Engraving methods

- Trench engraving
- Dot engraving

Trench engraving



operated with Nd:YAG laser



Dot engraving



Operated with Nd:YVO4 laser

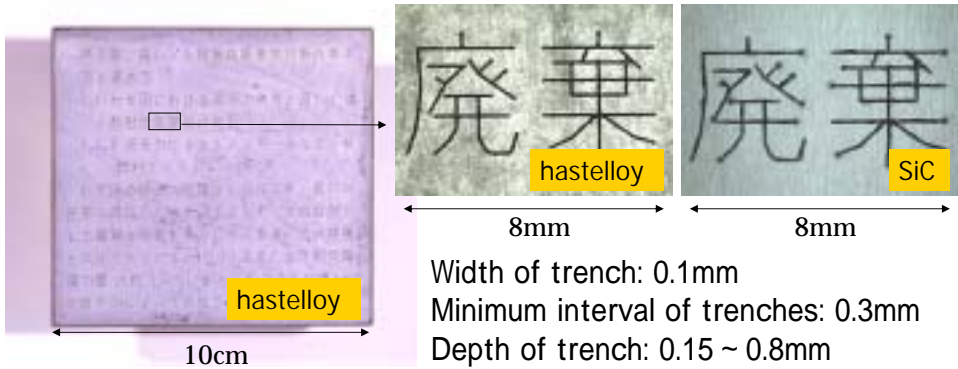


Result of engraving

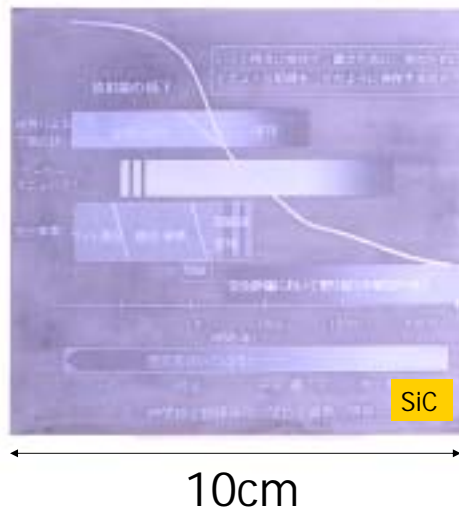
	trench engraving	dot engraving
Hastelloy	yes	good
Alumina	no	yes
Zirconia	no	yes
Silicon carbide	yes	good

Results of trench engraving

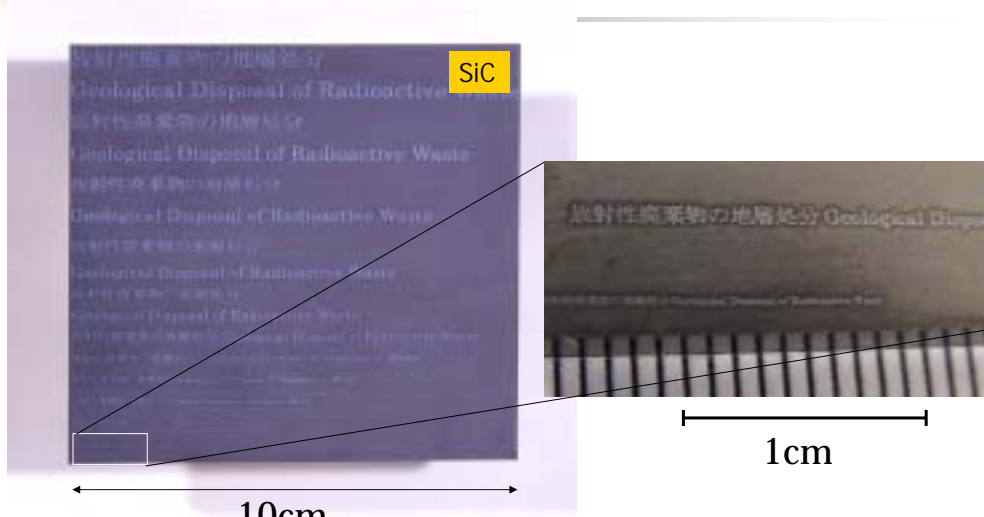
Well result was obtained on hastelloy and SiC



Result of dot engraving



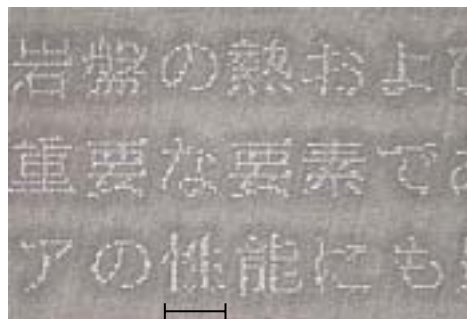
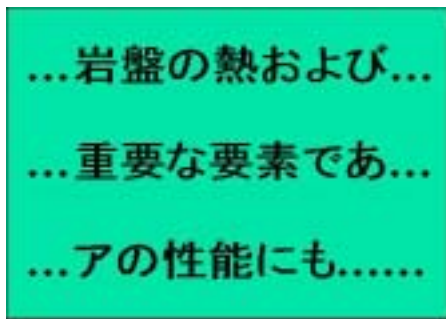
Result of dot engraving



Result of dot engraving

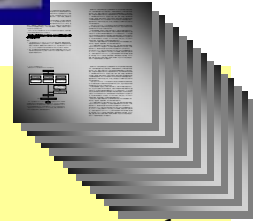
(Original import data)

(result)



0.7mm

Volume estimation



- Original document: 500 pages
- Plate size: 10cm × 10cm × 1mm
- Engraved size of characters: 2-points
- Number of pages of original document to be engraved on single side of a plate: 6
- Number of pages of original document to be engraved on both sides of a plate: 12
- Total number of plates needed: $500/12 = 42$
- The total thickness of plates: 42mm

Expected characteristics of SiC

(durable material)

- Strong resistance to:
 - wear,
 - chemical impact, and
 - heat.

(other characteristics)

- Well results of engraving
- Low density (light): easy to use.
- Easy to be produced (from Japanese market).



Summary of Part-2

- **Robust preservation system ...designed in trial**

- **Laser engraving technology on SiC plate ...proved**
 - **applicable to documentary record and face plate of monument**



RWMC's Study on the Record Preservation for HLW Geological Disposal - Significance, Methods and Technical Feasibility -

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INTRODUCTION

Radioactive Waste Management Funding and Research Center (RWMC) in Japan has been studying since 2000 the significances and technical issues on record preservation as an optional institutional control to build the public confidence in geological disposal (RWMC, 2003). We are aiming at providing options for bodies such as the government, implementing body, municipalities and other organizations for building public confidence in geological disposal.

In this paper, we discuss basic significance, objectives, and methods of long-term record preservation including a technical advantage of laser engraving on silicon carbide. The term "record preservation" is taken in the broad sense, covering from the record keeping and retrieval of documents to the communication of information by markers and monuments.

SIGNIFICANCE AND OBJECTIVES OF RECORD PRESERVATION

As HLW contains higher radioactivity, extensive discussions have been done on the environmental and ethical concerns for geological disposal. For example, OECD/NEA (1995) issued a report summarizing the opinions of the experts, and expressed an international consensus that we should not unnecessarily limit the capacity of future generations to take over management control, including the ability to recover the waste. Besides the provision of scientific and technological basis and data related to the safety assessment of geological disposal, it is also important to develop options from social and ethical viewpoints for building the public confidence in geological disposal. Institutional control including record preservation should be effective in minimizing the possibilities of unintentional human access to the geological repository (IAEA, 1999).

Considering the items mentioned above, we have confirmed the following two objectives of record preservation:

- 1) Preventing future generations from unintentional access to the repository, and
- 2) Providing future generations with information necessary for decision-making on

the repository.

In relation to the first objective, only basic information related to the existence of the repository would be necessitated. However for the second objective, more detailed information of the repository should be necessary to communicate to the future generations.

Record preservation for geological disposal would be vital from the viewpoint of intergenerational ethics. We point out that record preservation is not only a measure intended for future generations, but also a *Meta signal* to the present generation. “Do our best” for the future generations should be important for the present generation to accept geological disposal.

TIME FRAME TO BE CONSIDERED IN RECORD PRESERVATION

We discuss question of how long future generations need information on the repository. Figure 1 conceptualizes the timeframe of the repository and record preservation. The radioactivity of HLW decreases drastically within the first thousand years. As the higher radioactivity of HLW demands the significance of record preservation, the necessity for preserving records decreases according to the decreasing of the radioactivity. Future generations can make their own decisions such as re-use of the repository site, safety re-assessment and removal of HLW within the first thousand years.

From the above, we can conclude that the records to be preserved for future generations so they can make their decisions would be of significance during the first several hundreds to one thousand years in which the radioactivity of HLW is rather high. In such a time span, although paper documents could be preserved, the dependency on the preservation environments and the life of ink materials remain to be discussed. For this methodology to work, durable materials are expected to last longer than a thousand years and accommodate a large volume of information.

As the radioactivity of HLW will remain after the first one thousand years or so, it is important that necessary information to control future generations’ unintentional access to the repository should be communicated by using durable items such as markers and monuments down to the future.

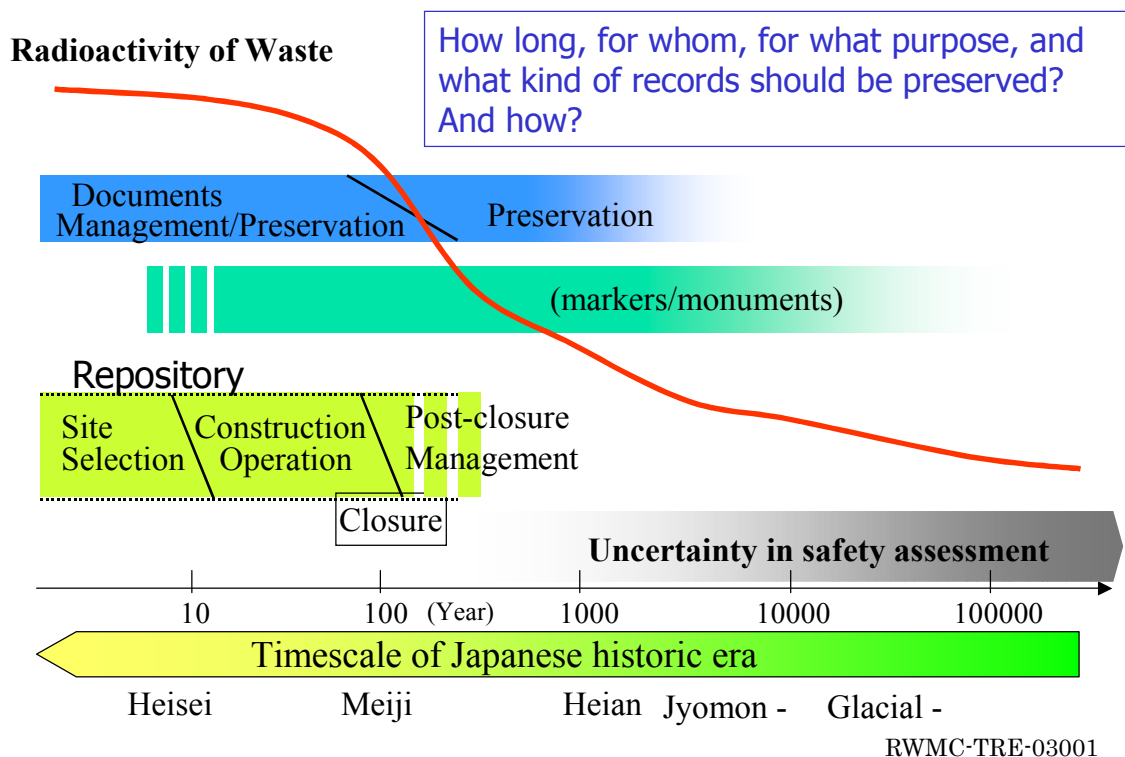


Fig. 1 Time frame for future and record preservation

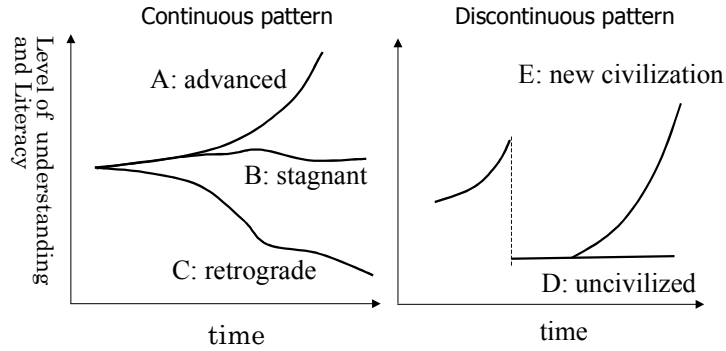
ROBUST RECORD PRESERVATION

Anticipating wide range of technological and institutional issues concerning record preservation, this study examined methods to communicate messages for future generations that is quite different from our own in terms of social systems, culture, values, languages, level of knowledge, etc. as well as for the future in which national systems for record preservation is maintained.

As the first step, from the viewpoint of the ability to understand the information, we have set five society models with different cultures, language, levels of knowledge, etc. (Fig. 2, and Table 1), and clarified the requirements. Next, the elemental methods of record preservation and communication of information, which could be effective in each society model was formulated into an appropriate combination. In Table 2, each elemental method was extracted from the examination on the cases of record preservation in history, archaeology and social institution as well as related technical field and recent discussions.

Combining several different methods would impart redundancy to the communication function of a record preservation system. And at the same time, it would enable the system to retain robustness so that the overall function would not be

influenced by partial damage, thus resulting in a flexible system that can adapt to changes in the background social condition in the future.



RWMC-TRE-03001

Fig. 2 Concept of modeled societies

Table 1 Characteristics of modeled societies

Society Model	Scientific Technology	Record Preservation in the Form of Social System	Knowledge Level and Language	Other Cultural Characteristics
A	•Advanced scientific technology and stable information network.	•Advanced management system for documentary records. •Possible international management system.	•Advanced level of knowledge, and substantial capability of understanding our language in spite of its transformation.	•High level of awareness toward record preservation, but social metabolism is so active that possibilities of old things being replaced by new ones would be high.
B	•Similar level of scientific technology and information network.	•Similar social systems maintained and public records offices and other organizations in charge of management and preservation of records in place.	•Similar level of knowledge. •In spite of a gradual transformation of languages, our languages could be understood.	•Similar level of awareness toward record preservation. •Social metabolism is not so high as in Society A, and upgrading activities are not so active.
C	•Lower level of scientific technology, and less possibility of an information network.	•Less possibility of record management and preservation in the form of a social system.	•Lower level of knowledge. •Due to a gradual transformation of languages, it is impossible to understand our languages.	•Lower level of awareness toward record preservation. •Strong religious influence.
D	•Unsatisfactory level of scientific technology.	•Lack of record management and preservation in the form of a social system.	•No common language would exist. •Our languages would not be understood.	•Similar to prehistoric society.
E	•Quite different scientific technology.	•Quite different social system.	•Less possibilities of understanding our language, but it would be possible to understand encoded messages.	•Quite different values.

A CASE STUDY OF RECORD PRESERVATION SYSTEM

To demonstrate meeting requirements and classifying the issues of record preservation, a record preservation system was tentatively formulated. U.S. WIPP (SNL, 1993) classified levels of the information to be preserved from Level I to V and discussed preservation methods. We have adapted markers and monuments to Level I to III messages for prevention of future generations' unintentional access to repository, and also adopted documents to Level IV and V information for future generations' decision-making (Table 3).

We have considered two categories of record preservation system. One is a "*relay system*", by which the records is kept, renewed and communicated through generations within a social system. Another is a "*permanent system*", by which the record and information are kept and communicated by using durable recording media such as markers and monuments.

Fig. 3 shows the hierarchical construction of requirements for robust record preservation system.

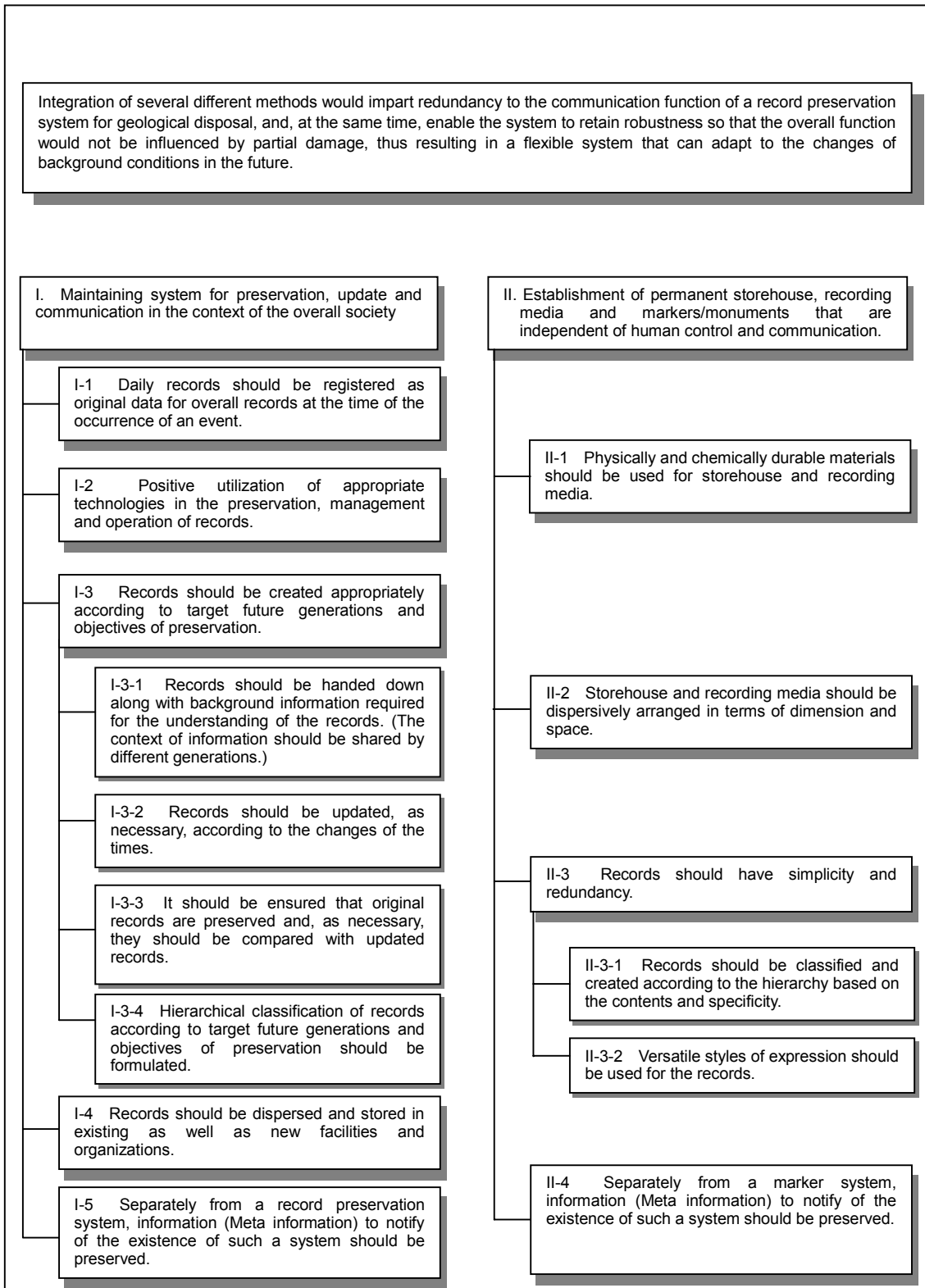
In order to discuss on the functions and issues of record preservation system, we formulated scenarios for future generations' retrieval of information and their access to the repository (Fig. 4). The upper part of this scenario illustrates the flow in the *relay system*, of which future generations' way to get information and make their decisions on the repository. The lower part of this scenario illustrates the flows in the *permanent system*, of which future generations' actions beginning from learning the existence of repository by encountering the leveled information to the discontinuation of their access to repository. Meanwhile, this scenario also illustrates unfavorable case that markers and other facilities were lost or future generations would not understand the meaning of the messages, thereby resulting in unintentional intrusion into the repository. In order to avoid these unfavorable cases to the greatest extent possible, it is pointed out that further examination should be made on the arrangement of markers, monuments and storehouse of permanent records, as well as their durability and information communication technologies such as languages, semiotic expressions, psychological means.

Table 3 Classified level, contents and preservation methods of information

Objective of Record Preservation	Level Classification and Contents ^(*)		Preservation Method
	Level	Contents	
Prevention of Unintentional Access to Repository	I/II	1. Information to be encountered first "Something artificial exists around here and it represents danger."	
	III	2. Information necessary after the danger is perceived "High-level radioactive waste exists" <ul style="list-style-type: none"> •What is high-level radioactive waste? •Why does it exist? •When was it disposed of? •Who disposed of the waste? •How is the information preserved? "It exists deep under the ground nearby." <ul style="list-style-type: none"> •Horizontal position and depth of underground facility "More detailed information exists" <ul style="list-style-type: none"> •Structure of marker system, domestic and overseas archives. 	
Future Generations' Decision-making	IV	3. Detailed information <ul style="list-style-type: none"> •Geological information •Geological location •Geological environment conditions •Location and the depth of repository •Specifications of repository •Characteristics of the waste •Safety assessment carried out by our generation •Original data of the safety assessment 	
	V	4. Further detailed information	

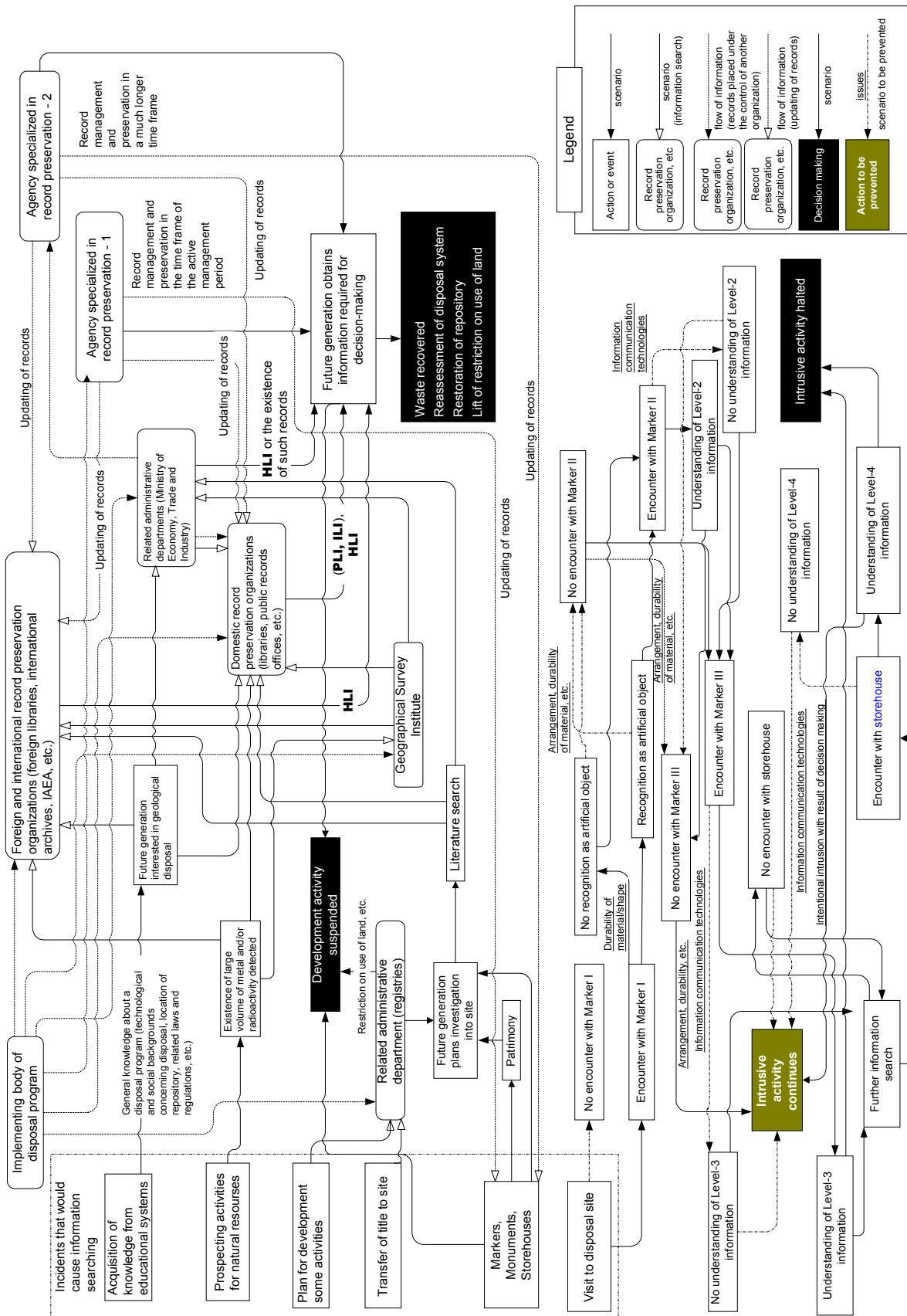
^(*) Referred to SNL, 1993 etc.

RWMC-TRE-03001



RWMC-TRE-03001

Fig. 3 Hierarchical construction of requirements for record preservation



PLI : Primary Level Information ILI : Intermediate Level Information HLI : High Level Information (IAEA 1999)

Fig. 4 A scenario of future generations' information retrieval and decision-making

DEVELOPMENT OF DURABLE RECORDING MEDIA

Paper, film and digital media are usually used as recording media for preserving documents in record management institutions such as national and regional archives. Paper, most common for documents, could remain more than several hundreds years in an appropriate storage environment. For example, there has been developed, in Japan, paper with durability up to one thousand years according to the ASTM standard. However, quantitative assessment concerning the long-term durability of written ink has not been confirmed.

Though the current technology is trying to strengthen the long-term durability of these media, it would be needed the human control for keeping suitable environment such as temperature and humidity to preserve documents. To preserve documents without human control during a thousand years or more, physically durable recording media is desirable.

Engraving experiments on the selected artificial materials such as metals and ceramics (Table 4) were carried out by laser technology to develop a long-term recording media. High-accuracy engraving tests were performed using the dot matrix method.

The results of the test show that lines, characters, patterns, and shading can be engraved at a certain level of quality (Figure 5). Among other things, silicon carbide, which is superior in strength, corrosion resistance and wear, has been indicated to be a promising material for long-term record preservation.

Figure 6 shows the experimentally engraved sintered silicon carbide. The left figure is a reproduction of Figure 1 on this paper onto a 10 cm × 10 cm sized plate. The right figure shows the reproduction of several pages of sentences at A4 size on a plate. The Chinese character, which is also used in Japanese language, has a complex structure in comparison with the alphabetical letter. In this case, the size of the engraved characters is 2-point, or nearly 0.7 cm, and sentences are readable with the naked eye or using a magnifying glass (Figure 7). As an ideogram, the Chinese character is thought to have an advantage for communicating messages for future generations as compared to phonogram system, such as the alphabetic system.

When a document that has 500 pages of A4 size paper is engraved on both sides of sintered silicon carbide plate that has the size of 10 cm × 10 cm and 1mm in thickness, the number of plate needed for a series of document package is estimated to be 32 pieces, then the total thickness is 32 mm.

The examination has shown the possibility of long-term preservation of documentation records as a *permanent system*

Table 4 List of materials used for experiments

Material	Density (g/cm ³)	Hardness (MPa)
Hastelloy C22 (Ni-base alloy)	8.7	0.6
Alumina sintered compact (Al ₂ O ₃ 99.9%)	4.0	19
Zirconia sintered compact (ZrO ₂ 94.7%)	5.5-6.1	12-14
Silicon carbide sintered compact (SiC 98%)	3.2	25-31
Silicon carbide-CVD	3.2	34

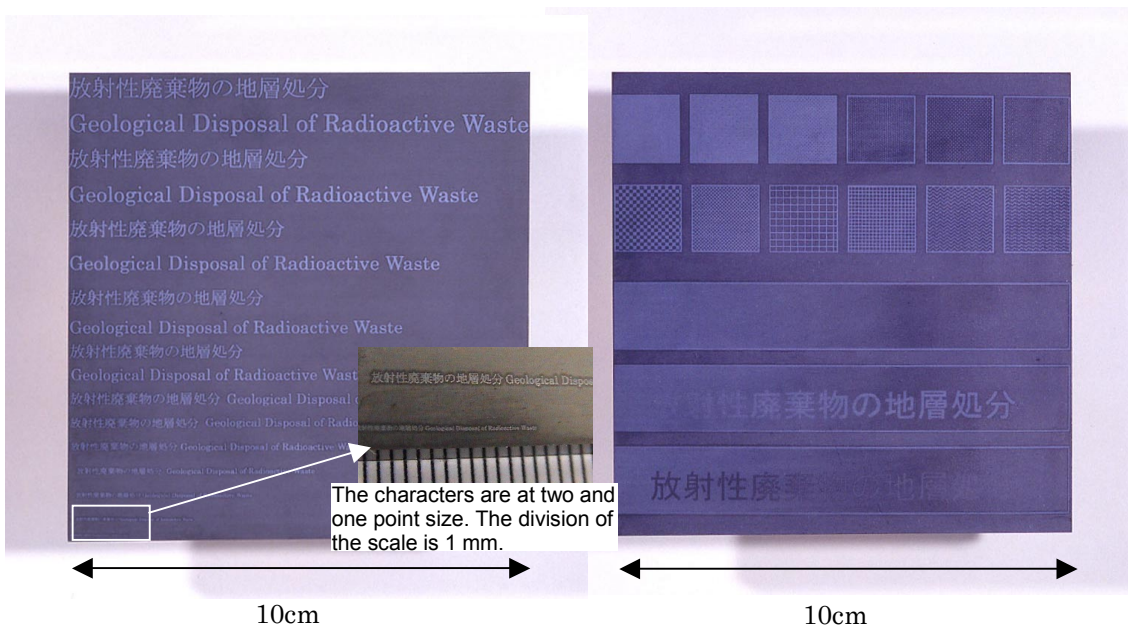


Fig. 5 Results of engraving on sintered SiC plates by dot matrix methods

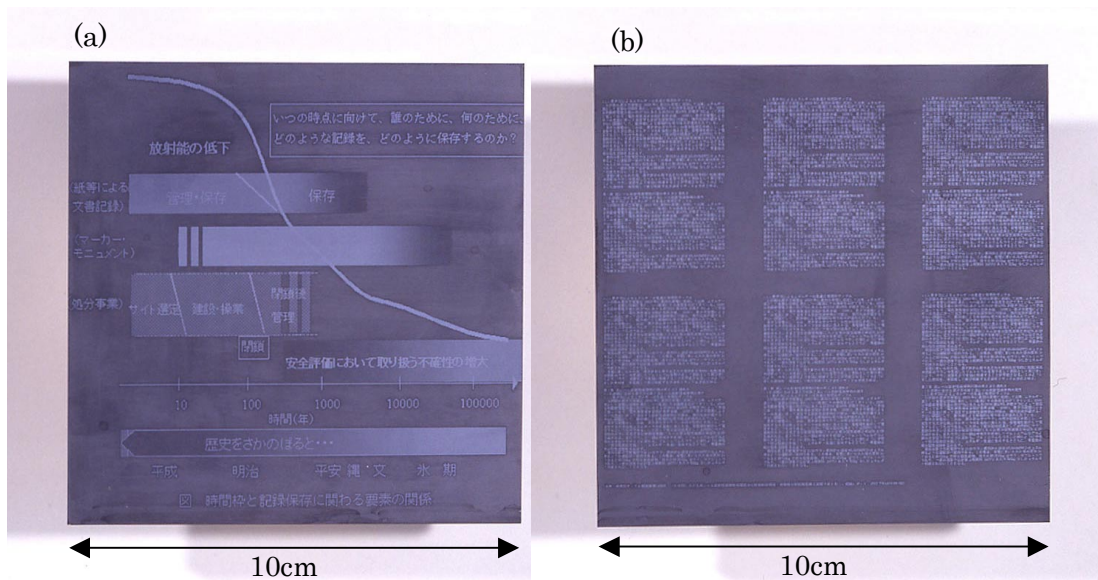
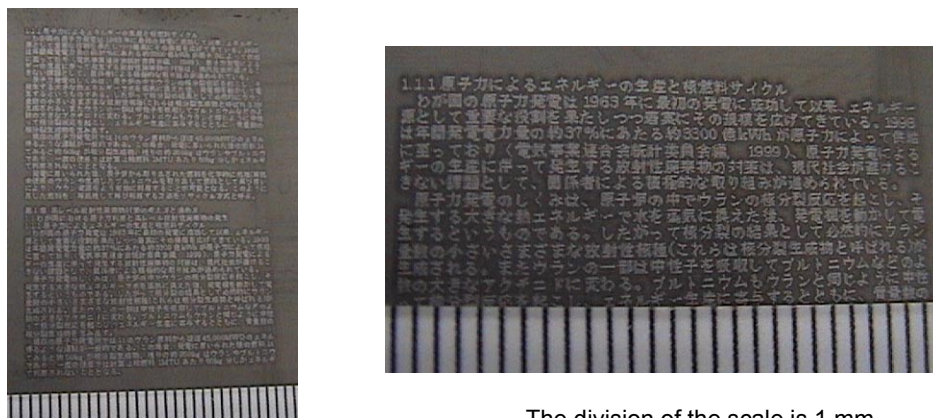


Fig. 6 Figures (a) and down-sized sentences (b) engraved on sintered SiC plate



The division of the scale is 1 mm.

Fig. 7 Sentences engraved in 2-point size (enlarged picture of Fig. 6(b))

CONCLUSIONS

Record preservation in HLW geological disposal is vital from the viewpoint of intergenerational ethics. We have pointed out that record preservation is not only a methodology intended for future generations, but also a meta-signal to the present generation. “Do our best” for the future generations might be important for the present generation to accept the geological disposal.

In this study we have arranged the conceptual requirements and elements for establishment of the robust record preservation system, and developed the durable recording media to indicate the technical feasibility of long-term record preservation.

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OECD/NEA (1982): Disposal of Radioactive Waste, An Overview of the Principles Involved.

OECD/NEA (1995): The Environmental and Ethical Basis of Geological Disposal of Long-Lived Radioactive Wastes, A Collective Opinion of the Radioactive Waste Management Committee of the OECD Nuclear Energy Agency

IAEA (1999): Maintenance of records for radioactive waste disposal, IAEA-TECDOC-1097.

SNL (1993): Expert Judgment on Markers to Deter Inadvertent Human Intrusion into the Waste Isolation Pilot Plant, Sandia National Laboratories, SAND92-1382.

KAN-1.3 (1993): Conservation and Retrieval of Information – Elements of a Strategy to Inform Future Societies about Nuclear Waste Repositories., Final Report of the Nordic Nuclear Safety Research Project KAN-1.3

RWMC (2003): Record Preservation Study on Geological Disposal. RWMC TECHNICAL REPORT, RWMC-TRE-03001.



Current status on record preservation in Japan

January 28, 2003

Radioactive Waste Management
Funding and Research Center
(RWMC)



Specified Radioactive Waste Final Disposal Act...May 2000

- Overall implementation scheme & three steps site selection process
- Implementing entity, NUMO
- Fund managing entity, RWMC
- ...**METI shall permanently retain the records submitted in accordance with the provision of the preceding clause.**
- ...(note)**National Archives shall not accept the documents in use.**
- ...**Site selection process begun in Dec.2002**

RWMC's record preservation study

To provide information for government and related bodies to utilize in formulating programs on the record preservation

- **Significance...re-confirmed**
 - Why, How long, etc.
- **Requirements**
 - Historical and current issues ...investigated
 - Requirements & applicable elements ...clarified
- **Robustness & Redundancy ...confirmed**
- **Laser engraving technology on SiC plate ...proved**



Supplement



The cost evaluation regarding SiC

- Number of pages of original document: 500
- Unit cost for a SiC sintered plate with engraving on both side (size: 10cm*10cm*1mm): 600 Euro
 - 200 Euro for material preparation
 - 200 Euro for laser engraving × 2 = 400 Euro
- Total number of plates needed: 42
- The total cost: 25,200 Euro

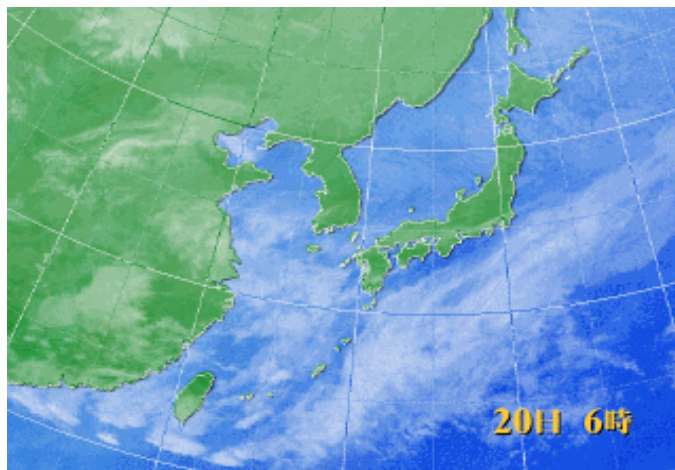
Examples of Long-term Record Preservation in Japanese History

Nozomu MATSUBARA
(University of Tokyo)

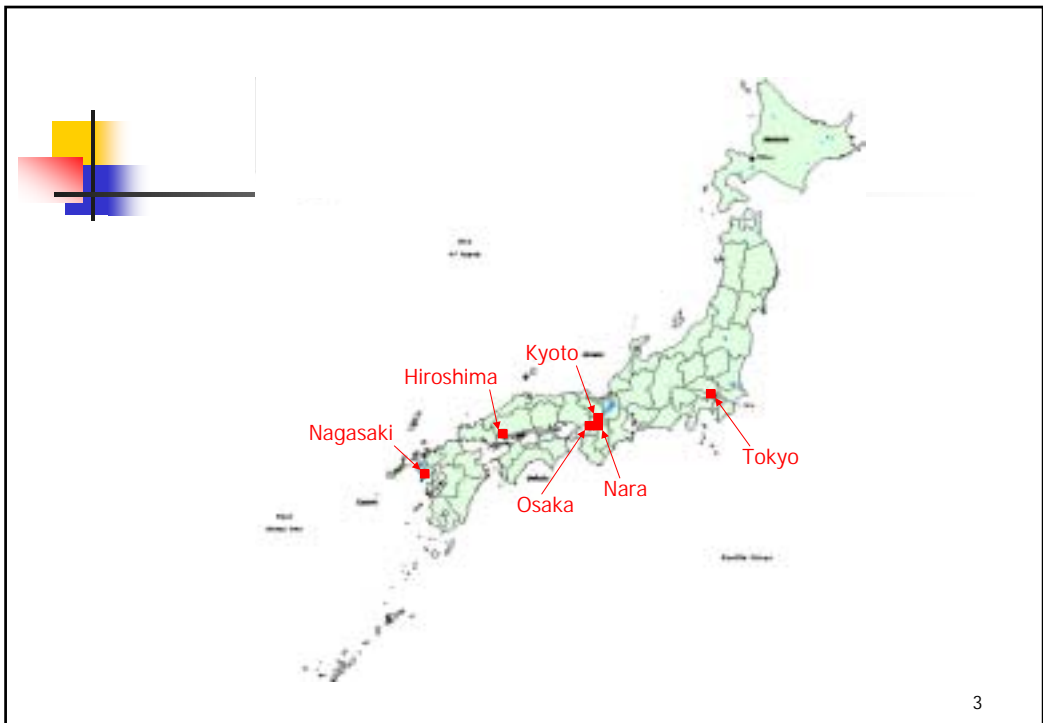
1

Introduction

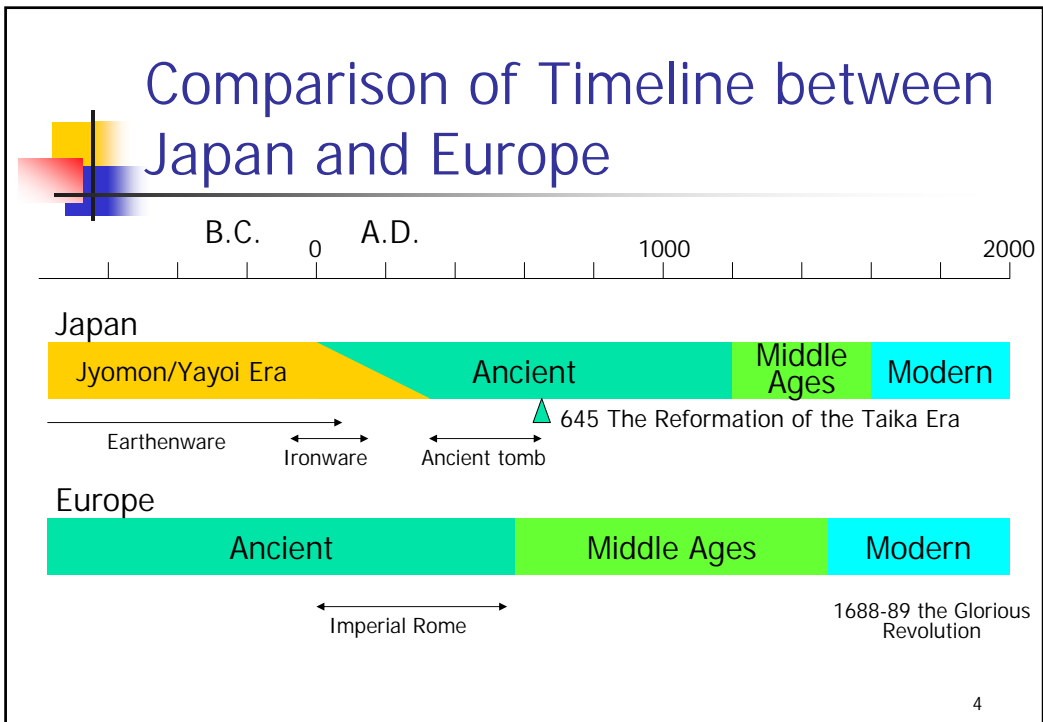
- Geographic Situation of Japan -



2

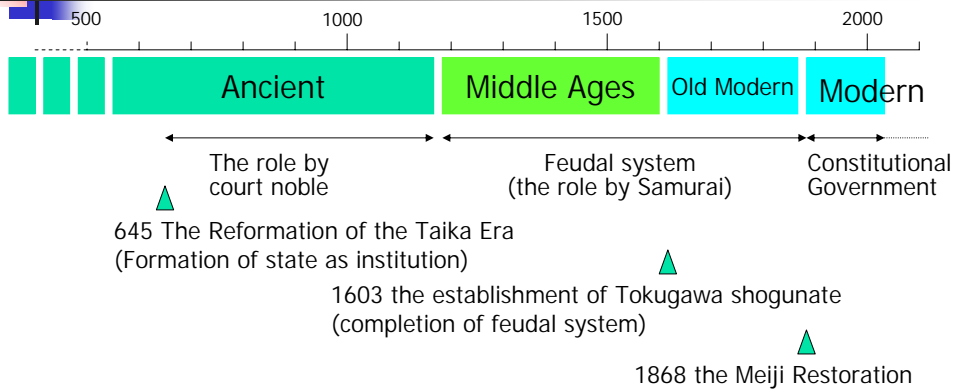


3



4

Overview of History of Japan since 5 century



5

Earthenware of Johmon Era Older than BC. 4th century



6

KOFUN (Ancient Tomb), 3-7 centuries



The group of KOFUNS and discovered Iron Sword with engraved message, 5th century. The Sakitama KOFUNS in Saitama

7

KOFUN (Ancient Tomb) 3-7 centuries



Entrance of a KOFUN. Fukuyama in Hiroshima



Stone room in KOFUN.
Tsukayama KOFUN, Nara

Example of the lost documents in history

- Kogonenjyaku (established in 670)
 - The first “family register” in the history of Japan
 - Though The Kogonenjyaku had been required to be preserved permanently by The Law of “Taihou” (702), its document has not existed in the history.
 - Why lost? : change of social system?, lost of its own value?, ...

9

ITABI (monolith with message) from Middle Ages (13c. – 16c.)



Many ITABIs have been made by schist rocks

五国史
通史編2中世」より)

SYOSO-IN, the Treasure House since 8th century, Nara



11

Treasures of the SYOSO-IN



Document written by Emperor
Syo-mu (701-756)



Pitcher

12



Historical Archive of Japan

- There are many historical documentary records of Middle Ages (12c.–16c.) in Japan. They had been kept in and relayed through:
 - Temples,
 - Houses of court nobles and samurai class.
- Libraries since Edo Era (17c-) exists at present.

13



Historical recording media for documents in Japan



Combination of Japanese paper and Chinese ink



Making the Japanese paper

14

Disaster and War



Many important records had been lost in the 1923 great earthquake in Tokyo and the World War-II

15

Record Management and Preservation



(National Archives of Japan)

16



Summary of workshop



Record management systems

- Existing local systems developed for operational needs.
- Strategic information system: focus of our discussion



Significance of record preservation

- One of issues of institutional control:
 - may help to provide societal confidence.
- Objectives:
 - To prevent future generations from unintentional access to the repository.
 - To provide future generations with information necessary for their own decision-making on the repository.



Current situation regarding record preservation in each country

- Regulations or guidelines regarding record preservation:
 - Regulatory guidance
 - Technical standard
 - Archives Law (comprehensive)
- Phase
 - Implementation
 - Programming or under development
 - R&D



Actual issues in current status

- Establishment of the **strategic** record management system.
- Domestic actions and joint international actions.



Technical and methodological issues

- Recording media: durability, accessibility, cost, ...
- Archiving and markers



Consideration of period

- Institutional period
- Non-institutional period



Strategic issues

- Consideration of cost and benefit.



Proposed next step

- Opportunity to discuss by:
 - international organization base,
 - host country rotating,
 - in cooperation with related academic society, e.g., the field of archives, history, sociology.

LASERGLYPH

Laser Engraving Technology on
Sintered Silicon Carbide Thin Plate
For Long-term Record Preservation



LASERGLYPH

For further information please contact :

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Technical cooperation

MITSUBISHI  **MITSUBISHI MATERIALS** Nuclear Fuel Cycle Technology Center

www.mmc.co.jp

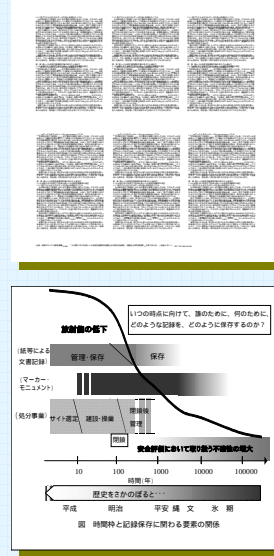
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Laser Engraving – Long-term Preservation of Documentary Archives –



Radioactive Waste Management Funding and Research Center (RWMC) has developed a new technology in cooperation with Mitsubishi Materials Co., to engrave on sintered SiC thin plate, which enables the long-term preservation of important documents and as archives for future generations.



Preparation of Import Data

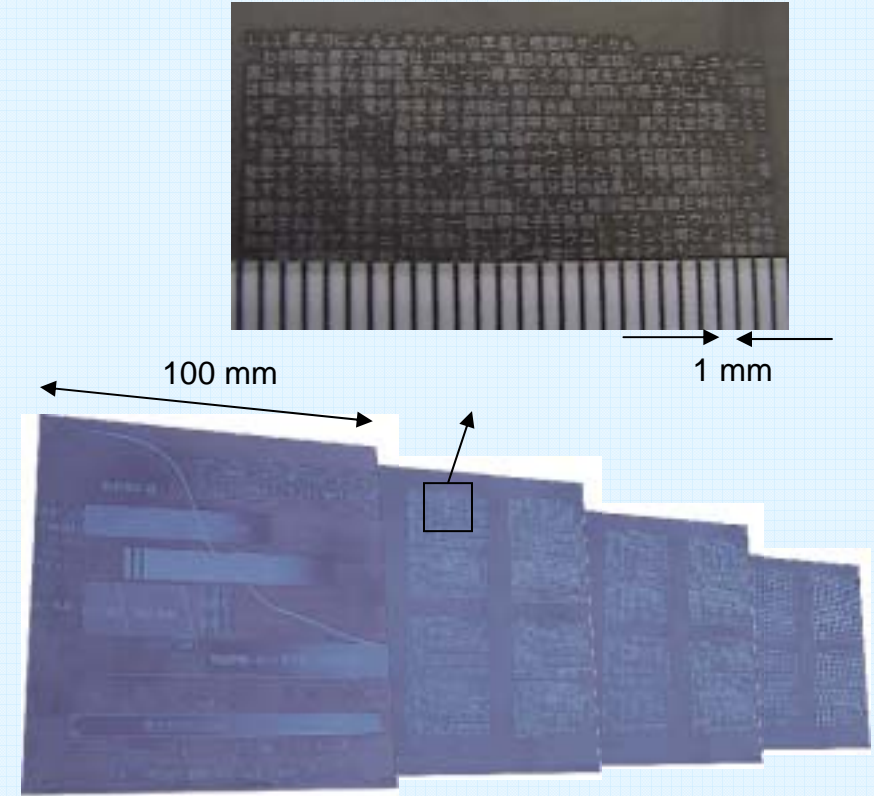
The files of Windows applications can be imported to the Laser marking system. Certainly, paper documents can be imported by use of the scanner, if you need. With respect to the density of characters, for example, with 2-point characters, information totaling 6 pages of A4 size can be engraved on a 10 cm x 10 cm plate on one side.



Laser technologies Inc.

Engraving

Laser machining method is well suited to express characters or figures on the SiC materials. Based on the results of the machining tests, it was confirmed that characters and patterns can be expressed and shading and gradation can also be expressed.



Laser engraved SiC plates

Background

Extensive discussions have been done on the environmental and ethical concerns for geological disposal of radioactive wastes. For example, in 1995, OECD/NEA issued a report summarizing the opinions of experts, and expressed the achievement on interest focuses of ethical concerns. One of them was “intergenerational equity” by choosing technologies and strategies which minimize the resource and risk burdens passed to future generations by current generations which produce the wastes. And it was also expressed that our actions and decisions will be more acceptable if appropriate degrees of equity or justice are respected, and we do not unduly restrict the freedom of choice of future generations.*

Besides the provision of scientific and technological basis and data related to the safety assessment of geological disposal, it is also important to develop options from social and ethical viewpoints for building the public confidence in geological disposal. Institutional control including record preservation should be effective in minimizing the possibilities of unintentional human access to the geological repository.

Silicon carbide plates as long-term record preservation media

Paper, film and digital media are usually used as recording media for preserving documents in record management institutions such as national and regional archives. Paper, most common for documents, could remain more than several hundreds years in an appropriate storage environment but combustible. And, to date, it has not been confirmed of the quantitative assessment concerning the long-term durability of ink materials. So, our target is to develop more durable recording media which can last written messages over thousands of years independent on any human control nor storage environment. Table 1 shows the comparison of durability and required technology level for recognition of various recording media. Silicon carbide (SiC) is a typical engineering ceramics. The SiC is one of the hard materials to the next of the diamond (Table 2), and has strong resistance against heat, wear and chemical impacts. The SiC thin plate is purchasing as commercial industrial materials.

Engraving the records by laser

Engraving the characters and graphics on the silicon carbide plate is achieved by Laser Technologies Inc., Japan (www.lti.co.jp). From the engraving results, a certain level of quality was confirmed with SiC. The character of 1-point (0.35mm) size engraved by this laser marking system was fully able to be distinguished.

When a document that has 500 pages of A4 sized paper is engraved with 2-points (0.7mm) sized character on both sides of SiC plate that has the size of 10cm x 10cm and 1mm in thickness, the number of plate needed for a series of document package is estimated to be 32 pieces, then the total thickness is 32mm.

Application of LASERGLYPH

Following application will be expected as archives for future generations.

- documentary records
- face plate of monument

Now the recording media using SiC plate can be expected to be applied in not only in the field of nuclear waste disposal but also wider area which requires long-term preservation of important records such as in the field of hazardous material disposal, national archives, etc.

*OECD/NEA(1995): The environmental and Ethical Basis of Geological Disposal of Long-Lived Radioactive Waste, A Collective Opinion of the Radioactive Waste Management Committee of the OECD Nuclear Energy Agency

Table 1

Materials	Durability of recording media		Required technology level for recognition
	Estimated life time	Dependence on preserving environment	
Digital media	several decays	high	high
Paper and film	several centuries - millennium	high	low
metal and ceramics	more than thousand years	low	low

Table 2

Materials	Vickers hardness
Stainless steel	330
Quartz	800
Zirconia	1300
Alumina	1600
Silicon nitride	1600
Silicon carbide	2500
Diamond	8500

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