nagra we care

annual report 2009

Foreword

Pankraz Freitag, President of the Board of Directors

Following the public announcement of Nagra's proposed geological siting regions for deep repositories towards the end of 2008, the main focus of activities in the year 2009 was on the detailed review of these proposals by the Swiss Federal Nuclear Safety Inspectorate (ENSI).

For Nagra, this meant processing and responding to the dozens of questions that arose as part of the review process. With absolute priority being assigned to safety, the discussions surrounding the proposals had to be conducted meticulously and at the highest scientific level.

It was therefore with a great sense of pride and satisfaction that we learned at the beginning of 2010 that ENSI had given its full approval to the proposals for the siting regions. This decision was based on a detailed consideration of the scientific background justifying the selection and was supported by other experts in the field.

In parallel with this, the activities surrounding the Sectoral Plan process also continued, as did communication efforts at different levels using a wide range of media.

Only by continuing our scientific work, using the full breadth of our knowledge and a comprehensive, targeted information strategy, will we gradually come closer to achieving our ultimate goal of realising safe geological repositories.

I would like to thank the Members of the Board of Directors for their cooperation during the year. My thanks also go to the Executive Board and to all Nagra employees for their great commitment and the successful outcome of their efforts.

Pankraz Freitag

Landscape to the east of the Grimsel pass.

Thomas Ernst, Chief Executive Officer

The year 2009 was dominated by the review of Nagra's proposals for siting regions for deep geological repositories for all radioactive waste arising in Switzerland. The six siting proposals were submitted to the lead organisation – the Federal Office of Energy (SFOE) – in October 2008. In 2009, the main task of the regulatory authority – the Swiss Federal Nuclear Safety Inspectorate (ENSI) – was to review these proposals in accordance with the requirements set out in the conceptual part of the Sectoral Plan. ENSI was supported in this review by the Commission for Nuclear Waste Management (KNE) and other experts.

The ENSI review was published at the end of February 2010. Among other things, ENSI had to decide whether Nagra had given proper consideration to all the possibilities for locating a repository in the underground environment of Switzerland. This was answered with a clear "yes", with ENSI approving all of Nagra's proposals from the viewpoint of safety and engineering feasibility. An important requirement for successful continuation of Stage 1 of the Sectoral Plan process has thus been met.

The Sectoral Plan process remained on course during the year, with different groups taking up their activities. The SFOE also initiated the setting up of regional participation structures. The provisional planning perimeters delimiting the areas for construction of surface facilities were drawn up by the Federal Office of Spatial Development (FOSD) together with the responsible cantonal authorities and were announced by the SFOE at the end of the year. A study on the spatial planning evaluation method to be applied in Stage 2 was also completed and the Technical Forum on Safety was occupied with answering questions from interested parties.

All the documentation for Stage 1 will be submitted as planned by the Federal Council for broad consultation in 2010.

The focus of Nagra's activities in 2009 was already on preparing for Stage 2 of the Sectoral Plan process, with work moving forward on the provisional safety analyses, the required geoscientific background and designing the surface facilities for the repositories. The stage has thus been set for proposing potential sites for the surface facilities to the SFOE at the beginning of Stage 2; these proposals will then be considered by the regional participation bodies.

Behind all these challenging tasks aimed at realising safe long-term waste disposal are the staff of Nagra. With their competence, commitment and wealth of ideas, they strive every day to achieve this mission of national significance. For this I would like to thank them all.

Dr. Thomas Ernst

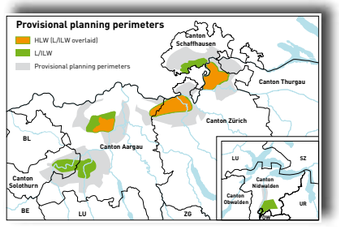
Highlights in 2009

1st January: Pankraz Freitag, new President of Nagra

29th May: Start of the information tour

23rd June: Official farewell to Hans Issler

25th September: 25-year celebration at the Grimsel Test Site



10th December: Federal Government announces the planning perimeters

January Nagra begins the year with Pankraz Freitag as the new President of the Board of Directors. Mr. Freitag is a Member of the Council of States (upper house of the Federal Assembly) for Canton Glarus. His previous position as a member of the cantonal government and director of public works provided him with wide experience in the areas of construction and environmental issues.

February The expansion of the Mont Terri Rock Laboratory with the new Gallery 08 is completed. Tours of the research facility are conducted throughout the year for interested groups from both Switzerland and abroad.

May The Federal Council sets up the Waste Management Advisory Council. This independent body has the task of monitoring the Sectoral Plan process and advising the federal authorities on the implementation of the site selection procedure.

May Nagra begins its information tour. During spring and summer, Nagra staff visit several locations in the potential siting regions and discuss issues of interest and concern with the public.

June The Technical Forum on Safety holds its first meeting. The Forum meets four times a year and is responsible for discussing and answering safety-related questions in the context of the site selection process. The Forum is made up of representatives of the safety authorities, the Cantons, the siting regions and Nagra.

June At its annual general meeting, Nagra officially bids farewell to the former President of the Board of Directors Hans Issler, who stepped down at the end of 2008. His successor, Pankraz Freitag, thanked him for his many years of service in the area of radioactive waste management.

June The long-term monitoring system in operation in the Benken borehole since 1999 is replaced. The system delivers hydrogeological data on the Opalinus Clay in the region of Northern Switzerland.

August Nagra announces plans for constructing ten new measuring stations in Northern Switzerland for the satellite-based precision measuring network GNSS (Global Navigation Satellite System). This complements the existing network operated by the Federal Office of Topography (Swisstopo).

September Nagra celebrates 25 years of research at the Grimsel Test Site together with national and international guests from the fields of science, politics and economy. The event is commemorated with a book of photographs documenting the history of the Test Site. Around 1750 people visit the laboratory over the course of the year.

November Nagra publishes its Research, Development and Demonstration (RD&D) plan (Nagra Technical Report 09-06), outlining the scientific and technical work that will be necessary for implementing repository projects in the coming decades.

December The Federal Government publishes the provisional planning perimeters as part of the Sectoral Plan process. These delimit the areas in which the surface facilities of the repositories could be constructed. The communities lying within the perimeters are included in the regional participation processes that will be conducted as part of site selection.

The basis of our work

In the management of radioactive waste, highest priority is assigned to safety in all project phases. We therefore conduct our work with scientific diligence and in accordance with objectively verifiable principles.

Protected mineral fracture at Gerstenegg. A tour of the Grimsel Test Site can be combined with a visit to this spectacular "crystal cave".

Our mandate

Radioactive waste arises in Switzerland from the operation and decommissioning of the nuclear power plants, as well as from the use of radioactive materials in the areas of medicine, industry and research (MIR waste). According to the Nuclear Energy Act of 2003, the producers of radioactive waste are responsible – under the supervision of the federal authorities – for the permanent safe management and disposal of the waste. The operators of the nuclear power plants and the Swiss Confederation, which is responsible for MIR waste, set up Nagra in 1972 and assigned it the task of safely disposing of all waste arising in Switzerland.

The Nuclear Energy Act entered into force in February 2005; it calls for deep geological disposal for all types of waste produced in Switzerland. Two repositories are planned: one for low- and intermediate-level waste (L/ILW) and one for spent fuel, high-level and long-lived intermediate-level waste (SF/HLW/ILW).

Nagra is responsible for preparing the technical and scientific basis for the safe, long-term management of radioactive waste. As part of the Sectoral Plan process for selecting sites for geological repositories, which is led by the Federal Government, Nagra's task is to propose geological siting regions and then disposal sites and to submit general licence applications for the repositories in accordance with the requirements set out in the conceptual part of the Plan. Nagra ensures ongoing inventorying of radioactive materials and advises the waste producers on conditioning of the waste to meet disposal criteria. With a view to fulfilling these responsibilities, Nagra has been conducting a broadly based research and development programme since the mid-seventies. The work is carried out in close cooperation with the Paul Scherrer Institute (PSI, Villigen) and various universities and research institutes both in Switzerland and abroad.

Our work

- Cooperating (on behalf of the waste producers) with the authorities within the framework set by the Sectoral Plan process.
- Characterisation and ongoing inventorying of radioactive materials as a basis for planning disposal projects; checking waste specifications as part of official waste clearance procedures and as a service to the members of the Nagra Cooperative.
- Acquisition and evaluation of the field data required for safety assessment and disposal projects.
- Project studies providing input for designing repository installations and engineered barrier systems, and for planning operating procedures.
- Ongoing analysis of results and data within the context of safety assessment studies and evaluation of information with a view to licensing procedures.
- Development of databases and fine-tuning of the methods used to evaluate disposal system behaviour; verification and validation of the data and models used in performance assessment.
- Active participation in international collaborative projects, with the aim of coordinating and optimising planning and development activities.
- Fulfilling responsibilities in the areas of communication and information, in particular keeping the public informed on the current status of the disposal programmes.
- Providing expert services to third parties.

Developments in 2009

The Sectoral Plan process led by the Federal Government regulates the search for sites for geological repositories. Six regions in northern and central Switzerland have been included in the selection process.

Legislation, authorities

Legal framework

The legal provisions applying to radioactive waste management are contained in the Nuclear Energy Act and the associated Nuclear Energy Ordinance. Both entered into force on 1st February 2005.

The following principles apply:

- Radioactive materials should be handled in such a way as to minimise waste production.
- Radioactive waste must be disposed of in a way that ensures the long-term protection of man and the environment.
- In principle, radioactive waste arising in Switzerland must be disposed of within Switzerland.
- The duty of disposal lies with the waste producers.
- The strategy specified for all waste types is monitored deep geological disposal.
- The waste producers are required to produce a waste management programme (Article 32 of the Nuclear Energy Act), which must be reviewed and approved by the Federal Government.
- The licensing procedures are focused at federal level. The general licence for a nuclear installation is subject to an optional national referendum. Participation of the siting Cantons, neighbouring Cantons and neighbouring countries in the process is assured.
- The Federal Government has to define the objectives and requirements for the site selection procedure in a Sectoral Plan.
- The costs of decommissioning and waste management are to be covered in funds set up by the waste producers and supervised by the Federal Government

Swiss Federal Nuclear Safety Inspectorate (ENSI)

The provisions of the Act on the Federal Nuclear Safety Inspectorate (ENSI) that apply to the ENSI Board entered into force on 1st January 2008 to allow the Board to make preparations for the transition from HSK to ENSI. This was followed in January 2009 by the remaining provisions of the Act and the supporting Ordinance. The effect of the legislation is to make the former HSK an independent organ of the Federal Government under public law. ENSI is led by the ENSI Board, which is responsible for electing the Executive Management and defining the strategic objectives.

The Federal Commission for the Safety of Nuclear Installations (KSA) was replaced on 1st January 2008 by the Commission for Nuclear Safety (KNS). The Ordinance on KNS entered into force on 1st January 2009.

Decommissioning and Waste Management Funds

The purpose of the Waste Management Fund is to secure the costs of disposal of operational radioactive waste and spent fuel elements following the decommissioning of the nuclear power plants. The most important cost components are containers for waste transport and storage, transport, reprocessing and disposal of spent fuel assemblies, waste treatment and interim storage and, finally, disposal of the waste in two deep geological repositories. The Decommissioning Fund secures the costs of decommissioning and dismantling of the nuclear power plants and disposal of the resulting waste.

The funds are supervised by the Federal Government. More detailed information can be found on the website www.entsorgungsfonds.ch. The cost estimates that form the basis for calculating the contributions to be made by the waste producers to the funds will be updated in 2011.

Sectoral Plan for Deep Geological Repositories

Article 5 of the Nuclear Energy Ordinance requires the objectives and criteria for the deep geological disposal of radioactive waste to be specified by the Federal Government in a Sectoral Plan. The Federal Council approved the conceptual part of the Sectoral Plan for Deep Geological Repositories on 2nd April 2008. The technical feasibility and safety of disposal had already been confirmed with the approval by the Federal Council of the "Entsorgungsnachweis" feasibility project in June 2006. At the same time, and based on a study commissioned by the SFOE, the Federal Council also came to the conclusion that waste disposal facilities could be constructed and operated in a way that is environmentally friendly and, overall, has a positive impact on regional economy. For siting decisions to be accepted, it is however imperative that those affected by these decisions be fully informed and involved in the selection process. The Sectoral Plan approach takes this important requirement into account.

The Sectoral Plan process (see Figure 1) will culminate in the granting of general licences for the repositories; the Swiss public is expected to vote on these in around ten years. According to the timetable, the repository for low- and intermediate-level waste will start operation from 2030 and the high-level waste repository from 2040. The Federal Council has decided not to

restrict the maximum disposal capacities for waste from the nuclear power plants – the capacities will be specified later with the general licences.

The Sectoral Plan process allows overarching coordination of all the impacts of a repository on spatial planning in a potential siting region and ensures early involvement of the affected Cantons and local communities and the authorities of neighbouring countries, as well as interested organisations in Switzerland and abroad.

Waste management programme as specified in the Nuclear Energy Act
Article 32 of the Nuclear Energy Act calls for a waste management programme to be prepared by the waste producers for all waste types. The programme is reviewed by the federal authorities and approved by the Federal Council. Together with the Sectoral Plan, the programme provides the basis for deciding on the way forward in Swiss waste management strategy. In line with the instructions given by the Federal Council, Nagra submitted the waste management programme to the authorities together with the siting proposals in October 2008. The review of the programme by ENSI will start in 2010 once the review of the siting proposals has been completed.

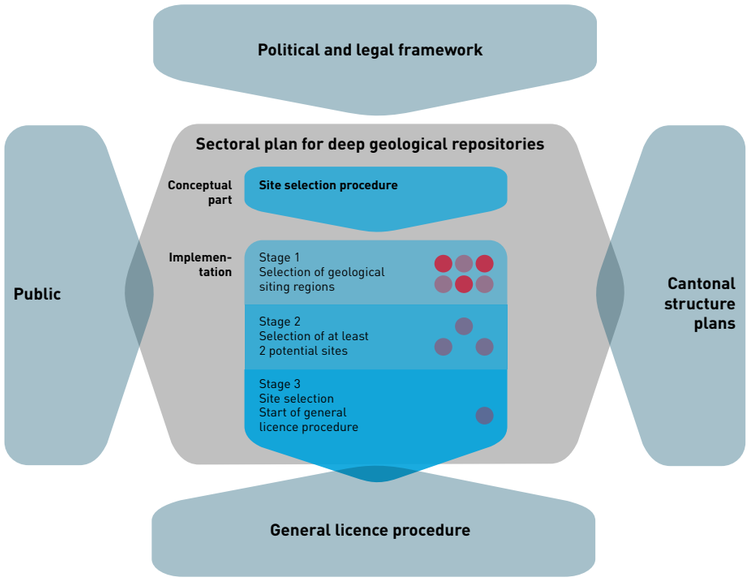


Figure 1: Stages, responsibilities and interactions in the Sectoral Plan for Deep Geological Repositories.

Inventory of radioactive materials

The five nuclear power plants generated around forty percent of total Swiss electricity production in 2009. The annual exchange of fuel assemblies produces spent fuel for disposal and low- and intermediate-level waste also arises from the operation of the power plants and from applications of radioactive materials in medicine, industry and research. An overview of waste types and volumes can be found on pages 54/55.

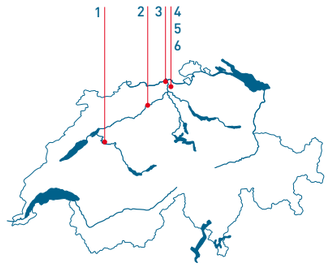
Nagra maintains a centralised inventory of existing radioactive waste and a Model Inventory of Radioactive Materials (MIRAM); the latter also contains information on future waste arisings. As a service to the Members of the Cooperative, the inventory of waste stored at the nuclear power plants, in the ZWILAG interim storage facility and in the Federal Government's interim storage facility was updated by carrying out extensive radiochemical measurements in specialised laboratories. For MIRAM, the inventories and key data for potential new power plants were modelled as realistically as possible and the processing of waste from current and future large-scale research facilities at PSI and CERN in Geneva were included. MIRAM is an important basis for the planning of facilities and operational procedures, as well as carrying out the safety analyses for the geological repositories.

Work continued and new studies started on particular classes of radioactive waste. A method for mineralisation of waste containing organic materials was evaluated and a cost study carried out for potential realisation of a treatment plant. The possibilities for melting metallic radioactive wastes were also clarified and a study on this will be completed in the coming year. Finally, work was initiated on determining the chemotoxic inventories of all categories of radioactive waste that will later be implemented in MIRAM.

To prepare for the inventorying of activated reactor components (reactor pressure vessel with internals, bioshield, etc.), a 3D model was prepared for NPP Mühleberg; this will also be used for the decommissioning studies planned for 2010/2011. The model allows neutron fluxes and radiological inventories to be calculated more realistically than before. Similar work has started for the other reactors.

Research and development on waste products continued successfully at PSI, with the focus on developing cement recipes for waste conditioned in ZWILAG. Disposability certification procedures were also carried out for waste from the nuclear power plants, ZWILAG and PSI. For waste from reprocessing that will be transported to ZWILAG in the future, preliminary clarification has been carried out on later acceptance in a geological repository.

The work described above is carried out in close collaboration with the waste producers and in accordance with the guidelines issued by the safety authority ENSI. Participation in international working groups also ensures that the inventorying and characterisation of radioactive waste in Switzerland is in line with internationally recognised standards.



Nuclear power plants and interim storage facilities
1 NPP Mühleberg
2 NPP Gösgen-Däniken
3 NPP Leibstadt
4 NPP Beznau
5 ZWILAG
6 Federal Government interim storage facility

Sectoral Plan process

From how to where

In June 2006, the Federal Council approved the demonstration of disposal feasibility (Entsorgungsnachweis) for high-level waste. The demonstration for low- and intermediate-level waste had already been approved in 1988, meaning that the fundamental question of how all types of radioactive waste can be safely disposed of in Switzerland has been answered. The question of where the required repositories should be constructed is being clarified as part of the Sectoral Plan process under the lead of the SFOE. In the coming years, a stepwise approach will be followed to evaluate and identify firstly potential siting regions and then disposal sites. Safety takes precedence over all other considerations during the entire process.

Federal Government lead – independent supervision

The lead in the Sectoral Plan process lies with the SFOE. Against a background of consultation and participatory processes, the authorities and the Federal Council will evaluate Nagra's siting proposals based on scientific-technical criteria. Cantons and local communities, neighbouring countries, interested organisations and associations, political parties and the public are brought into the process by the SFOE. Parliament, and ultimately the Swiss people (optional national referendum), have the final say on the general licence for a repository. Nagra's responsibility is to prepare the scientific and technical background; based on the safety criteria set out in the Sectoral Plan, Nagra submitted proposals for suitable geological siting regions to the SFOE at the beginning of Stage 1. Later, in the second stage, Nagra will propose sites for constructing the surface facilities. Applications are submitted for the necessary general licences in the third stage. ENSI – supported by independent experts – reviews Nagra's proposals.

Clear rules for site selection
With the approval of the conceptual part of the Sectoral Plan for Geological Repositories by the Federal Council on 2nd April 2008, the criteria, procedure and roles of those involved in the site selection process were clearly defined. The siting question will be clarified in three stages, working together with the Cantons and local communities. Safety has highest priority throughout the process, although spatial planning and socio-economic aspects are also considered.

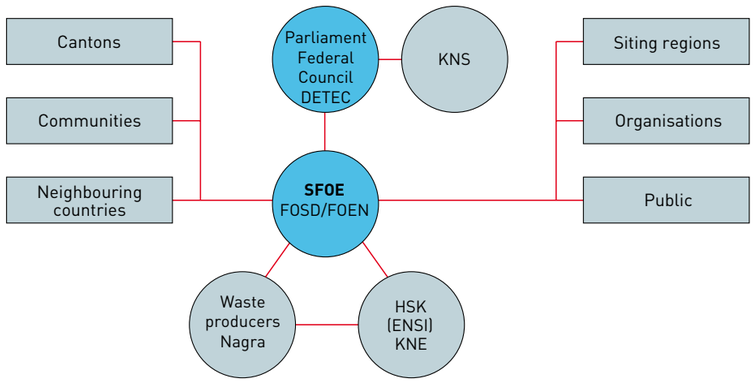


Figure 2: Actors in the site selection process

Proposals for geological siting regions

Following the Federal Council's decision to proceed with the conceptual part of the Sectoral Plan, the first stage began with Nagra making proposals, at the end of 2008, for three geological siting regions for the high-level waste repository and six for the low-and intermediate-level waste repository. Starting with the whole of Switzerland, Nagra applied a systematic selection process based on safety criteria and the narrowing-down steps specified in the Sectoral Plan. Nagra's proposals are based solely on scientific and technical criteria; a wider overall evaluation taking into account other aspects such as socio-economic impacts is a matter for the authorities and the Federal Council.

The report documenting the siting proposals (NTB 08-03) was submitted in October 2008 and the proposals were published by the SFOE on 6th November 2008. It was Nagra's decision to inform the public as early as possible about the results of its work and to complete the comprehensive reference documentation in stages. With the exception of the final editing and printing, the documentation was available to ENSI in electronic form at the end of 2008 and printing of the reports was completed in February 2009.

Proposals for geological siting regions
For the HLW repository, Nagra proposes the regions Zürcher Weinland (ZH, TG), North of Lägeren (ZH, AG) and Bözberg (AG). For the L/ILW repository, the proposed siting regions are Südranden (SH), Zürcher Weinland (ZH, TG), North of Lägeren (ZH, AG), Bözberg (AG), Jura-Südfuss (SO, AG) and Wellenberg (NW, OW). The Zürcher Weinland, North of Lägeren and Bözberg thus come into question for both types of repository.

Note: On 26th February 2010, ENSI approved all the proposed siting regions from the viewpoint of safety and engineering feasibility.

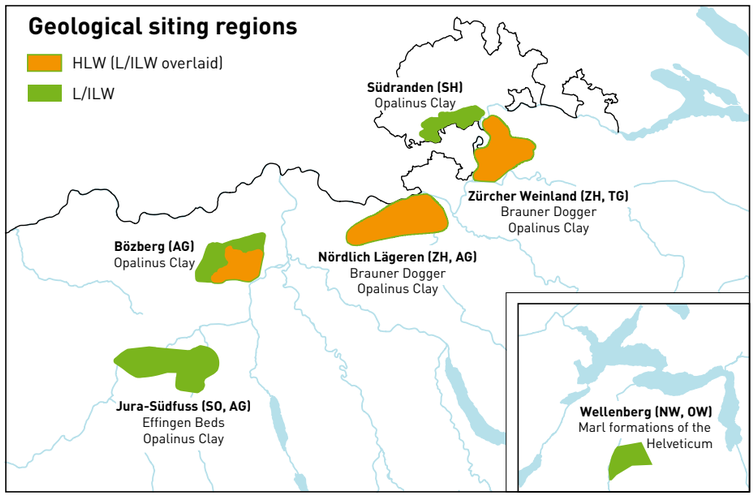


Figure 3: Geological siting regions proposed by Nagra

Provisional planning perimeters
Preparation of a spatial planning inventory by the Federal Office for Spatial Development (FOSD) runs in parallel with the safety analyses. Based on this inventory, and working together with the cantonal planning authorities, the FOSD has drawn up provisional planning perimeters, within which the surface facilities of the repositories could be constructed. These provisional perimeters were published by the SFOE in December 2009 and serve as the basis for defining the siting regions that will be involved in closer participation. In justified cases, additional neighbouring communities can be included in a siting region and the SFOE has published criteria for selection of such communities. The siting regions are expected to be defined in the first half of 2010.

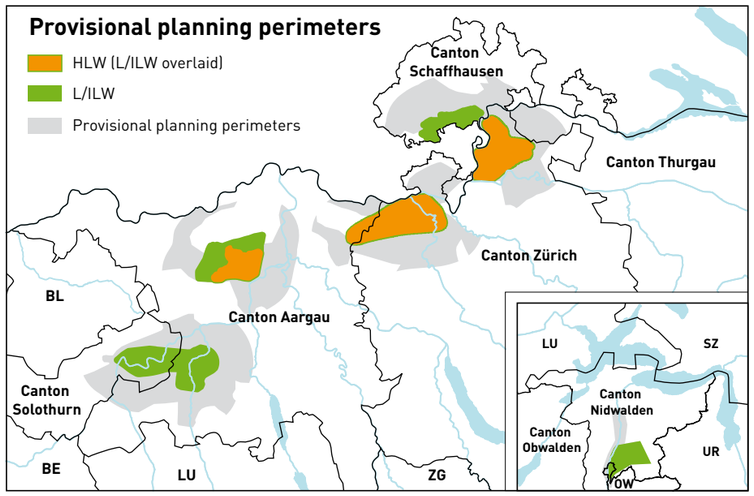


Figure 4: Provisional planning perimeters

Informing the affected public is a key issue for Nagra. In October 2009, the opportunity arose during a visit to the Mont Terri Rock Laboratory to inform a group from the Frick valley regional planning association about the ongoing site selection process and the research being conducted in the Laboratory.

At the invitation of Forum Opalinus, Nagra participated in a podium discussion in Marthalen (Zürcher Weinland) at the beginning of November 2009.

Background images (pages 14, 17, 19, 24, 29, 32) Impressions of investigations at the Grimsel Test Site.

Supporting the Sectoral Plan process

Waste Management Advisory Council
Advises DETEC on implementing the site selection process for geological repositories.

Cantonal Commission
Ensures cooperation between the siting Cantons and affected neighbouring Cantons and countries and supports the Federal Government in implementing the site selection process.

Spatial Planning Working Group
Supports and advises the FOSD.

Working Group on Information and Communication
Coordinates information and communication activities.

Technical Forum on Safety
Answers questions from the public, Cantons, neighbouring countries and siting regions.

Comprehensive documentation – detailed review of safety
The database documented in the various Nagra Technical Reports (NTBs) and numerous working reports was reviewed in depth in 2009 by ENSI and its experts. KNS will deliver an independent expert opinion on the safety review conducted by ENSI. ENSI's work was largely complete by the end of the year. In the course of the review by the federal experts, Nagra was called on to explain its work in detail during various technical discussions and responded in written form to numerous questions from the authorities.

Besides the federal authorities, cantonal experts and the German expert group on Swiss repositories (ESchT) will also carry out a critical review of Nagra's documented results.

Wide support for the Sectoral Plan approach
A number of the bodies specified in the Sectoral Plan were set up at the beginning of Stage 1 and began their activities in 2009 and, in some cases, already in the previous year. These groups provide wide support for the process and ensure transparent implementation.

The "Waste Management Advisory Council" was set up by the Federal Department for the Environment, Transport, Energy and Communications (DETEC) and advises the latter on implementation of the site selection process. Because of its independent status and positioning at a national level, the Council is able to bring an outside, impartial viewpoint into the process. The Council is also responsible for promoting dialogue among all parties involved and helping to recognise process-related risks and blockades.

The "Cantonal Commission" ensures cooperation between the government representatives of the siting Cantons and the affected neighbouring Cantons and countries, supports the Federal Government in implementing the site selection process and makes recommendations to the Government. The siting Cantons take responsibility for coordinating their own activities; operational tasks relating to safety, spatial planning, communication and regional participation are planned and managed by the "Technical Coordination Group of Siting Cantons", while safety evaluations are entrusted to the "Cantonal Working Group on Safety". The latter also supports the "Cantonal Expert Group on Safety", which advises the Cantons on evaluating safety-related documentation.

Under the lead of the Federal Office for Spatial Development (FOSD), the "Working Group on Spatial Planning" provides support and advice in the following areas: preparing the spatial planning evaluation methodology for comparing sites in Stage 2, compilation of spatial planning data, defining the provisional planning perimeters, ensuring information exchange and discussing the draft object sheets (map and text) describing the individual projects. The Working Group is made up of federal experts (FOSD, SFOE and Federal Office for the Environment FOEN) and representatives from the siting Cantons, Germany and Nagra.

The "Working Group on Information and Communication" is led by the SFOE and includes representatives of the Federal Government (SFOE, ENSI), the

siting Cantons and regions, Germany and Nagra. It plans and coordinates information and communication activities connected with the Sectoral Plan process and ensures early information of the politically responsible Swiss and German authorities.

The "Technical Forum on Safety" consists of technical experts from authorities and commissions of the Federal Government and representatives of the waste producers. Also represented are the siting regions, siting Cantons, the Cantonal Working Group on Safety, German authorities and the organisation Klar! (opposes the construction of a repository in the Zürcher Weinland). Under the guidance of ENSI, the Forum answers questions submitted by the public (general public, communities, interest groups), Cantons, neighbouring countries and the siting regions. The questions directed to the Forum and the responses to these are published on the SFOE website.

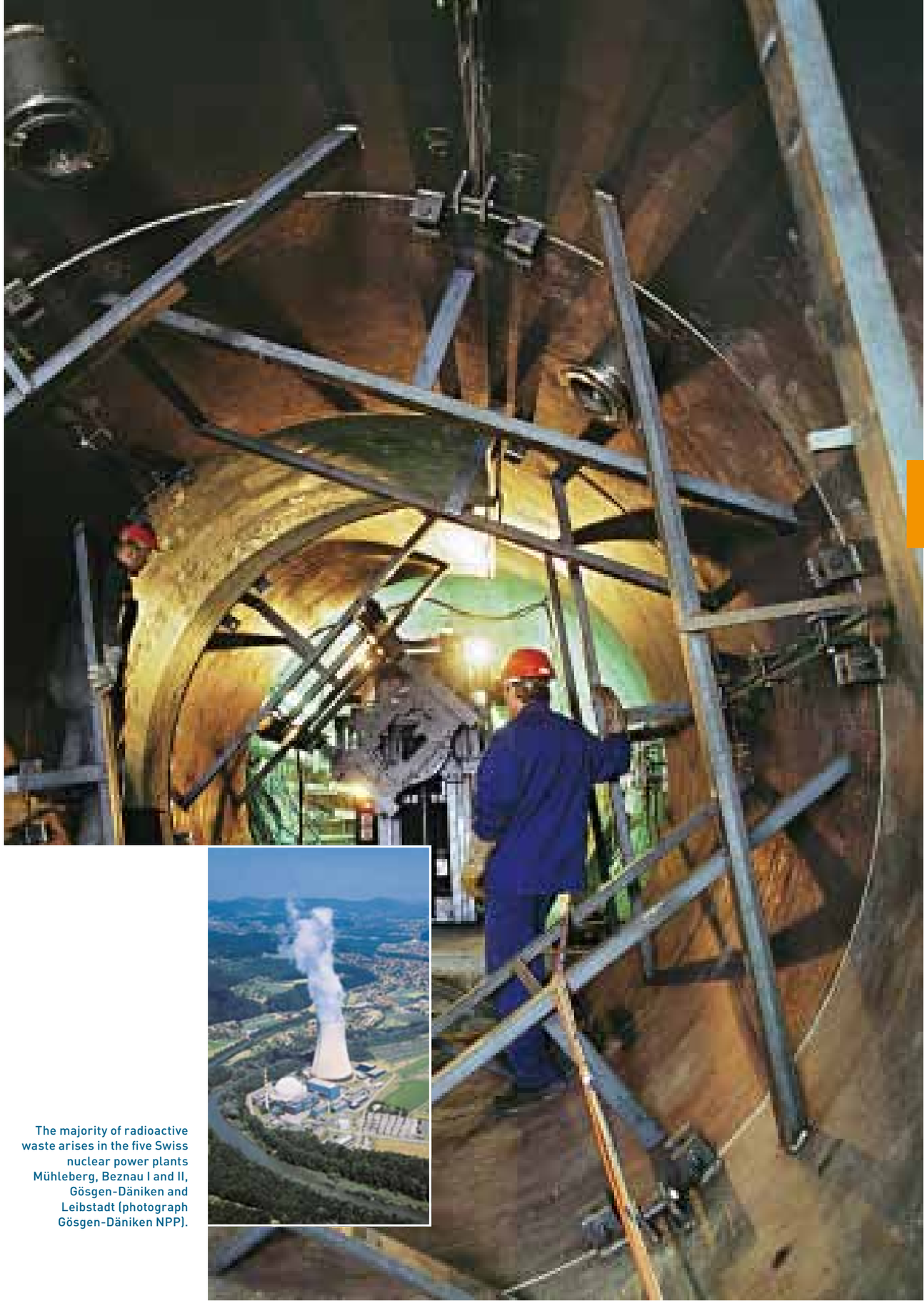
Building up regional participation

Besides the groups outlined above, different forums and platforms with the aim of representing regional interests were set up during the year in the individual siting regions through the fusion of local communities and planning associations. In autumn, the SFOE published guidelines for establishing regional participation and initiated support for the build-up of the required structures. By the end of the year, start-up teams had begun their work in most of the regions.

The next steps

Based on the results of the safety reviews and the spatial planning investigations, the SFOE can apply to the Federal Council in 2010 for inclusion of the proposed and evaluated geological siting regions in the Sectoral Plan. The decision of the Federal Council will come after a several month period of open consultation that is expected to take place in autumn 2010. The decision is then expected for 2011.

Possibilities for the location and design of the surface facilities will be considered together with the siting regions in Stage 2. Safety will continue to be assessed and quantified and spatial planning, socio-economic and ecological aspects will enter the equation. Stage 2 ends with the Federal Council deciding on at least two potential sites each for the L/ILW and HLW repositories. In Stage 3, these sites will be investigated in more detail, with field work (e.g. seismic campaigns, boreholes) being carried out as required. Based on the results of the investigations, applications will be prepared for general licences. The three stages of the Sectoral Plan process will extend over around ten years. The general licences specify the sites at which the repositories will be constructed. The licences are granted by the Federal Council, approved by Parliament and are subject to an optional national referendum. At the close of the procedure, the final word thus lies with the Swiss voters.



The majority of radioactive waste arises in the five Swiss nuclear power plants Mühleberg, Beznau I and II, Gösgen-Däniken and Leibstadt (photograph Gösgen-Däniken NPP).

Scientific and technical background

Since the approval by the Federal Council of the demonstrations of disposal feasibility for all types of waste, the focus of research and development has been directed towards deepening understanding with a view to the upcoming general licence applications. This should allow the conservative assumptions made in the safety analyses to date, which take account of uncertainties, to be replaced by more accurate information. The reliability of information on the detailed behaviour of the barrier functions will thus be improved. This applies in particular to the long-term containment of the waste, the long-term evolution of the properties of the engineered barriers and the retention of radionuclides in the engineered and natural barriers. The RD&D plan was completed and published (NTB 09-06) in the year of reporting.

Geology

A range of work was initiated that will deliver more detailed information on the underground environment of the proposed siting regions and their surroundings for Stages 2 and 3 of the Sectoral Plan process. Work also began on carrying out systematic structural geological measurements and reprocessing of existing reflection seismics data. Gravity data for Northern Switzerland were integrated with data for Southern Germany and areas identified for control and compaction measurements. A comprehensive set of remote sensing data was prepared and a start made on evaluating structural geological aspects. To achieve a better understanding of kinematic evolution and layer geometry in the siting regions, a retrodeformation (kinematic balancing) of geological profile sections was also initiated.

Two large-scale projects were implemented to look at the long-term geological evolution of Northern Switzerland. A more dense seismic network and a permanent network of GNSS (Global Navigation Satellite System) receivers should result in improved monitoring of recent crustal movements. University work on investigation of Quaternary rock channels was also supported.

An important component of the geological work for Stage 2 is characterisation of deep groundwater movement in the proposed siting regions in Northern Switzerland using a refined hydrogeological model.

For both the Wellenberg project and as part of the Entsorgungsnachweis feasibility study, the "Rock-Water Interaction" group at the University of Bern had already carried out background work on understanding radionuclide transport in potential host rocks (marl, Opalinus Clay with confining units). This work will be pursued in greater depth as part of the Sectoral Plan process and extended to include the new host rocks proposed in Stage 1 (claystone sequences "Brauner Dogger" and Effingen Beds). State-of-the-art geochemical modelling methods were used to define reference porewaters for all host rocks; this provides key input for the sorption and diffusion studies being carried out at PSI.

Geochemical retention processes and transport mechanisms

a) Investigations for the HLW repository: In the HLW programme, work continued on retention and transport of radionuclides in bentonite (self-sealing backfill material forming part of the engineered barrier system) and in the Opalinus Clay. A significant achievement was defining the contributions of

In 2009, Nagra initiated a project on expanding the satellite-based precision measuring network of the Federal Office of Topography to include ten additional stations in Northern Switzerland.

Nagra works closely with the Laboratory for Waste Management (LES) of the Paul Scherrer Institute. The LES website provides information on ongoing investigations (http://les.web.psi.ch/).

Radionuclide retention

Retention of radionuclides in the engineered barriers and surrounding geological barrier is one of the key safety-relevant features of a geological repository. Predictions of long-term safety require a detailed understanding of the geochemical processes responsible for such retention.

Investigating and characterising these processes has been the focus of a long-standing collaboration between Nagra and the Laboratory for Waste Management (LES) at PSI. To obtain a mechanical understanding of the key processes, classical radiochemical techniques have been complemented with modern spectroscopic methods. Modelling studies aid in process understanding and prepare the way for implementation in the safety analysis. Size scales have to be extended from submicroscopic through laboratory to field scale to allow the necessary time and space dimensions to be considered.

The compilation of geochemical data prepared by PSI, such as the updated Nagra/PSI thermodynamic databank and the generic sorption databank, form the basis for solubility and sorption datasets that are used as direct input for the Nagra safety analyses.

LES/PSI for Stage 2 of the Sectoral Plan process. A central component of this will be an updated model of the evolution of the near-field of the HLW repository over the entire period considered in the safety analysis. The results will provide input for preparing datasets on solubility, sorption and diffusion of radionuclides in bentonite.

The sorption of radionuclides on the clay minerals of the host rock as a key process for retention in the geosphere has to be described in more detail in the safety analyses. The generic sorption databank established for Stage 1 has been refined and is now based on montmorillonite and illite, two typical clay minerals that, due to their structure, are mainly responsible for sorption processes. A concept was prepared and initial measurements performed to evaluate the influence of temperature on sorption. These showed that increased temperatures such as those expected at disposal depth slightly weaken sorption phenomena.

Diffusion is the main migration mechanism for radionuclides in the Opalinus Clay host rock. The scientific understanding of radionuclide diffusion in claystone was brought together in a synthesis report which reflects the current status of experimental investigations and modelling on a national and international level and contributes to validating the models used in the safety analyses.

b) Investigations for the L/ILW repository: As part of this programme, work began on retention and transport of radionuclides in the preferred host rocks ("Brauner Dogger", Effingen Beds, marl formations of the Helveticum, Opalinus Clay). Studies also continued on the repository near-field; in this environment large amounts of cement-based materials are used that could efficiently retain radionuclides.

There are indications that the anaerobic corrosion of activated metals produces C-14-containing molecules. Because C-14 belongs to the nuclides that dominate dose, the resulting corrosion products have to be investigated in terms of their properties and stability.

As a result of porewater exchange, cement will cause chemical changes in the host rock and the bentonite-based backfill material in the access tunnels. These can include changes in porosity, gas permeability and retention properties that have to be taken into account in assessing long-term safety. An experiment on the long-term interactions between cement and Opalinus Clay and between cement and bentonite began in the Mont Terri Rock Laboratory in 2007. The spatial propagation of such changes occurs very slowly in claystones, meaning that, on the long term, only a small part of the host rock or tunnel backfill will be affected. Because of the restricted spatial extent of these effects, experiments investigating cement-clay boundary layers are particularly challenging. Spectroscopic methods based on X-ray diffraction and electron microscopy for the micrometre range have therefore been developed for investigating samples from the Mont Terri experiment.

c) Investigations on the behaviour and properties of bentonite: Thanks to a large-scale experiment in the Äspö rock laboratory in Sweden, in which Nagra is involved, samples that are representative of bentonite under the conditions in a deep geological repository are now available (including the influence of decay heat and saturation of the bentonite). The experiment involves placing bentonite blocks in a borehole under conditions similar to those in a repository and heating them with a central heating element over several years. The questions that arise relate to the safety-relevant properties of the bentonite and changes due to decay heat and saturation processes. The samples are now being investigated in several laboratories.

A method originally developed in the field of life sciences for freezing samples as quickly as possible was modified to allow artefact-free visualisation and quantification of the pore space of the bentonite. EMPA (Swiss Federal Laboratories for Materials Testing and Research) applied this method to Nagra's samples, which led to a better understanding and improved modelling of the development of the pore space in bentonite under a wide range of conditions. The results are applied in the modelling of gas transport, mechanical properties and the diffusion properties of bentonite.

d) Preparing further background on transport and geochemistry: For evaluating long-term safety, it is essential to understand the transport mechanisms in the engineered and geological barriers of a deep repository on a large spatial scale. Using molecular dynamic methods, diffusion coefficients and the mobility of hydronium ions (protonated water) are modelled on a molecular scale. Transport modelling for interpreting diffusion experiments (Mont Terri Rock Laboratory) has been further developed.

Updating the thermodynamic databank that forms the basis for all geochemical databanks (sorption and solubilities) was completed. The current version includes new information from the international OECD/NEA project "Chemical Thermodynamics", in which Nagra and PSI are involved.

Know-how relating to the modelling of solid solutions was developed further. The formation of solid solutions is an important mechanism in radionuclide retention in both the near-field and the geosphere. Ion-exchange on montmorillonite was modelled using this approach. Based on experimental data, the stability of layered double hydroxides – an important mineral group in a cementitious near-field for the retention of anionic radionuclides – was modelled as a solid solution. Modelling of the experimental data from a joint project between PSI and the Japan Atomic Energy Agency (JAEA) has shown that the safety-relevant radioelement radium is incorporated in barium sulphate with formation of a solid solution; besides sorption this is an efficient retention mechanism for radium.

System analyses

a) System analyses on radionuclide transport: One of the aims of system analyses is to determine the contribution of individual waste types to important safety-relevant indicators such as dose, radiotoxicity, gas formation, etc. for a wide spectrum of system properties. These analyses provide key input for preparing the provisional safety analyses in Stage 2 of the Sectoral Plan process. To this end, numerous transport calculations were carried out and the tools for evaluating the results were refined.

b) Investigations of gas pressure build-up and transport: A series of research projects was carried out during the year to investigate the influence of gas generated from the waste on the hydraulic conditions in the repository vicinity. As part of the L/ILW programme, synthesis work was completed on gas pressure build-up in a model repository in the Opalinus Clay. The model calculations show that, over the entire period of gas production, no significant degradation of gas transport capacity is expected.

A wide range of gas-related model calculations were carried out to provide input to an investigation of the fundamental feasibility of realising a combined repository (for L/ILW and HLW) in Opalinus Clay. The simulations show that, given sufficient distance between the disposal zones for L/ILW and SF/HLW/ILW, no interference between the thermal effects from the HLW repository and the gas pressure build-up in the L/ILW repository that would impact on safety is to be expected.

Further gas-related research and development work with a range of partners was either initiated or continued, for example with the EPFL Lausanne (EU project FORGE), the ETH Zürich, EMPA and various companies from the oil and gas industry.

Safety-relevant properties of radioactive waste

In addition to the work described on page 11 on characterisation and inventorying of radioactive waste, investigations were carried out on selected safety-relevant aspects. The focus for many years has been on the long-term behaviour of the spent fuel matrix. Relevant in this area is the EU project MICADO (see page 31), with the aim of improving models for describing the release of radionuclides from spent fuel assemblies; the project was completed in 2009.

Both internationally and in the Swiss nuclear power plants, the trend is towards higher burnup of fuel. As the understanding of the retention properties of fuel assemblies with high burnup is currently incomplete, the calculations on release of radionuclides from the fuel have to use conservative values for the relevant parameters in order to take existing uncertainties into account. Reducing these uncertainties could therefore result in a reduction of the dose maxima calculated to date and hence to higher safety reserves in the safety analyses. A new project was initiated in this area; the work will be carried out at PSI by Nagra together with SKB of Sweden.

Design of the geological repositories and the engineered barriers

a) Modules for the L/ILW and HLW repositories: In preparation for Stage 2 of the Sectoral Plan process, various studies were intensified and partly completed. These serve as the basis for developing repository modules and comprise generic ventilation concepts, studies on the reception facilities (including 3D visualisations) and rock mechanical investigations for underground modules (caverns and disposal tunnels), as well as alternative concepts for disposal tunnels.

b) Container materials for spent fuel and high-level waste: Based on the recommendations of an expert group set up by Nagra, work on container materials for spent fuel and vitrified high-level waste continued in the year of reporting.

Investigations were initiated on the anaerobic corrosion of carbon steel in bentonite saturated with Opalinus Clay porewater. Corrosion rates are determined by observing the evolution with time of the corrosion-driven formation of hydrogen gas. Recommendations were made for selection of the steel composition and for welding and handling the steel in order to avoid the possibility of fissure formation under the expected container environment conditions.

Work was also completed on the technical requirements placed on the SF/HLW container as the basis for preparing design concepts.

Alternatives to the steel reference material for the SF/HLW container were also evaluated. Work being carried out on copper by other waste management organisations was followed. An agreement was also concluded with Andra of France to allow Nagra to participate in the French programme on ceramics as potential container materials.

Rock laboratories

Recovering a core from an overcoring borehole at the Grimsel Test Site (LTD experiment).

Panel discussion on the topic "Rock laboratories – more than a scientific instrument" on the occasion of the 25-year celebration of the Grimsel Test Site.

Projects at the Grimsel Test Site

CFM (Colloid formation and migration)
Formation and transport of colloids and radionuclides under realistic conditions

C-FRS (Criepi fractured rock studies)
Hydrogeological and geological characterisation of tectonic fracture systems

ESDRED plug experiment[1]
(Engineering studies and demonstration of repository designs)
Use of low-pH cements

FEBEXe (Full-scale HLW engineered barriers experiment extension)
1:1 demonstration of the emplacement concept for high-level waste

FORGE[1] (Fate of repository gases)
Experiments on gas migration in engineered barriers (bentonite/sand)

FUNMIG[1] (Fundamental processes of radionuclide migration)
Fundamental aspects of radionuclide migration in crystalline rock

GST (Gas-permeable seal test)
Gas sealing experiment (planning phase)

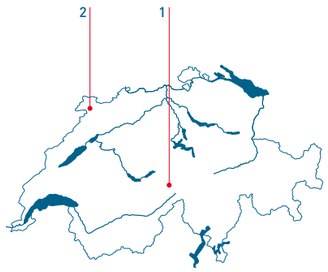
JGP (JAEA grouting project)
Cement injection experiment

LCS (Long-term cement studies)
Long-term interactions between cement solutions, porewaters and rock

LTD (Long-term diffusion)
Long-term diffusion of radionuclides

TEM[2] (Testing and evaluation of monitoring techniques)
Testing of monitoring methods

[1] Sub-project as part of an EU project
[2] Sub-project as part of EU project MoDeRn



1 Grimsel Test Site
2 Mont Terri Rock Laboratory

Overview of current investigations:
www.grimsel.com
www.mont-terri.ch

Grimsel Test Site (GTS)

For more than 25 years, the GTS has provided a platform for Nagra and its partners to perform underground research projects on developing and testing safe disposal concepts for radioactive waste in geological repositories and on characterising rock formations of interest. In September 2009, the GTS opened its doors to guests from Switzerland and abroad for the 25-year celebration of the research facility.

15 partner organisations from 10 countries as well as the EU are involved in phase VI (2003-2013) and a number of universities and research institutes from both Switzerland and abroad make a significant contribution to the success of the experiments. Some experiments are supported financially by the EU. Current projects extend over five to ten years. In addition to the field work, each project has its own laboratory and modelling components.

The focus of phase VI is on projects aimed at providing a better understanding of engineered barrier systems and their implementation in practice. One example is the FEBEXe experiment (see text-box for abbreviations) that has been running successfully for more than 10 years. Current activities are focused on long-term monitoring and extensive modelling studies.

The year 2009 was marked by a wide spectrum of field activities in the GTS projects looking at the transport behaviour of radionuclides under realistic boundary conditions. As part of the LTD project, the so-called monopole experiment (circulation of a radioactive tracer cocktail) was completed, the test site was overcored under radiation-controlled conditions and the sample material sent to the project partners for analysis. The activities in the LCS project included performing the first two phases of the experiment (1. Injection of shotcrete, 2. Placing of hardened cement blocks) and a first sample analysis. The focal point of the CFM project was technical modification of the megapacker system and performing function and tracer tests.

Once again, the GTS infrastructure offered the possibility for partner organisations to carry out their own small-scale projects, for example the continuation of the C-FRS project. Drilling of further cored boreholes was followed by intensive test campaigns (e.g. tracer tests, radon measurements, high resolution borehole imaging).

As part of EU-supported projects (MoDeRn-TEM and ESDRED), wireless monitoring of saturation of the plug test (low-pH cement plug/bentonite) continued without interruption.

The radiation controlled zone in the AU tunnel (reserved for field experiments with radiotracers) was checked regularly for contamination and radiation dose in accordance with the requirements of the Federal Office of Public Health (FOPH). All work in this zone was problem-free.

As part of the IAEA initiative "Centres of Excellence – Training in and Demonstration of Waste Disposal Technologies in Underground Research Facilities", the GTS supported training courses and the fellowship programme.

Investigations in the Mont Terri Rock Laboratory, where Nagra is involved in many of the experiments.

Mont Terri Rock Laboratory.

Key experiments in the Mont Terri Rock Laboratory

CI (Cement-clay interaction)
Mineralogical interaction between clay and cement

DI-A (Long-term diffusion)
Long-term diffusion experiment

DR (Diffusion and retention)
Diffusion and retention of radionuclides

EB (Engineered barriers)
Emplacement and evolution of engineered barriers

FE (Full-scale emplacement demonstration)
1:1 emplacement experiment

GM-A (Geophysical monitoring)
Geophysical monitoring

HG-A (Gas path host rock and seals)
Gas flowpaths through clay and along sealing structures

HG-D (Reactive gas transport in Opalinus Clay)
Reactive gas transport in clay

HT (Hydrogen transfer)
Transport of hydrogen gas

MB (Mine-by test)
Deformation and hydromechanical effects during the excavation of tunnels and galleries

SE-H (Self-sealing in combination with heat)
Self-sealing of fissures in the excavation damaged zone, taking into account thermal influences

VE (Ventilation experiment)
Ventilation experiment

Mont Terri Rock Laboratory (FMT)

The international Mont Terri research project (St-Ursanne, Canton Jura) has been underway since 1996 in side tunnels of the security gallery of the Mont Terri motorway tunnel. The experiments are aimed at the geological, hydrogeological, geochemical and geotechnical characterisation of clay formations, in particular the Opalinus Clay. With a view to upcoming licensing procedures and improving process understanding, the project allows Nagra to further investigate, on a realistic scale, the properties of this potential host rock that are relevant for disposal of radioactive waste.

14 partner organisations from 8 countries are currently involved in the extensive research projects; for the first time in 2009, an oil company joined the project as a partner. The project is led by the Federal Office of Topography (Swisstopo). It is supported by a "Commission stratégique" and the interests of Canton Jura are represented by the "Commission de suivi".

The first half of the year saw the completion of the 14th programme phase as planned, with Nagra being involved in 28 of a total of 36 experiments. Participation in phase 15 (July 2009 – June 2010) involves continuation of most of the experiments from the previous phase as well as the start of new experiments in the areas of gas migration and hydrogeology. Projects from the 6th Framework Programme of the EU (GM-A and SE-H experiments) will also continue. Based on Nagra's experience, and on the recommendations made following the review by the authorities of the "Entsorgungsnachweis" project, the focus of Swiss activity has been on in-depth research on the development of the excavation damaged zone (MB, SE-H and HG-A experiments), radionuclide diffusion in the Opalinus Clay (DR and DI-A experiments), gas migration (HG-A, HG-D and HT experiments) and the continuation of a long-term experiment on the interaction between clay and cement (CI experiment). Cement is used in a repository as a solidification, backfill and construction material. Planning of the large-scale FE experiment also began in 2009; the main objective is to investigate the behaviour of the tunnel vicinity (i.e. geology surrounding the tunnel) under the influence of a simulated section of a spent fuel disposal tunnel. The main interest is the effect of temperature on hydraulic and mechanical processes in the host rock. Experience will also be gained in the technology to be used for excavating and securing the disposal tunnels and for emplacing the containers and backfill materials. Actual construction work for the experiment will begin in 2010 at the earliest.

The laboratory was expanded in 2008 with around 170 metres of galleries and 80 metres of niches. The equipping of these areas was completed in 2009.

Commercial services

Review of waste management costs (cost study)
To secure the financing of waste management activities, the owners of the nuclear facilities are required to put aside financial reserves; the amount of these reserves is derived from the estimated waste management costs. The cost estimates are reviewed periodically; the last update was in 2006 and the results were approved by the authorities. Preparations began in 2009 for the next update, which is planned for 2011. Documentation also had to be prepared for evaluating the socio-economic impact of a L/ILW and HLW repository for a study commissioned by Canton Schaffhausen.

International Services and Projects (ISP)
The know-how and experience in the field of radioactive waste management accumulated by Nagra over the last 35 years continues to be recognised as a valuable resource for other national waste management programmes, as well as for technical applications outside the nuclear area. The spectrum of support offered ranges from strategic programme planning, specification of waste inventories, site selection, characterisation and evaluation to repository design, safety case development, safety analyses and public communication. We are strongly committed to providing timely, high quality and cost-effective solutions, maximising the value offered by engaging motivated and dynamic staff who are also actively involved in the national programme. Of particular interest are joint projects that have synergies with the activities in the Swiss national programme.

A major component of the contract work in 2009 again came from partners in Japan. The work was carried out as part of various bilateral collaboration agreements between Nagra and Criepi, JAEA, JNFL, Numo, RWMC and Obayashi (see page 57 for abbreviations).

Nagra and JAEA (with the support of Obayashi) initiated a new project at the Grimsel Test Site to test injection techniques. The focus of the collaboration in 2009 was on JAEA's rock laboratory programme, which involves parallel development of two underground facilities (Mizunami in crystalline rock and Horonobe in sediments), interpretation techniques for hydraulic measurements and the development of palaeo-hydrogeological models for Horonobe.

The long-term project with Criepi on the characterisation of fractured rock at the Grimsel Test Site also continued. This work was supported by attachment of a guest scientist from Criepi to Nagra.

Nagra's know-how in the area of gas migration through low-permeability media was put to use in the concept for a new project being carried out by Obayashi on behalf of JNES of Japan. The laboratory test is performed in a steel shell around four metres long and investigates the behaviour of bentonite materials for the situation of a planned intermediate-depth Japanese repository. Setting up the test zone was carried out together with Solexperts AG; emplacement of the bentonite and the required instrumentation began in autumn 2009.

Activities in Europe continued to expand. In November, a team led by Nagra staff and consultants won a four-year project to support the Belgian organisation Ondraf/Niras in developing their so-called "Safety and Feasibility Case

The long and successful collaboration with Japanese organisations continued in 2009. The photograph shows work being carried out as part of the cement injection experiment (JAEA, Obayashi).

(SFC 1"). Support for the Lithuanian implementing organisation RATA on waste characterisation and acceptance with a view to operating a repository for low-level waste was completed at the end of the year with a training course in the Spanish El Cabril repository and production of a brochure and a DVD for RATA's public outreach programme. Advising on site investigation and evaluation for a low-level waste repository and the HLW programme in Canada (OPG/NWMO), bilateral discussions with the newly established Korean Radioactive Waste Management Corporation (KRMC) and supporting the Romanian organisation Andrad widened the geographic spectrum of our activities. Nagra geoscientists continued to contribute their expertise towards solution of environmental issues in 2009; examples include CO_2 sequestration (Norway and Sweden) and geothermal exploration (geophysical investigation and drilling campaign in Switzerland).

International collaboration

A regular exchange of information between Nagra and its foreign partner organisations takes place within the framework of the various formal bilateral agreements. Joint projects are also carried out with several partners, either on a multilateral basis (e.g. rock laboratory projects) or together with international organisations (particularly the OECD/NEA and the EU). In addition to the formal collaboration structure, international contacts have also generated a close network of personal relationships, which provide Nagra scientists with a wealth of opportunities to discuss technical issues with their peers. This network includes not only partner organisations but also the wider scientific community that is integrated into Nagra's daily activities through review of its scientific work.

Nagra staff continued to be involved in Andra's Bure rock laboratory in France. These activities were complemented by joint laboratory programmes run by various research institutes on model development and on evaluation of databanks. This includes projects on sorption and thermochemical databanks under the auspices of the OECD/NEA. Nagra's involvement in the EU Framework Programmes now represents an important component of its research and development activities. Collaboration with EU partners has been strengthened by Nagra's involvement in the "Technology Platform for Implementation of Radioactive Waste Disposal", which was set up in 2009. Nagra staff continue to be involved in various advisory bodies and working groups (particularly in Belgium, Finland, France and Canada) and are able to benefit directly from the experience of sister organisations. Over and above the various specific joint projects, Nagra is also represented in relevant working groups of the OECD/NEA and works together with the IAEA. Nagra is also a member of EDRAM, an association of high-level staff from waste management organisations worldwide. Key results of international collaboration are presented in the project-specific sections of this report.

Sixth EU Framework Research Programme

MICADO (Model uncertainty for the mechanism of dissolution of spent fuel in a nuclear waste repository).
Topic: **Addressing uncertainties in the modelling of dissolution processes for spent fuel in geological repositories.**
Coordination: Armines Nantes (France). Participation: 19 organisations from 7 countries. Duration: 2006 – 2009.

PAMINA (Performance assessment methodologies in application to guide the development of the safety case).
Topic: **Use of analytical methods for guiding the development of the safety case.**
Coordination: GRS mbH (Germany). Participation: 26 organisations from 10 countries. Duration: 2006 – 2009.

TIMODAZ (Thermal impact on the damaged zone around a radioactive waste repository in clay host rocks).
Topic: **Thermal impact on the excavation damaged zone surrounding disposal tunnels in clay host rocks.**
Coordination: ESV EURIDICE GIE (Belgium). Participation: 14 partners from 8 countries. Duration: 2006 – 2010.

Seventh EU Framework Research Programme

MoDeRn (Monitoring developments for safe repository operation and staged closure).
Topic: **Investigating the possibilities and limitations of monitoring in a geological repository.**
Coordination: Andra (France). Participation: 17 organisations from 12 countries. Duration: 2009 – 2013.

FORGE (Fate of repository gases).
Topic: **Influence of gas production and release on the long-term safety of a geological repository.**
Coordination: BGS (United Kingdom). Participation: 24 organisations from 12 countries. Duration: 2009 – 2013.

PEBS (Long-term performance of Engineered Barrier Systems – EBS).
Topic: **Validation of THM models for simulating the HLW near-field in the early post-operational phase.**
Coordination: BGR (Germany). Participation: 10 organisations from 5 countries. Duration: 2010 – 2014.

As in previous years, Nagra took part in international meetings on the topic of waste disposal, with frequent invitations to make presentations and representation on the programme committee for some events. As part of what is now an annual event, Nagra also attended the meeting of the German-Swiss Commission (DSK, working group 4).

Framework Research Programmes of the European Union (EU)
Since 1984, the Framework Research Programmes of the EU have functioned as an important instrument for financing research projects in Europe. Many of the challenges faced by industry and society today can no longer be solved in isolation by one country alone. The 6th and 7th Framework Programmes are aimed specifically at creating a European Research Area. The idea is to promote excellence in scientific and technological capacities and to encourage European competitiveness and innovation by supporting improved cooperation among researchers and coordination of their projects.

Based on the research agreement between Switzerland and the EU, Swiss researchers have been able, since 2004, to participate fully in the Framework Programmes. In return, Switzerland makes a direct contribution to the total budget of the EU Framework Programmes.

The research projects planned in the area of deep geological disposal of radioactive waste developed as part of the EURATOM (nuclear fission) programme allow Nagra to expand its technical knowledge base efficiently and continuously and to be instrumental in shaping important developments in Europe. The focus in 2009 was on completion of the MICADO and PAMINA projects (see text-boxes). The TIMODAZ project is also continuing.

As part of the 7th Framework Programme (EURATOM work programme 2007), work began on the new projects MoDeRn and FORGE. An application for the PEBS project was approved and work is expected to begin from 2010.

Public outreach

Every year, Nagra participates in a number of trade fairs and visits several towns with its information stand with the aim of informing the local public.

The announcement of the six potential siting regions for deep geological repositories in November 2008 set the tone for public relations activities in 2009. Much of the work was targeted at the siting regions, where the main question was: Why here? Also of interest were the next steps in the waste management programme and the possibilities for participation of local people in the siting process.

Communicating the facts

Factual information and open dialogue form the basis for trust. The public rightly expect answers to their questions on the topic of radioactive waste disposal and to be able to bring their concerns to the discussion table. Nagra's public relations activities are aimed at maintaining contact with the public and providing them with comprehensive and accurate information. A wide range of communication tools is used – the internet, brochures, films, media presence, guided tours, presentations and lectures, presence at regional events, street actions, discussion platforms and so on.

Intensive contact with the public

Nagra was represented at various regional trade fairs with its information stand. Towns and communities within the siting regions were selected for these events (total of 13) and for the information tour (6 locations). Nagra staff had the opportunity to conduct interesting and sometimes quite emotional discussions with visitors to the stand.

A total of 2750 people visited the Grimsel Test Site and the Mont Terri Rock Laboratory. Besides the regular tours of the facilities, there were two additional open days at the Grimsel Test Site (13th June and 27th September). Nagra also took part in the third "Festival Science et Cité base camp 09", opening the Grimsel Test Site to schools for this event on 21st August.

Nagra also participated in four TecDays at Swiss schools; these are organised by the Swiss Academy for Technical Sciences. Students have the opportunity to select several modules of interest to them and the topic of radioactive waste management proved to be very popular.

More information for interested readers

Nagra's palette of information material is constantly being expanded to meet the needs of the public. In 2009, the brochures and topical publications produced in connection with the announcement of the potential siting regions were translated into French and Italian. Various other materials were also produced (e.g. image brochure, waste management game, documentation for schools). The newsletter "nagra info" has a circulation of 135,000 and the electronic newsletter e-info is sent to 1900 addresses. In 2009, e-info circulation was also regionalised.

Internet

The Nagra website functions as a central information platform. It is dynamic and is continually updated. The site also provides comprehensive answers to frequently asked questions on the management of radioactive waste. The range of films and animations provided has also increased significantly. Brochures, technical reports and images are available for download.

Nagra in the media spotlight

Nagra produced five media releases in 2009. There were also numerous media contributions, both in printed and audiovisual form. Key topics included the announcement of the potential siting regions at the end of 2008, the setting up of participation groups and the announcement of the provisional planning perimeters. Representatives of Nagra had the opportunity to explain current activities during interviews. The German media continued to take a particular interest in the Swiss waste management programme and the Sectoral Plan process in 2009.

Organisation, funding and oversight bodies

President of the Board of Directors

Pankraz Freitag
Haslen (Glarus), member of the Council of States

"The management of radioactive waste is an emotionally difficult but necessary undertaking. Safety has the highest priority. We have to be able to show this without compromise – in this respect dialogue with the public plays a decisive role."

Executive Board

Dr. Thomas Ernst
Chief Executive Officer

"The safe long-term disposal of radioactive waste in deep geological repositories is a challenging task that we undertake in full awareness of our responsibility and in the interests of man and the environment."

Dr. Markus Fritschi
Division Head, Repository Projects and Public Affairs

"As a national competence centre in the area of nuclear waste management, our aim is to realise safe repositories for all categories of waste in a timely manner and at reasonable cost."

Dr. Piet Zuidema
Head of Science and Technology

"The research and investigations programmes carried out by Nagra have resulted in an advanced level of knowledge. In Switzerland, we have host rocks of excellent quality for confining radioactive waste. Geological repositories can be realised with the required level of safety."

Management and organisation

Management structure and headquarters
At the end of 2009, 88 people were employed at Nagra's headquarters (81 full-time employees and 7 part-time staff), corresponding to 76.1 full-time positions.

The Science and Technology Division was split as of 1st July into the Divisions "Geosciences and Safety Analysis" and "Engineering and Field Investigations". Dr. Piet Zuidema headed the two divisions during the transition phase up to the end of March 2009. On 1st April, Andreas Gautschi took over the Geosciences and Safety Analysis Division and Peter Marquart the Engineering and Field Investigations Division. Following the sudden death of Peter Marquart on 26th October, Ulrich Nabholz became interim Head of the Division on 8th December for a period of six months (see organigram).

Board of Directors and general meeting
Pankraz Freitag took over as President of the Board of Directors at the beginning of the year. The Board held five meetings to handle ongoing business, with the focus on the Sectoral Plan process and the proposals for siting regions. The Board took note of the planned research and development work for 2010 and approved the required outline credit.

Important technical questions were discussed by the various Commissions. The Technical Committee and the Commission for Communication and Information met four times. The Finance Commission met twice to consider the closing of the annual accounts for 2008 and the budget for 2010, as well as the accumulated accounts.

The ordinary general meeting of the Members of the Nagra Cooperative took place on 23rd June 2009 in Bern. The Members approved the annual report and accounts for 2008. Hans Issler, who stepped down as President of the Board at the end of 2008 and was present for the last time at a Board meeting, was officially relieved of his duties. Pankraz Freitag thanked him for his many years of service and commitment in the field of radioactive waste management.

Members of the Cooperative, Board of Directors, Commissions, Statutory Auditors

Members of the Cooperative
Swiss Federal Government
Bern

Axpo AG
Baden

BKW FMB Energie AG
Bern

Kernkraftwerk Gösgen-Däniken AG
Däniken

Kernkraftwerk Leibstadt AG
Leibstadt

Alpiq Suisse SA
Lausanne

Board of Directors
Pankraz Freitag
Haslen (GL)
President
Nagra

Dr. Stephan W. Döhler
Vice-president
Axpo AG

Peter Hirt
Kernkraftwerk Gösgen-Däniken AG

Hermann Ineichen
BKW FMB Energie AG

Martin Jermann
Paul Scherrer Institute

Dr. Michael Plaschy
Alpiq Suisse SA

Mario Schönenberger
Kernkraftwerk Leibstadt AG

Peter Zbinden
Wallisellen (ZH)
former chairman of
GL AlpTransit Gotthard AG

Technical Committee
Mario Schönenberger
Chairman
Kernkraftwerk Leibstadt AG

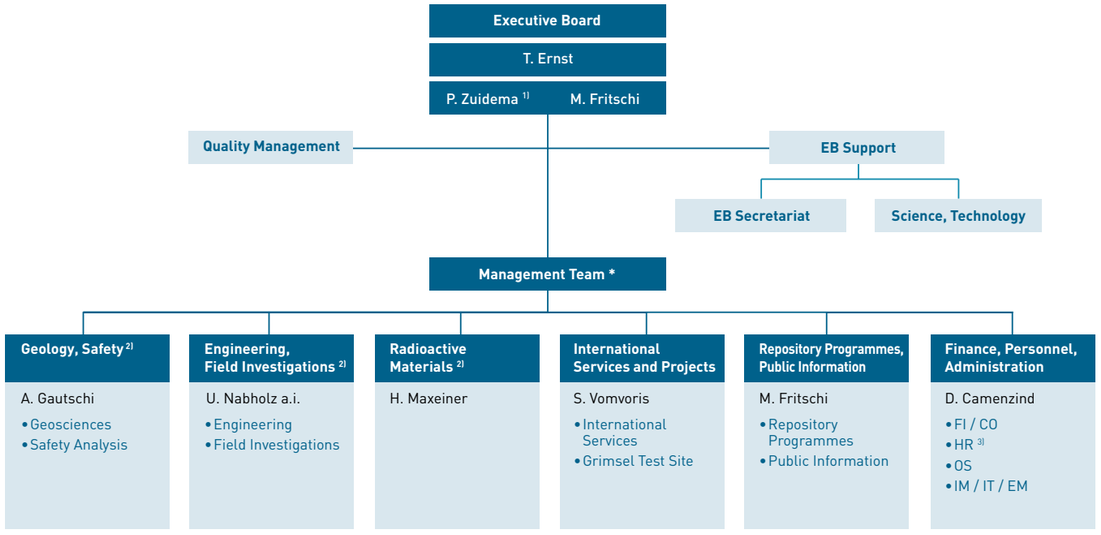
Finance Commission
Michael Sieber
Chairman
Axpo AG

Commission for Legal Issues
Hansueli Sallenbach
Chairman
Axpo AG

Commission for Communication and Information
Peter Hirt
Chairman
Kernkraftwerk Gösgen-Däniken AG

Auditors
PricewaterhouseCoopers AG
Zürich

Organigram



* Members of the Management Team: T. Ernst, M. Fritschi, P. Zuidema, D. Camenzind, A. Gautschi, H. Maxeiner, A. Murer, U. Nabholz, S. Vomvoris. December 2009

1) P. Zuidema is responsible for the overall coordination and management of the Science & Technology programme.
2) The Divisions "Geology, Safety", "Engineering, Field Investigations" and "Radioactive Materials" report directly to the person responsible for the overall coordination and management of the Science & Technology programme.
3) Direct access to the Executive Board.

Annual accounts 2009

Notes on the annual accounts for 2009

Total expenditure rose compared to the previous year by a total of around 5.8 million CHF. Increased fees (+ 2.8 million CHF), work on the interim result for the Sectoral Plan and completion of the reports on the preliminary orientation (+ 1.5 million CHF), additional investigations for site characterisation (+ 1.1 million CHF) and increased costs for methodology development and laboratory work (+ 0.8 million CHF), as well as various miscellaneous costs (+ 1.0 million CHF), were balanced against lower expenditure for the Mont Terri Rock Laboratory (- 1.4 million CHF). Documented external expenditure rose by a total of 5.4 million CHF to 27.4 million CHF.

Similarly to total expenditure, total revenues also increased by 5.8 million CHF compared to the previous year to 42.8 million CHF. The contributions of the Members of the Cooperative rose by 5.5 million CHF to 37.5 million CHF.

Further information on the different positions can be found in the appendix to the annual accounts, which has been restructured.

Wettingen, 12th April 2010

Dr. Thomas Ernst, Chief Executive Officer

Balance sheet

Assets	31.12.2008 CHF	31.12.2009 CHF	
Land and buildings	2 533 379	2 503 379	
Other property, plant and equipment	146 600	382 650	
Total non-current assets	**2 679 979**	**2 886 029**	1
Work in progress	1 167 105	3 757 250	2
Trade receivables	1 306 549	1 439 303	3
Other receivables	604 611	665 368	
Accrued income and prepaid expenses	274 426	337 380	
Cash and cash equivalents	11 238 435	16 174 042	4
Current assets	**14 591 126**	**22 373 343**	
Assets	**17 271 105**	**25 259 372**	

Liabilities			
Cooperative capital	120 000	120 000	
Equity	**120 000**	**120 000**	
Financial liabilities	650 000	650 000	1
Provisions	6 683 380	6 430 345	5
Trade payables	7 198 971	9 006 752	6
Advance payments	537 869	4 013 857	2
Other liabilities	184 372	1 573 834	7
Accrued expenses and deferred income	1 896 513	3 464 584	8
Liabilities	**17 151 105**	**25 139 372**	
Equity and liabilities	**17 271 105**	**25 259 372**	

Explanations in appendix page 44

Operating accounts

Total revenues	2008 CHF	2009 CHF	
Contributions to administration costs	600 000	600 000	
Contributions for project expenditure	31 397 444	36 860 697	
Contributions of Members of the Cooperative	**31 997 444**	**37 460 697**	
Research contributions	288 173	323 223	
Income from other services for Cooperative Members	791 291	940 569	
Income from services for third parties	3 771 193	4 024 026	
Change in advance payments	857 843	–	2
Income from deliveries and services	**5 708 500**	**5 287 818**	
Change in work in progress	**-722 383**	**–**	2
Other operating income	**57 035**	**70 666**	
Total revenues	**37 040 596**	**42 819 181**	

Total expenditure			
Third party supplies	22 026 193	27 378 486	9
Personnel costs	12 511 755	12 671 180	10
Depreciation	85 055	114 483	
Other operating expenses	2 321 450	2 534 017	11
Operating expenses	**36 944 453**	**42 698 166**	
Financial income	-174 503	-45 341	
Financial expenses	155 219	65 488	
Taxes	115 427	100 868	
Financial result and taxes	**96 143**	**121 015**	
Total expenditure	**37 040 596**	**42 819 181**	

Explanations in appendix page 44

Cash flow statement

Change in cash and cash equivalents	2008 CHF	2009 CHF	
Annual result	-	-	
Depreciation	85 055	114 483	1
Formation of provisions	-	4 283	5
Application of provisions	-424 997	-257 319	5
Change in net current assets (without cash and cash equivalents)	6 469 420	5 394 693	4
Cash flow from operating activities	**6 129 478**	**5 256 140**	
Investments	-33 154	-320 533	1
Cash flow from investment activities	**-33 154**	**-320 533**	
Cash flow from financing activities	**-**	**-**	
Change in cash and cash equivalents	**6 096 324**	**4 935 607**	4

Statement	2008 CHF	2009 CHF	
Cash and cash equivalents per 1.1.	5 142 111	11 238 435	
Cash and cash equivalents per 31.12	11 238 435	16 174 042	
Change in cash and cash equivalents	**6 096 324**	**4 935 607**	4

Explanations in appendix page 44

Appendix

Accounting principles
The annual accounts for 2009 comply with the accounting principles set out in the Swiss Code of Obligations.

Valuation principles
Impairment in value of assets
The waste producers (identical with the Members of the Nagra Cooperative) are obliged in terms of the Nuclear Energy Act to finance the costs of waste management. The Members of the Cooperative have undertaken contractually to meet all expenditure incurred by Nagra. The intrinsic value of the assets is thus assured.

Capital (non-current) assets
Property, plant and equipment
Property, plant and equipment are carried at purchase cost less accumulated depreciation. The depreciation is made as planned over the expected useful lifetime of the asset category.
The lifetimes for depreciation fall within the following bandwidth for the individual categories that are relevant for Nagra:

Land	Depreciation only in the case of value impairment
Buildings	20 to 50 years
Operating and business equipment	5 to 10 years
IT hard- and software	2 to 3 years

Current assets
Work in progress
Under this position, the expenses associated with all ongoing commercial projects are capitalised at the balance sheet date at acquisition or production costs.
Receivables
Receivables are shown at nominal value less any appropriate provisions for bad and doubtful receivables.
Cash and cash equivalents
Cash and cash equivalents comprise petty cash, credit balances with bank and postal giro accounts and bank deposits with an original term of not more than 90 days. They are carried at nominal value.

Liabilities
Provisions
Provisions are carried at the actual nominal value as of the balance sheet date.
Payables
This position contains short-term obligations that are carried as of the repayment amount.
Advance payments
This position includes advance payments for ongoing commercial projects.

Notes on the balance sheet, operating accounts and cash flow statement
1 **Fixed (non-current) assets**

	Land and buildings	Office equipment	Vehicles	Total
	TCHF	TCHF	TCHF	TCHF
Acquisition value per 1.1.2009	2 728	198	598	3 524
Additions	–	127	194	321
Disposals	–	–	-114	-114
Reclassifications	–	–	–	–
Acquisition cost per 31.12.2009	**2 728**	**325**	**678**	**3 731**
Accumulated depreciations 1.1.2009	195	142	507	844
Additions	30	53	31	114
Disposals	–	–	-114	-114
Reclassifications	–	–	–	–
Accumulated depreciations 31.12.2009	**225**	**195**	**425**	**845**
Carrying amount at 1.1.2009	2 533	56	91	2 680
Carrying amount at 31.12.2009	**2 503**	**130**	**253**	**2 886**

Fire insurance payments for property, plant and equipment amounted to 10 680 TCHF as of 31st December 2009 (2008: 10 590 TCHF) for each case of damage.

Financial liabilities contains an advance payment of 650 TCHF for the planned sale of the parcel of land in Hägendorf. The sale will take place early in 2010.

2 **Work in progress and advance payments**
The capitalised work in progress/advance payments result exclusively from contracts for third parties. Of the ongoing projects, new is that all costs are capitalised under work in progress and all customer invoices capitalised under advance payments. The numbers for the previous year were not corrected, which is why the balance has risen strongly compared to the previous year. The accounts for changes in inventories were also dissolved and all movements are now booked against the income from trade receivables.

3 **Trade receivables**

Acc. to partner	31.12.2008 TCHF	31.12.2009 TCHF
Receivables from Cooperative Members	77	18
Receivables from third parties	1 230	1 421
Total	**1 307**	**1439**

The largest open position relates to the cost contribution by JAEA of around 500 TCHF to various Grimsel projects. Also outstanding are receivables from Obayashi of around 200 TCHF, ZWILAG of around 200 TCHF and SKB of around 100 TCHF.

4 **Cash and cash equivalents**
Cash and cash equivalents increased during the year of reporting by 4936 TCHF. As a result of the current interest situation, there were no fixed term deposits as of 31st December 2009. The high amount of cash and cash equivalents will be reduced in the coming year by moving the payment targets for the Members of the Cooperative.

5 **Provisions**
The provisions contain credit balances for vacation time and overtime and an obligation for restructuring costs since December 2007. In total, the provisions have decreased by 253 TCHF.
In 2003, Nagra took over possible obligations for the Wellenberg site for a one-off payment of around 4800 TCHF from the now liquidated company GNW. The provision created with this payment will be used over a period of ten years for recultivation work, preparing project documentation and the final report and paying various fees. In the current business year there was no expenditure of this nature. The provision therefore remains changed.

6 **Trade payables**

Acc. to Coop. Members and third parties	31.12.2008 TCHF	31.12.2009 TCHF
Payables Cooperative Members	771	1 263
Payables third parties	6 428	7 744
Total payables	**7 199**	**9 007**

The largest creditors as of the balance sheet date are ENSI, PSI, the SFOE and the company BSF Swissphoto, with a total of around 4800 TCHF.

7 **Other payables**

Acc. to Coop. Members and third parties	31.12.2008 TCHF	31.12.2009 TCHF
Payables Cooperative Members	–	1 217
Payables third parties	184	357
Total payables	**184**	**1 574**

Other payables to the Members of the Cooperative include creditors on the debit side and open receivables towards the Members of the Cooperative per balance sheet date.

8 **Accrued expenses and deferred income**
Accrued expenses and deferred income increased in the year of reporting by around 1600 TCHF; this is due to project cost contributions that have to be paid back to the Members of the Cooperative (increase of around 800 TCHF). The accrued expenses and deferred income towards third parties increased by around 800 TCHF to around 1300 TCHF.

9 **Third party services**

Project-related services for:	Actual 2008 TCHF	Actual 2009 TCHF
Projects	14 791	17 493
Communication	2 399	2 350
Fees (ENSI, SFOE, diverse)	4 120	6 907
Travel costs	716	628
Total	**22 026**	**27 378**

10 **Personnel costs**
Personnel costs increased compared to the previous year by 1.3% to 12 671 TCHF. At the end of the year, staff consisted of 76.1 full-time positions, an increase of 4.5 compared to the previous year.

11 **Other operating expenses**
This position contains inter alia rents of around 900 TCHF, informatics of around 700 TCHF and miscellaneous operating expenses of around 900 TCHF.

Further information

Off balance sheet transactions
In order to secure large project income from Japan, two currency futures transactions were made as of payment dates 17.5.2010 for 30 million JPY and 1.6.2010 for 51 million JPY. The value as of 31.12.2009 is 899 424 CHF; the non-realised profit of 44 526 CHF is not booked.

Contingent obligations
There are two bank guarantees in the amount of 73 989 Euros up to 10.2.2011 for an ongoing support contract for the state agency for managing radioactive waste in Lithuania (RATA). There is also a guarantee in the amount of 27 385 Euros up to 31.12.2013 for a support contract for Ondraf/Niras in Belgium. All bank guarantees are non-balanced.

Transactions with associated persons
Transactions with associated persons are understood to mean transactions with the Members of the Cooperative according to page 37. There are no further transactions with associated persons.

Events subsequent to the balance sheet date
After the balance sheet date of 31st December 2009, no events occurred that are worthy of mention. Events after the balance sheet date were taken into consideration up to 9th April 2010. On this date, the annual accounts were approved by Nagra's Board of Directors.

Accumulated accounts

Revenues including allocations	Increase 2008 CHF	Status 31.12.2008 CHF	Increase 2009 CHF	Status 31.12.2009 CHF	
Swiss Confederation	906 852	26 914 478	1 065 019	27 979 497	
Axpo AG	6 919 243	202 674 262	8 123 720	210 797 982	
BKW FMB Energie AG	3 358 585	92 819 606	3 942 154	96 761 760	
Kernkraftwerk Gösgen-Däniken AG	9 190 974	261 602 521	10 790 958	272 393 479	
Kernkraftwerk Leibstadt AG	11 021 790	288 436 207	12 938 846	301 375 053	
Contributions for project expenditure	**31 397 444**	**872 447 074**	**36 860 697**	**909 307 771**	
Contributions to administration costs	600 000	84 320 000	600 000	84 920 000	
Contributions of members to Nagra	**31 997 444**	**956 767 074**	**37 460 697**	**994 227 771**	
Contributions of GNW	**–**	**65 265 331**	**–**	**65 265 331**	
Contributions of Members of the Cooperative	**31 997 444**	**1 022 032 405**	**37 460 697**	**1 059 493 102**	12

Explanations in appendix page 50

Total expenses	Increase 2008 CHF	Status 31.12.2008 CHF	Increase 2009 CHF	Status 31.12.2009 CHF	
Geoscientific studies	2 484 112	159 044 291	3 120 016	162 164 307	
Nuclear technology and safety	1 925 941	35 892 748	1 394 828	37 287 576	
Radioactive materials	1 186 607	30 569 461	1 220 781	31 790 242	
Facility planning	636 530	18 673 158	941 993	19 615 151	
Generic (non-site-specific) work	3 139 919	78 175 484	2 931 496	81 106 980	
General programme costs	3 795 960	59 011 416	4 251 531	63 262 947	
Fees and compensation	2 287 923	21 191 945	4 316 644	25 508 589	
L/ILW programme	**15 456 992**	**402 558 503**	**18 177 289**	**420 735 792**	
Geoscientific studies	1 743 414	295 923 834	3 612 401	299 536 235	
Nuclear technology and safety	1 838 563	48 237 307	2 124 970	50 362 277	
Radioactive materials	641 891	21 075 633	754 629	21 830 262	
Facility planning	536 255	14 772 419	880 955	15 653 374	
Generic (non-site-specific) work	5 569 542	77 469 820	4 482 436	81 952 256	
General programme costs	3 787 366	45 106 226	4 251 665	49 357 891	
Fees and compensation	1 823 421	32 568 663	2 576 351	35 145 014	
HLW programme	**15 940 452**	**535 153 902**	**18 683 408**	**553 837 310**	
Project expenses for repository programmes	**31 397 444**	**937 712 405**	**36 860 697**	**974 573 102**	13
Administration and general project expenses	**600 000**	**84 320 000**	**600 000**	**84 920 000**	
Total expenses for L/ILW and HLW programmes and administration and general project expenses	**31 997 444**	**1 022 032 405**	**37 460 697**	**1 059 493 102**	14

The allocation of the accumulated costs per 31.12.2005, which were divided in the previous year between the repository programmes in accordance with a resolution of the Board of Directors of 24th June 2008, is no longer shown from this year. It can be found in the 2008 annual report.

Explanations in appendix page 50

Notes on the accumulated accounts

The accumulated treatment of the contributions of the Members of the Cooperative and the application of these contributions forms the basis, at the time of waste emplacement, for any adjustments in payments between the Members. It also indicates what work has resulted in project-related expenditure.
The structure of the total revenues is oriented primarily to the operating accounts. The total expenditure and the total revenues are presented including allocations.

12 **Contributions of Members of the Cooperative**
The contributions of the Members of the Nagra Cooperative towards covering project costs are calculated based on the thermal output of the individual nuclear power plants. The contributions of the Members in the total amount of 37.5 million CHF (32.0 in the previous year) correspond to those in the operating accounts. Included is a contribution to administration costs in the total amount of 0.6 million CHF.
The GNW contributions include payments by GNW for contract work on the Wellenberg project, which is now terminated.

13 **Project-specific expenditure for the repository programmes**
The two repository programmes basically have the same structure in the presentation of the accumulated accounts and are oriented towards the most important technical tasks to be performed up to the completion of waste management activities. If there is no explicit reference to a specific programme, the following explanations of the individual positions apply to both projects.
Project-related expenditure amounted in the year of reporting to around 36.9 million CHF, with 18.2 million CHF allocated to the L/ILW programme and 18.7 million CHF to the HLW programme.

a) Geoscientific investigations
Geological investigations for identifying potential siting regions comprise geological studies in the investigation area of Northern Switzerland relating to HLW disposal, as well as processing of geological information on the L/ILW repository.

b) Nuclear technology and safety
The work comprises a safety-based evaluation of potential siting regions, laboratory studies on the near-field and on various backfill materials.

c) Radioactive materials
Expenditure on assessing the disposability of waste packages and on ongoing documentation and inventorying of radioactive waste.

d) Facility planning
This position includes expenditure on developing the concepts for surface and underground facilities of the repositories for HLW and L/ILW.

e) Generic investigations
This includes work on developing methodologies, modelling and validation of the models used in safety analyses, laboratory work, participation in the work at the rock laboratories (Grimsel and Mont Terri) and research programmes of the EU.

f) General programme costs
This expenditure results from programme management, expenditure on cost studies and public relations activities.

g) Fees and compensation
This includes the fees passed on to Nagra from the regulatory and safety authorities.

14 **Total expenditure for the HLW and L/ILW programmes and management and general project costs**
Total sum of the accumulated accounts taking into account the described adjustments. The amount has to agree with note 12, contributions of Members of the Cooperative.

Report of the auditors

(available only in German)

Bericht der Revisionsstelle an die Generalversammlung der Nagra

Bericht der Revisionsstelle zur Jahresrechnung

Als Revisionsstelle haben wir die beiliegende Jahresrechnung bestehend aus Bilanz, Betriebsrechnung, Geldflussrechnung und Anhang (Erläuterungen zur Bilanz, Betriebs- und Geldflussrechnung) (Seiten 41 bis 46) der Nagra Nationale Genossenschaft für die Lagerung radioaktiver Abfälle für das am 31. Dezember 2009 abgeschlossene Geschäftsjahr geprüft.

Verantwortung der Verwaltung
Die Verwaltung ist für die Aufstellung der Jahresrechnung in Übereinstimmung mit den gesetzlichen Vorschriften und den Statuten verantwortlich. Diese Verantwortung beinhaltet die Ausgestaltung, Implementierung und Aufrechterhaltung eines internen Kontrollsystems mit Bezug auf die Aufstellung einer Jahresrechnung, die frei von wesentlichen falschen Angaben als Folge von Verstössen oder Irrtümern ist. Darüber hinaus ist die Verwaltung für die Auswahl und die Anwendung sachgemässer Rechnungslegungsmethoden sowie die Vornahme angemessener Schätzungen verantwortlich.

Verantwortung der Revisionsstelle
Unsere Verantwortung ist es, aufgrund unserer Prüfung ein Prüfungsurteil über die Jahresrechnung abzugeben. Wir haben unsere Prüfung in Übereinstimmung mit dem schweizerischen Gesetz und den Schweizer Prüfungsstandards vorgenommen. Nach diesen Standards haben wir die Prüfung so zu planen und durchzuführen, dass wir hinreichende Sicherheit gewinnen, ob die Jahresrechnung frei von wesentlichen falschen Angaben ist.

Eine Prüfung beinhaltet die Durchführung von Prüfungshandlungen zur Erlangung von Prüfungsnachweisen für die in der Jahresrechnung enthaltenen Wertansätze und sonstigen Angaben. Die Auswahl der Prüfungshandlungen liegt im pflichtgemässen Ermessen des Prüfers. Dies schliesst eine Beurteilung der Risiken wesentlicher falscher Angaben in der Jahresrechnung als Folge von Verstössen oder Irrtümern ein. Bei der Beurteilung dieser Risiken berücksichtigt der Prüfer das interne Kontrollsystem, soweit es für die Aufstellung der Jahresrechnung von Bedeutung ist, um die den Umständen entsprechenden Prüfungshandlungen festzulegen, nicht aber um ein Prüfungsurteil über die Wirksamkeit des internen Kontrollsystems abzugeben. Die Prüfung umfasst zudem die Beurteilung der Angemessenheit der angewandten Rechnungslegungsmethoden, der Plausibilität der vorgenommenen Schätzungen sowie eine Würdigung der Gesamtdarstellung der Jahresrechnung. Wir sind der Auffassung, dass die von uns erlangten Prüfungsnachweise eine ausreichende und angemessene Grundlage für unser Prüfungsurteil bilden.

Prüfungsurteil
Nach unserer Beurteilung entspricht die Jahresrechnung für das am 31. Dezember 2009 abgeschlossene Geschäftsjahr dem schweizerischen Gesetz und den Statuten.

Berichterstattung aufgrund weiterer gesetzlicher Vorschriften

Wir bestätigen, dass wir die gesetzlichen Anforderungen an die Zulassung gemäss Revisionsaufsichtsgesetz (RAG) und die Unabhängigkeit (Art. 906 OR in Verbindung mit Art. 728 OR) erfüllen und keine mit unserer Unabhängigkeit nicht vereinbare Sachverhalte vorliegen.

In Übereinstimmung mit Art. 906 OR in Verbindung mit Art. 728a Abs. 1 Ziff. 3 OR und dem Schweizer Prüfungsstandard 890 bestätigen wir, dass ein gemäss den Vorgaben der Verwaltung ausgestaltetes internes Kontrollsystem für die Aufstellung der Jahresrechnung existiert.

Wir empfehlen, die vorliegende Jahresrechnung zu genehmigen.

PricewaterhouseCoopers AG

Willy Wenger	Stephan Bugget
Revisionsexperte	Revisionsexperte
Leitender Revisor	

Zürich, 12. April 2010

Appendices

Waste inventories and volumes

Radioactive waste arises mainly from electricity production in the five Swiss nuclear power plants. It is also produced from application of radioactive materials in the areas of medicine, industry and research (MIR waste).

Waste volumes at the end of 2009
As a service to the waste producers, Nagra maintains a centralised databank of all waste packages. The following table shows the volumes and activities as of the end of 2009 of waste that has been prepared for geological disposal. Not contained in the table are pre-conditioned raw waste and waste packages, for example waste packaged for processing in the ZWILAG plasma furnace.

Conditioned waste (31st December 2009, figures rounded)	**Volume (m^3)**	**Activity (Bq)**
Nuclear power plants	3 375	$1{,}2 \cdot 10^{15}$
ZWILAG	1 318	$3{,}1 \cdot 10^{18}$
Federal Government interim storage facility (waste from medicine, industry and research)	1 439	$7{,}0 \cdot 10^{15}$

The ZWILAG waste consists of waste delivered to the interim storage facility from the power plants, waste packages from the plasma furnace and containers with vitrified high-level waste from reprocessing.

Predicted waste volumes and inventories for deep geological disposal
Planning the geological repositories requires information on expected waste volumes. The total volume of waste for disposal will be around 99 000 m^3 packaged in disposal containers (see table for details). The volumes were determined assuming a 50-year operating lifetime for the power plants. The volumes of waste from medicine, industry and research are based on the operational planning of the repositories.

Predicted waste volumes (50-year NPP operation)	**L/ILW (m^3)**		**ATW (m^3)**		**HLW/SF (m^3)**	
	conditioned	packaged	conditioned	packaged	conditioned	packaged
BA-KKW Operational waste from the NPPs (from cleaning systems and mixed waste), inc. post-operational phase before decommissioning	7 260	24 400	10	40		
RA-KKW NPP reactor waste (activated components)	340	1 560				
SA-KKW NPP decommissioning waste	28 265	28 265				
WA-KKW NPP reprocessing waste (substitution BNFL)			200	1 320		
BA-ZWI ZWILAG operational waste	45	140				
SA-ZWI ZWILAG decommissioning waste	620	655				
BA-MIF MIR waste from BAG[2] and operational waste from PSI	4 270	9 170	325	920		
SA-MIF[1] PSI decommissioning waste and others	23 000	23 000				
BEVA Waste from the future SF encapsulation plant in the HLW/SF repository	2 220	2 220				
HLW Canisters from reprocessing (completion of existing contracts, with substitution BNFL)					115	730
BE Spent fuel					1 135	6 595
Total volumes (rounded)	**66 020**	**89 410**	**535**	**2 280**	**1 250**	**7 325**
Percentage (rounded)	97,3 %	90,3 %	0,8 %	2,3 %	1,9 %	7,4 %
Activity[2]	$4{,}7 \cdot 10^{17}$ Bq		$3{,}4 \cdot 10^{16}$ Bq		$3{,}0 \cdot 10^{19}$ Bq	
Percentage	1,6 %		0,1 %		98,3 %	

[1] For the first time this contains a reserve of 12,000 m^3 for the as yet unspecified L/ILW from large-scale research facilities.
[2] Activity inventory for reference year 2050.

Publications 2009

Nagra Technical Reports (NTBs)

All the NTBs listed here are available in printed form. They can also be downloaded free of charge from the Nagra website. A complete list of all reports published to date (including prices) can be obtained from the Nagra offices in Wettingen or downloaded from the internet.

NTB 09-06
"The Nagra Research, Development and Demonstration (RD&D) Plan for the Disposal of Radioactive Waste in Switzerland"; November 2009.

NTB 09-04
"A Review of the Possible Effects of Hydrogen on Lifetime of Carbon Steel Nuclear Waste Canisters"; July 2009.

NTB 09-02
"A Review of Materials and Corrosion Issues Regarding Canisters for Disposal of Spent Fuel and High-level Waste in Opalinus Clay"; January 2009.

Information for the general public

The website www.nagra.ch is continually updated in terms of content, images, animations and short films. The site is available in three languages (German, French and English).

In 2009, several brochures were published in French and Italian. These can be downloaded from the internet or ordered from Nagra. Other publications include a picture book titled "Grimsel Test Site – 25 years of underground research", materials for schools and a waste management board game.

Three issues of "nagra info" appeared in 2009. This publication provides current information on radioactive waste management. It can be subscribed to free of charge or downloaded from the internet. Its content is also distributed in the form of the newsletter e-info.

Internet addresses

Nagra
National Cooperative for the Disposal of Radioactive Waste
www.nagra.ch

SFOE
Federal Office of Energy
www.bfe.admin.ch

ENSI
Swiss Federal Nuclear Safety Inspectorate
www.ensi.ch

Waste management fund (SFOE)
www.entsorgungsfonds.ch

GTS
Grimsel Test Site
www.grimsel.com

FMT
Mont Terri Rock Laboratory
www.mont-terri.ch

Forum VERA
www.forumvera.ch

IAEA
International Atomic Energy Agency
www.iaea.org

ITC
International Training Center, School of Underground Waste Storage and Disposal
www.itc-school.org

Nuclear energy internet portal
www.kernenergie.ch

KNE
Commission for Nuclear Waste Management
www.kne-schweiz.ch

KNS
Federal Commission for Nuclear Safety
www.bfe.admin.ch/kns

LES
Waste Management Laboratory (PSI)
les.web.psi.ch

Nuklearforum
www.nuklearforum.ch

PSI
Paul Scherrer Institute
www.psi.ch

Radioactive waste (SFOE)
www.radioaktiveabfaelle.ch

Decommissioning fund (SFOE)
www.stilllegungsfonds.ch

ZWILAG
Zwischenlager Würenlingen AG
www.zwilag.ch

Glossary

Andra
Agence nationale pour la gestion des déchets radioactifs, France.

Andrad
Agentia Nationala pentru Deseuri Radioactive, Romania.

ATW
Alpha-toxic waste.

BGR
Bundesanstalt für Geowissenschaften und Rohstoffe, Germany.

BGS
British Geological Survey.

BKW FMB
BKW FMB Energie AG, Bern.

BNFL
British Nuclear Fuels.

CERN
European Organization for Nuclear Research.

Criepi
Central Research Institute of Electric Power Industry, Japan.

DETEC
Swiss Federal Department for the Environment, Transport, Energy and Communications.

EDRAM
International Association for Environmentally Safe Disposal of Radioactive Material.

EMPA
Swiss Federal Laboratories for Materials Testing and Research.

ENSI
Swiss Federal Nuclear Safety Inspectorate.

EU
European Union.

FMT
Mont Terri Rock Laboratory – rock laboratory in Opalinus Clay located near St-Ursanne, Canton Jura. Project managed by Swisstopo.

FOEN
Federal Office for the Environment.

FOSD
Federal Office for Spatial Development.

GRS
Gesellschaft für Anlagen- und Reaktorsicherheit, Germany.

GTS
Grimsel Test Site – Nagra's underground laboratory in crystalline rock on the Grimsel Pass, Canton Bern.

HLW
Vitrified high-level waste from reprocessing.

HSK
Swiss Federal Nuclear Safety Inspectorate (Villigen), replaced at the beginning of 2009 by ENSI.

IAEA
International Atomic Energy Agency, Vienna.

IEA
International Energy Agency, Paris.

ILW
Long-lived intermediate-level waste.

JAEA
Japan Atomic Energy Agency.

JNES
Japan Nuclear Energy Safety Organization.

JNFL
Japan Nuclear Fuel Limited.

KNE
Commission for Nuclear Waste Management.

KNS
Federal Commission for Nuclear Safety.

KRMC
Korea Radioactive Waste Management Corporation.

L/ILW
Low- and intermediate-level waste.

LES
Waste Management Laboratory (PSI).

MIR
Radioactive waste from medicine, industry and research.

MIRAM
Model Inventory of Radioactive Materials.

NEA
Nuclear Energy Agency of the OECD, Paris.

NPP
Nuclear power plant.

NTB
Nagra Technical Report. Series of scientific publications.

Numo
Nuclear Waste Management Organization of Japan.

NWMO
Nuclear Waste Management Organization, Canada.

Obayashi
Obayashi Corporation, Japan.

OECD
Organisation for Economic Cooperation and Development.

Ondraf/Niras
Organisme national des déchets radioactifs et des matières fissiles enrichies / Nationale instelling voor radioactief afval en verrijkte splijstoffen, Belgium.

OPG
Ontario Power Generation, Canada.

PSI
Paul Scherrer Institute, Villigen, Canton Aargau.

RATA
Radioactive Waste Management Agency, Lithuania.

RWMC
Radioactive Waste Management Funding and Research Center, Japan.

SF
Spent fuel.

SFOE
Federal Office of Energy.

SKB
Svensk Kärnbränslehantering, Sweden.

Swisstopo
Federal Office of Topography swisstopo. Mont Terri project manager from 2006.

ZWILAG
Centralised interim storage facility of the Swiss nuclear power plants for all categories of waste (Würenlingen, Canton Aargau).

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