

**nagra** ● we care

**annual report  
2011**

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## Foreword



### Pankraz Freitag, President of the Board of Directors

If we look back at the year 2011 from Nagra's point of view, then two dates stand out in particular: 11<sup>th</sup> March and 30<sup>th</sup> November.

On the 11<sup>th</sup> of March, the north-east coast of Japan was hit by a huge earthquake and tsunami, with catastrophic consequences for the residents in the area of Fukushima and the nuclear power plants located in the region. The event also had implications for Switzerland: within a few months of the accident at the power plant, the Swiss Federal Council decided in favour of a stepwise phase-out of nuclear energy, with a gradual shut-down of the country's nuclear power plants by 2034. Parliament later endorsed this decision.

However, the need for safe disposal of radioactive waste remains – the waste already exists and will continue to arise in the foreseeable future, not only from nuclear power production but also in the fields of medicine, industry and research.

Some opponents of deep geological disposal argued up till recently that they would oppose the construction of repositories until a decision was made to phase out nuclear energy. As this has now effectively happened, a change in their attitude would be a logical consequence. My initial impression is that – at least to some extent – arguments have changed rather than attitudes and the implementation of the Sectoral Plan process continues to be opposed. I sincerely hope that my initial impression will prove to be misleading.

The second date – 30<sup>th</sup> November – was a very welcome one for our organisation. Following reviews by several technical bodies, the Federal Council confirmed all the repository siting regions proposed by Nagra at the end of 2008. Stage 1 of the Sectoral Plan process is thus complete and an important milestone on the long road to realising safe geological disposal has been reached.

This positive result is, in effect, an acknowledgement of the technically excellent and credible work being carried out by Nagra's employees and it sends an important signal to the public: the process is moving forward, the first key milestones have been reached and the next stage has begun.

I would like to thank the Members of the Board of Directors most warmly 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



30<sup>th</sup> November 2011:

Stage 1 of the Sectoral Plan for Deep Geological Repositories is complete. The Federal Council decides to include all six siting regions proposed by Nagra in the next stage of the site selection process.



**Thomas Ernst, Chief Executive Officer**

Following the specification of the site selection procedure and criteria in 2008, the decision of the Federal Council of 30<sup>th</sup> November 2011 represents the second major milestone in the ongoing site selection process for deep geological repositories in Switzerland. All six of the siting regions proposed in autumn 2008 (Südranden, Zürich Nordost, North of Lägern, Jura Ost, Jura-Südfuss and Wellenberg) have been incorporated into the Sectoral Plan for further consideration. This decision not only marked the end of Stage 1, but can also be seen as confirmation of the high standard of scientific and technical work being carried out by Nagra. A solid foundation has thus been laid for proceeding with Stage 2 of the process.

At the end of March 2011, the Swiss Federal Nuclear Safety Inspectorate (ENSI) expressed its opinion on whether the level of geological knowledge documented in a detailed report by Nagra in 2010 is sufficient to allow a safety-based comparison of the siting regions in Stage 2. ENSI found that the required level of knowledge can be achieved through the investigations already initiated or planned by Nagra, supplemented by a list of additional requirements specified by ENSI. Exploratory boreholes requiring a permit will be drilled later in Stage 3. Based on requests by the Cantons and the Nuclear Safety Commission (NSC), Nagra decided to give priority to 2D seismic measurements and to include the results of these in the safety comparison in Stage 2.

The focus of Nagra's technical work was on the systematic expansion of the geological knowledge base. Besides a number of other activities, an extensive seismic campaign was carried out in the regions North of Lägern, Jura Ost, Südranden and Jura-Südfuss; the work was completed in the spring of 2012. In a positive light, the constructive support of the Cantons and local communities affected by the campaign ensured that the work proceeded according to plan and was accepted by the public.

The regional conferences in five of the six siting regions were also established in 2011. In 2012, these bodies will be involved intensively in considering the location and accessing of the repository surface facilities. As a basis for this collaboration, Nagra submitted siting proposals for the surface facilities to the Federal Office of Energy (SFOE) at the end of 2011 and these were published on 20<sup>th</sup> January 2012. The objective is to achieve optimum regional integration of the facilities, at the same time ensuring that construction of the facilities is technically feasible.

A large number of actors contributed to the substantial progress that was made over the year in the challenging process of finding sites for geological repositories and for this I would like to thank them. My particular thanks go of course to all Nagra employees – under conditions that are not always straightforward, they continue to show great commitment towards making progress in the siting programme.

Dr. Thomas Ernst

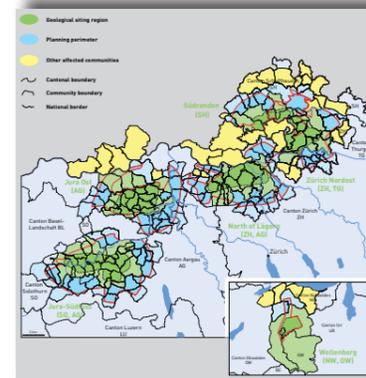
## Highlights in 2011



5<sup>th</sup> September: Opening of the new visitors' centre at the Mont Terri Rock Laboratory



24<sup>th</sup> October: Start of seismic measurements in the regions Jura Ost and North of Lägern



30<sup>th</sup> November: The Federal Council confirms that all six potential siting regions will be carried through to the next stage of the Sectoral Plan process



15<sup>th</sup> December: Nagra submits proposals for potential siting areas for the repository surface facilities

**March** The Swiss Federal Nuclear Safety Inspectorate (ENSI) publishes its review of a report submitted by Nagra in November 2010. The fundamental question is whether additional geological investigations are required with a view to Stage 2 of the Sectoral Plan process. ENSI reaches the conclusion that the investigations that have already been initiated or are planned by Nagra, together with additional studies proposed by ENSI, will provide sufficient geological data for the safety-based comparison of the potential siting regions in Stage 2.

**June** At the annual general meeting of Nagra in Bern, the Board of Directors elects Herbert Meinecke as successor to Peter Hirt.

**July** The Federal Nuclear Safety Commission (NSC) expresses its opinion on the Nagra report on the geological knowledge base mentioned above. For Stage 2, it recommends that, in addition to the other investigations already planned, seismic measurements should be carried out in the regions Jura-Südfuss and Südranden. Otherwise, the NSC concurs with the conclusions of ENSI regarding the report.

**September** The new visitors' centre at the Mont Terri Rock Laboratory opens its doors. The guests at the opening ceremony include Federal Council member Ueli Maurer. Some 2800 people visit the laboratory during the year.

**October** Nagra initiates extensive seismic measurement campaigns in the siting regions Jura Ost and North of Lägern. The work continues until February 2012. The measurements will provide a more detailed picture of the underground geological environment for Stage 2 of the Sectoral Plan process.

**November** The Cantonal Commission announces that Nagra also intends to carry out seismic measurements in the regions Jura-Südfuss and Südranden in spring 2012. As was the case for the measurements in Jura Ost and North of Lägern, this is a response by Nagra to the wishes of the Cantons and the NSC for additional investigations.

**November** The Federal Council announces its conclusions on Stage 1 of the Sectoral Plan process: all six potential siting regions for geological repositories proposed by Nagra are to be carried through to the next stage. This signals the start of Stage 2 of the site selection process. In the coming years, the regions will be investigated in more detailed and compared with one another.

**December** For each of the six potential siting regions, Nagra submits proposals to the Federal Office of Energy (SFOE) for potential locations for the surface facilities required for constructing and operating the repository. The proposals serve as the basis for discussions within the framework of regional participation in Stage 2.

## Our task

The safe, long-term disposal of radioactive waste in deep geological repositories is a challenge that we undertake in the interests of humans and the environment. The Federal Government and the Swiss people have granted us a mandate to carry out this work in the national interest.



### Our mandate

Radioactive waste arises in Switzerland from the operation and decommissioning of the nuclear power plants, and from the use of radioactive materials in the areas of medicine, industry and research (MIR waste). According to the Nuclear Energy Act, the producers of radioactive waste are responsible – under the supervision of the federal authorities – for the 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, with the mandate of safely disposing of all waste arising in Switzerland.

The Nuclear Energy Act calls for deep geological disposal of 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). The site selection process (Sectoral Plan for Deep Geological Repositories) is underway, under the lead of the Federal Government.

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 repository sites, Nagra's task is to propose geological siting regions and sites, to narrow these down as part of a step-wise procedure and to submit the required general licence applications. Nagra ensures inventoring 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 (Villigen) and various universities and research institutes both in Switzerland and abroad.

### Our work

- Working together with the authorities and the siting regions within the framework set by the Sectoral Plan process.
- Characterisation and ongoing inventoring 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.
- Analysis of results and data as part of safety assessment studies and evaluation of the knowledge base 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 safety analysis.
- 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 Nagra's activities.
- Providing expert services to third parties.

# Developments in 2011



## 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 1<sup>st</sup> 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 humans 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 has to 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.
- Site selection procedure: the Federal Government defines the objectives and requirements 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.

### Federal Nuclear Safety Inspectorate, Federal Nuclear Safety Commission

The Federal Nuclear Safety Inspectorate (ENSI) is the regulatory authority responsible for the nuclear safety and security of the Swiss nuclear installations. In this capacity, it monitors Nagra's siting investigations and the later construction and operation of the repositories.

The Nuclear Safety Commission (NSC) advises the Federal Council, the Department for the Environment, Traffic, Energy and Communications (DETEC) and ENSI on questions of nuclear safety.

### Decommissioning and Waste Management Funds

The purpose of the Waste Management Fund is to secure the costs of disposing of operational waste and spent fuel assemblies following the decommissioning of the nuclear power plants. The Decommissioning Fund secures the costs of decommissioning and dismantling the nuclear power plants at the end of their operational lifetime and disposing of the resulting waste. The Funds are supervised by the Federal Government. At the end of 2011, the accumulated capital in the Waste Management Fund was around 2.8 billion CHF; the figure for the Decommissioning Fund was around 1.3 billion CHF. More detailed information can be found on the website [www.entsorgungsfonds.ch](http://www.entsorgungsfonds.ch) (some material available in English). The cost estimates that serve as the basis for calculating contributions to the Funds were updated during the current year (see page 28).

### Waste management programme as specified in the Nuclear Energy Act

Article 32 of the Nuclear Energy Act requires the waste producers to prepare a waste management programme for all types of waste arising in Switzerland. The programme is reviewed by the federal authorities and approved by the Federal Council. Together with the Sectoral Plan for Deep Geological Repositories, it provides the basis for deciding on the way forward in Swiss waste management strategy. In line with the requirement of the Federal Council, Nagra submitted the waste management programme to the authorities in October 2008, together with the report documenting the proposals for repository siting regions. ENSI began its review of the programme once the siting proposals had been evaluated and the results are expected sometime in 2012.

### 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, which regulates the site selection process, on 2<sup>nd</sup> April 2008. The technical feasibility and safety of geological disposal had already been confirmed with the approval by the Federal Council of the "Entsorgungsnachweis" high-level waste feasibility study in June 2006. At the same time, based on a study commissioned by the SFOE, the Federal Council also concluded that waste disposal facilities can be constructed and operated in a way that is environmentally sound and, considered overall, has a positive impact on regional economy. The Federal Council also noted that, for siting decisions to be accepted, it is imperative that those affected by these decisions be fully informed and involved in the selection process.

The Sectoral Plan approach (see Figure 1 and page 12) takes this requirement for information and involvement into account. The authorities and the public in the siting regions can participate in the process, as can authorities from neighbouring countries and interested foreign and domestic organisations. The process comes to a conclusion with a decision of the Federal Council and Parliament on the general licences for the repositories. Their decision is then subject to an optional national referendum.

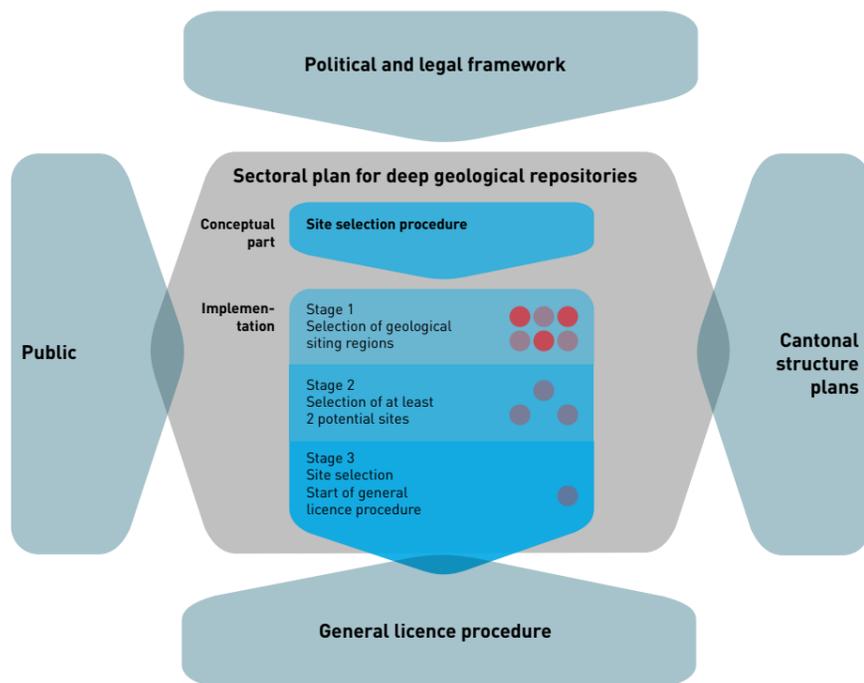


Figure 1: Stages, responsibilities and interactions in the Sectoral Plan for Deep Geological Repositories

## Inventory of radioactive materials

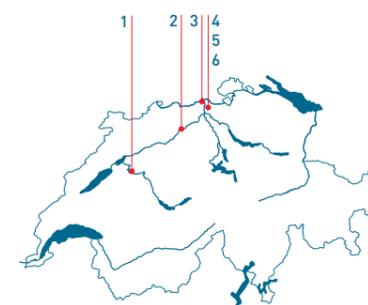
Nagra maintains a centralised inventory of existing radioactive wastes. This was expanded in 2011 to include new waste types, in particular waste from reprocessing. The main purpose of the inventory is to provide a record of the waste packages stored at the nuclear power plants, in the ZWILAG centralised interim storage facility and in the Federal Government's interim storage facility. It also provides the basis for the Model Inventory of Radioactive Materials (MIRAM), which includes future waste arisings.

MIRAM contains information on the inventories, properties and volumes of waste and provides input for the planning and safety analysis of geological repositories. The updating of MIRAM in 2011 focused on detailed documentation of the chemical inventory in a geological repository. Research waste from CERN and waste that will arise later from the repository surface facility were also included in the database. The updated MIRAM database was used to prepare a waste volume and transport framework for the 2011 cost study (see page 28). An overview of waste types and volumes can be found on pages 54/55.

Nagra also carried out further developments on a three-dimensional model for inventorying activated reactor components. Following detailed validation using measured data, the model was used for the 2010/2011 decommissioning studies. It provided the base data for determining the total inventory and volumes of decommissioning waste for the purpose of cost calculations.

The first results of laboratory experiments on the mineralisation of wastes containing organic materials are now available. The analyses will provide input for planning detailed experiments on solidification of these wastes in a way that is suitable for disposal. A study was also initiated on metallic radioactive waste, with the aim of showing the potential for reducing gas production in a repository.

Nagra is carrying out research on waste products together with the Paul Scherrer Institute (PSI) for the purpose of quality assurance, as specified by the guidelines of the Federal Nuclear Safety Inspectorate (ENSI). Additional development work ensures that suitable solidification methods are also available for special wastes. Nagra also carried out reviews of the suitability for later disposal of wastes from the power plants, ZWILAG and PSI as part of the disposability certification procedures, all with positive results. The reviews related in particular to activated components from the reactor pressure vessel and waste from the reprocessing of spent fuel assemblies. The work was carried out in accordance with the applicable guidelines and led to clearance of the conditioning procedures by ENSI.



- 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

### Clear rules for site selection

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

### From how to where

The fundamental question of how to safely dispose of all types of radioactive waste in Switzerland has been answered from a technical and scientific viewpoint: in June 2006, the Federal Council approved the demonstration of disposal feasibility (Entsorgungsnachweis) for high-level waste (HLW); the corresponding demonstration for low- and intermediate-level waste (L/ILW) had already been approved in 1988. The question of where the two repositories should be constructed is being clarified as part of the Sectoral Plan process. In the search for sites, safety always has first priority. Because of its transparent, systematic approach and the extensive rights of participation of a wide range of stakeholders, the Swiss site selection process is also considered by other countries to be exemplary.

### Federal Government lead – proposals by Nagra – independent supervision

The Sectoral Plan process consists of three stages; the lead lies with the Swiss Federal Office of Energy (SFOE; see Figure 2). Cantons and local communities, neighbouring countries, interested organisations and associations, political parties and the public are brought into the process by the SFOE. Nagra's responsibility is to prepare the scientific and technical background, to propose siting regions and then sites and, at the end of Stage 3, to submit general licence applications for the repositories. ENSI reviews Nagra's proposals from the viewpoint of safety and technical feasibility, for which it relies on the support of external experts. At the end of each stage, the authorities and the Federal Council conduct an overall evaluation of progress; this is preceded by consultation and participatory processes.

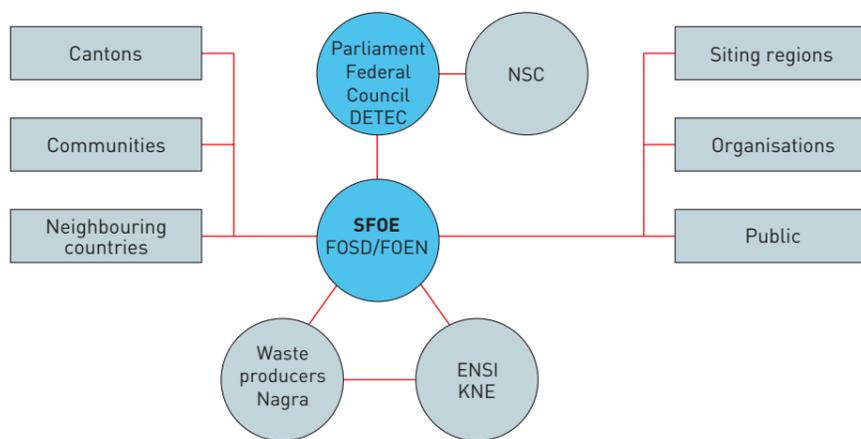


Figure 2: Actors in the site selection process

### Stage 1 – a retrospective

The first stage of the Sectoral Plan process lasted from 2008 to 2011 and is now complete. The objective was to determine which geological siting regions are suitable in principle for hosting repositories. Beginning with the whole of Switzerland, Nagra applied a systematic site selection procedure based on the safety criteria and the narrowing-down steps specified in the Sectoral Plan. This resulted in three proposed geological siting regions for high-level waste (HLW) and six for low- and intermediate-level waste (L/ILW).

Nagra's proposals were subjected to a rigorous safety review by various authorities and technical bodies. ENSI and its various experts, the Commission

### Broad support and supervision of the Sectoral Plan process

Several bodies have the task of monitoring and supporting the Sectoral Plan process and ensuring transparent implementation.

The 'Waste Management Advisory Council' advises the Federal Department for the Environment, Transport, Energy and Communications (DETEC) on implementation of the site selection process.

The 'Cantonal Commission' (AdK) ensures cooperation between the siting Cantons, the affected neighbouring Cantons and neighbouring countries. It supports the Federal Government in the implementation of the site selection process and makes appropriate recommendations.

The 'Working Group on Spatial Planning' supports the Federal Office of Spatial Development (FOSD). Its members include federal experts (from the FOSD, SFOE and the Federal Office for the Environment (FOEN)), representatives of the siting Cantons, Germany and Nagra.

The 'Working Group on Information and Communication' 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.

The 'Technical Forum on Safety' is made up of technical experts from the authorities, the commissions of the Federal Government and the waste producers. Also represented are the siting regions, the siting Cantons, the Cantonal Working Group on Safety, German authorities and environmental organisations. The Forum answers questions submitted by the public, Cantons, neighbouring countries and the siting regions. The questions directed to the Forum and the responses to these are published on the SFOE website ([www.radioaktiveabfaelle.ch](http://www.radioaktiveabfaelle.ch)).

### Principles for narrowing down the siting regions in Stage 2

- An extensive geological investigation programme will be conducted in Stage 2 to improve the knowledge base. This will take into account the 41 requirements set out by ENSI.
- If Nagra can demonstrate reliably, based on the results of these investigations, that certain siting regions have clear disadvantages in terms of safety compared to others, these siting regions will not be proposed for Stage 3.
- All the remaining siting regions will be proposed by Nagra and will be investigated in depth in Stage 3 (with boreholes, 3D seismics, etc.).

Result: No site will be ruled out because it has been investigated less extensively than the others or because there is less knowledge of its relevant properties.

for Nuclear Waste Disposal (KNE), the Federal Office of Topography (Swiss-topo) and the Nuclear Safety Commission (NSC), as well as cantonal experts and the German expert group on Swiss repositories (ESchT), joined together in confirming that all six siting regions should be carried forward for further investigation in Stage 2 of the process.

The Cantonal Commission (AdK) also reviewed the results of Stage 1 and found that the requirements relating to fairness, transparency and participation had been met. Overall, the procedures applied in Stage 1 were considered to be appropriate and goal-oriented and the Commission agreed that the six siting regions should be considered further. It also called for uncertainties regarding geological conditions to be eliminated by carrying out suitable investigations before the end of Stage 2.

Between September and November 2010, all interested parties had the opportunity to express their views as part of a broad consultation process on the results of Stage 1. All the relevant reports, reviews and expert opinions were made available to the public, together with the draft of the results report for Stage 1. Information events were hosted by the SFOE in all the siting regions and in several communities in southern Germany. The SFOE received a total of around 3700 responses during the consultation process and revised the results report based on this input. The Cantons were then given a final opportunity to express their views.

### Decision of the Federal Council: All six geological siting regions to go forward to Stage 2

On 30<sup>th</sup> November 2011, the Federal Council announced its decision that all six potential siting regions would be carried forward to Stage 2. The siting regions for the participation process were also defined, as were the planning perimeters (see Figure 3 and text-box). Stage 1 of the process is thus complete and Stage 2 has formally begun; the latter will last around 4 years.

### Objectives of Stage 2

Various tasks have to be carried out in Stage 2. Working together with the public and the authorities in each of the six siting regions, Nagra has to designate at least one siting area where the surface facility of a repository could be located. The selection of potential repository siting regions will also be narrowed down, with Nagra proposing at least two regions each for the HLW and L/ILW repositories; these will be investigated in more detail in Stage 3. Cross-cantonal comparative socio-economic-ecological impact studies will also be carried out under the lead of the SFOE.

The narrowing-down of the geological siting regions is a technical/scientific issue and focuses on a comparison of safety based on the geological situation in the regions. The requirements applying to this comparison are set out in the Sectoral Plan and have been defined in more detail in a special ENSI report. For Stage 3, Nagra may not propose any siting regions that are clearly less suitable than the others from a safety viewpoint (see text-box). The available knowledge base has to allow a conclusive comparison, but not with the same degree of detail as will be required for the general licence applications in Stage 3.



Background images (pages 14, 19, 23, 29, 32): Impressions of the seismic measurement campaigns in 2011/2012.

As part of regional participation, the members of the regional conferences and Nagra discuss where the surface facility of a potential repository could be located and how it would be accessed.



Exchanges with the public, the authorities and relevant organisations are a key concern of Nagra. In June 2011, the German regional association for Bodensee-Oberschwaben visited the Mont Terri Rock Laboratory to obtain information on the Sectoral Plan process and ongoing research activities.

#### Regional conferences

The regional conferences represent the interests of the siting regions in the participation process. They are made up of around 85 to 110 members, including representatives of local communities, regional organisations (e.g. associations or political parties) and individual members of the population.

Each conference has set up technical groups which are responsible for considering specific topics in more depth and providing opinions on these. All of the regions have technical groups on the surface facilities, socio-economic-ecological studies and safety. The SFOE guides and supports the work of the conferences.

Further information (websites in German):

Südramden:  
[www.plattform-suedramden.ch](http://www.plattform-suedramden.ch)  
 Zürich Nordost:  
[www.zuerichnordost.ch](http://www.zuerichnordost.ch)  
 North of Lägern:  
[www.regionalkonferenz-laegern.ch](http://www.regionalkonferenz-laegern.ch)  
 Jura Ost:  
[www.jura-ost.ch](http://www.jura-ost.ch)  
 Jura-Südfuss:  
[www.jura-suedfuss.ch](http://www.jura-suedfuss.ch)  
 Wellenberg:  
[www.plattform-wellenberg.ch](http://www.plattform-wellenberg.ch)

For the surface facility, safety depends primarily on the layout of the facility rather than on the site itself. Compared to the situation underground, there is a degree of flexibility in this respect. Considerable importance is attached to the needs and wishes of the region and, for this reason, Nagra works together with the regions in selecting the location and layout for the surface facility.

#### Strengthening the knowledge base for Stage 2

With a view to Stage 2 of the Sectoral Plan process, Nagra began at an early stage to expand the database on the properties of the potential host rocks and the geological situation in the siting regions. In November 2010, the decision was made to document the investigation programme in a technical report (NTB 10-01) for the consideration of ENSI. The latter considered whether the level of geological understanding is sufficient to allow clear conclusions regarding safety to be drawn in Stage 2 and to allow a comparison of the potential siting regions. In its review published on 28<sup>th</sup> March 2011, ENSI concluded that the required level of geological knowledge can be achieved with the investigations that are already ongoing or planned by Nagra and the additional investigations specified by ENSI in 41 requirements. In ENSI's view, no geological investigations requiring a permit (e.g. boreholes) will be required in Stage 2.

#### 2D seismics at the wish of the Cantons and the NSC

Both the NSC and cantonal experts called for 2D seismic investigations in the HLW siting regions North of Lägern and Jura Ost and in the L/ILW regions Südramden and Jura-Südfuss. In response, Nagra stated that it was willing to carry out these measurements, particularly respecting the wishes of the siting Cantons, and would bring forward the work that was originally planned for later. Thanks to the constructive support of the Cantons in planning and performing the seismic campaigns, it will be possible to integrate the results into the safety-based comparison of the sites in Stage 2. The seismic measurements were carried out by Nagra between October 2011 and March 2012, in parallel with a comprehensive investigation programme that also addresses ENSI's 41 requirements.

#### Start of participation in the regions

The aim of regional participation is to involve the siting regions in the Sectoral Plan process. The regions are represented in the process by so-called regional conferences (see text-box). Following a preparatory and build-up phase, regional conferences were set up in all the siting regions in 2011, except for Wellenberg. Their task in Stage 2 includes working together with Nagra in selecting areas for locating the surface facilities and participating in the socio-economic-ecological studies.

**Planning perimeters and siting regions**

For each potential siting region, the planning perimeter delineates the area within which the surface facility required for repository construction and operation could be located.

The siting regions comprise all the local communities that could be affected by the repository. This includes the communities within the geological siting regions, communities within the planning perimeter and other communities that could be affected due to spatial planning, economic or social factors. A total of 202 communities (including 12 in Germany) belong to a siting region.

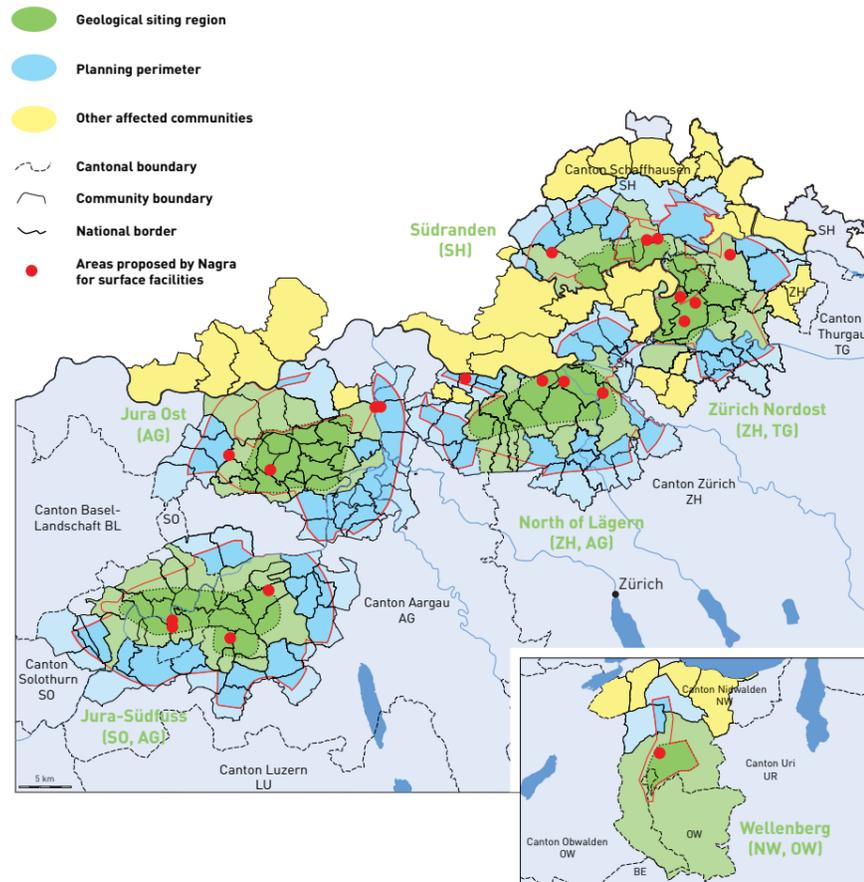


Figure 3: Geological siting regions, planning perimeters, siting regions and Nagra's proposals for potential areas for locating the surface facilities

**Surface facilities: proposals submitted for discussion**

On 15<sup>th</sup> December 2011, Nagra submitted proposals for siting the surface facilities to the SFOE. These will serve as the basis for discussions with the regional conferences (and their responsible technical groups). The conferences can express their views on the proposals, but they can also put forward their own proposals for consideration. Based on this collaborative process, Nagra will then designate one siting area for each region where the surface facility could be integrated into the regional landscape in a way that is safe and technically feasible.

**Comprehensive analysis of economic, environmental and social impacts of a repository**

In Stage 2, the SFOE will conduct a study in all the siting regions on the impact of repositories on the environment, economy and society. The method to be used for evaluating these impacts was defined by the Federal Government in 2010. The study will form the basis for evaluating the regions in terms of non-safety-related aspects in Stage 2. At the same time, it lays the foundation for discussions on long-term development strategies with and without repositories.

**The final step: decision via the ballot box**

Stage 2 ends with a decision by the Federal Council on at least two sites each for a HLW and L/ILW repository and on the areas for locating the surface facilities. These sites are then investigated in more detail by Nagra in Stage 3, compared with one another and any necessary field investigations are carried out (e.g. 3D seismics, additional boreholes). Based on the results of the investigations, Nagra proposes the final repository sites and prepares the general licence applications. The Federal Council and Parliament decide on the licence applications, but their decision is also subject to an optional national referendum. The final say in the Sectoral Plan process thus lies with the Swiss voters.

## 18 Scientific and technical background

The research and development work currently underway is aimed at improving the knowledge base, mainly with a view to preparing the input required for the general licence applications in Stage 3 of the Sectoral Plan process. Nagra is carrying out an interim evaluation with respect to topics that are already relevant in connection with Stage 2. In the safety analyses carried out to date, conservative assumptions have been made in order to take uncertainties into account. The aim of the current investigations is to replace these assumptions in selected areas with more realistic and accurate information. This should have the effect of improving the reliability of conclusions on the safety of the repositories.

### Geology/field work

Nagra is carrying out a range of studies that will provide more detailed information on the proposed geological siting regions for Stages 2 and 3 of the Sectoral Plan process. Modern methods have been used to reprocess the reflection seismic lines from earlier campaigns with a total length of 1400 kilometres. Additional seismic lines with a total length of 300 kilometres have also been surveyed to provide a denser network. The seismic data are also undergoing geological analysis. Geological profile sections are checked for internal consistency using computer-based methods (so-called retrodeformation, kinematic balancing). Nagra is also involved in a geothermal borehole project at Schlattingen (Canton Thurgau), where additional investigations are being carried out in the Opalinus Clay, the Brauner Dogger and other adjacent rock formations (tests in-borehole or laboratory analyses of drillcores). Where meaningful and possible, Nagra is also using information from borehole projects of third parties (e.g. geothermal heat boreholes).

Two further projects were initiated to look at the long-term geological evolution of Northern Switzerland: a permanent network of GNSS (Global Navigation Satellite System) receivers and a denser network of earthquake measurement stations should allow improved monitoring of recent crustal movements. At the end of the year, nine of eleven Nagra GNSS stations were in operation. Nagra also contracted the Swiss Seismological Service to carry out model calculations and test measurements of weak earthquakes and set up the first new stations for this project.

An important component of the work for Stage 2 is characterisation of the movement of deep groundwaters using regional and local hydrogeological models. The regional geological model, which serves as the basis for the hydrogeological models, was complete by the end of the year. A reconstruction of the geological profile sections through the Wellenberg siting region taking the most recent literature data into consideration indicated no significant changes in terms of the fundamental geometry and hence the space available for the repository.

Nagra is also carrying out various studies on the sedimentology and hydrogeology of the "Brauner Dogger" and the Effingen Beds. The work contributes to the characterisation of the key properties of these potential host rock formations.



Hydrotests in the Schlattingen borehole.

### Geochemical retention processes and transport mechanisms

Ongoing studies on the retention of radionuclides are long-term in character and aim to expand the detailed databases on the topic. Of particular interest is retention in the near-field of the L/ILW and HLW repositories and in the potential host rocks.

In connection with the chemical evolution of the near-field under realistic conditions, Nagra has supplemented its quantitative calculations with qualitative arguments. The methods developed by PSI for deriving sorption and diffusion parameters for host rocks have been further refined. Nagra has used this work as the basis for compiling definitive datasets for the provisional safety analyses in Stage 2. Uncertainties have also been estimated. In parallel, sorption and diffusion parameters are being measured on samples of all potential host rocks in order to verify the methods used. Within the bandwidths for uncertainties, the results to date indicate a good agreement with modelling data and thus confirm the modelling approach used. This represents an important milestone in the validation of modelling approaches for safety analysis.

The radionuclides Cl-36, I-129 and Se-79, present in anionic form, but also C-14 in organic form, dominate the doses calculated in the safety analysis and are therefore the focus of investigations: the chemical retention of Cl, I and Se in cement was measured in porewater with increased chloride content. The cement minerals that are responsible for retention were also identified. The results can be used to determine how an increase in porewater salinity – as may occur in host rocks – can influence the sorption of the above radionuclides. Nagra has also initiated a project for investigating organic corrosion products containing C-14 from activated steel. The aim is to characterise these products and to measure their stability and mobility.

### Investigations on the behaviour and properties of bentonite

Nagra has used the results of studies conducted in recent years, together with experience gained from active participation in large-scale international projects of the EU and in Sweden, to describe in more detail how the safety-relevant properties of bentonite evolve in the near-field of a HLW repository. The results of experiments and coupled model calculations are currently being analysed and documented in a synthesis report. This information will form the basis for refining the design of disposal tunnels and installations from the perspective of long-term safety. The work is being carried out with a view to the general licence applications.

### Gas pressure build-up and transport

Gas formation in a deep geological repository is a relevant process for consideration in safety analysis. Gas formation rates due to corrosion of metals in the L/ILW and ILW repositories are important in this respect. Because resaturation of the disposal chambers with porewater takes several thousand years, the steel corrosion rate under unsaturated conditions is also of interest. A series of relevant experiments looking at the corrosion of steel in cement mortars is being carried out at the University of Toronto. Initial results confirm that the corrosion rates are significantly lower than under saturated conditions. The measurements will contribute to reducing uncertainties regarding corrosion rates.

Gas can also be produced by the microbiological degradation of organic materials such as are found in the wastes emplaced in the L/ILW and ILW repositories. The data on degradation rates contain considerable uncertainties. To remedy this, work is being carried out together with the Zürich University of Applied Sciences in Wädenswil on microbiological processes in a repository that could potentially affect gas formation. In order to quantify the influence of uncertainties, Nagra carried out sensitivity analyses during the past year and modelled the spectrum of potential gas formation rates in the L/ILW and ILW repositories. The results provide important input for evaluating gas pressure build-up and gas transport.

Nagra has also continued its modelling studies on gas pressure build-up in the underground installations of a L/ILW and SF/HLW/ILW repository. The studies use two- and three-dimensional numerical models. Sensitivity studies have been carried out on gas-related host rock properties and the depth of the waste emplacement installations. The calculations show that, even assuming low gas permeability, the host rock itself makes an important contribution to the release of gases formed in the repository. A series of laboratory investigations was also carried out on core material from the Schlattingen borehole to supplement the database on gas-related properties of the host rocks "Brauner Dogger", Opalinus Clay and Effingen Beds. The characterisation studies included capillary pressure saturation measurements, gas permeability measurements and microstructural investigations.

Further R&D related to gas issues includes the new large-scale GAST (Gas Permeable Seal Test) experiment at the Grimsel Test Site (see page 25). Laboratory investigations on the gas transport capacity of the materials used for the engineered barriers (bentonite, sand-bentonite mixtures) and of clay samples are being carried out at the EPFL Lausanne as part of the EU FORGE project (see page 31), at the ETH Zurich and at EMPA, as well as with various companies from the oil and gas industry.

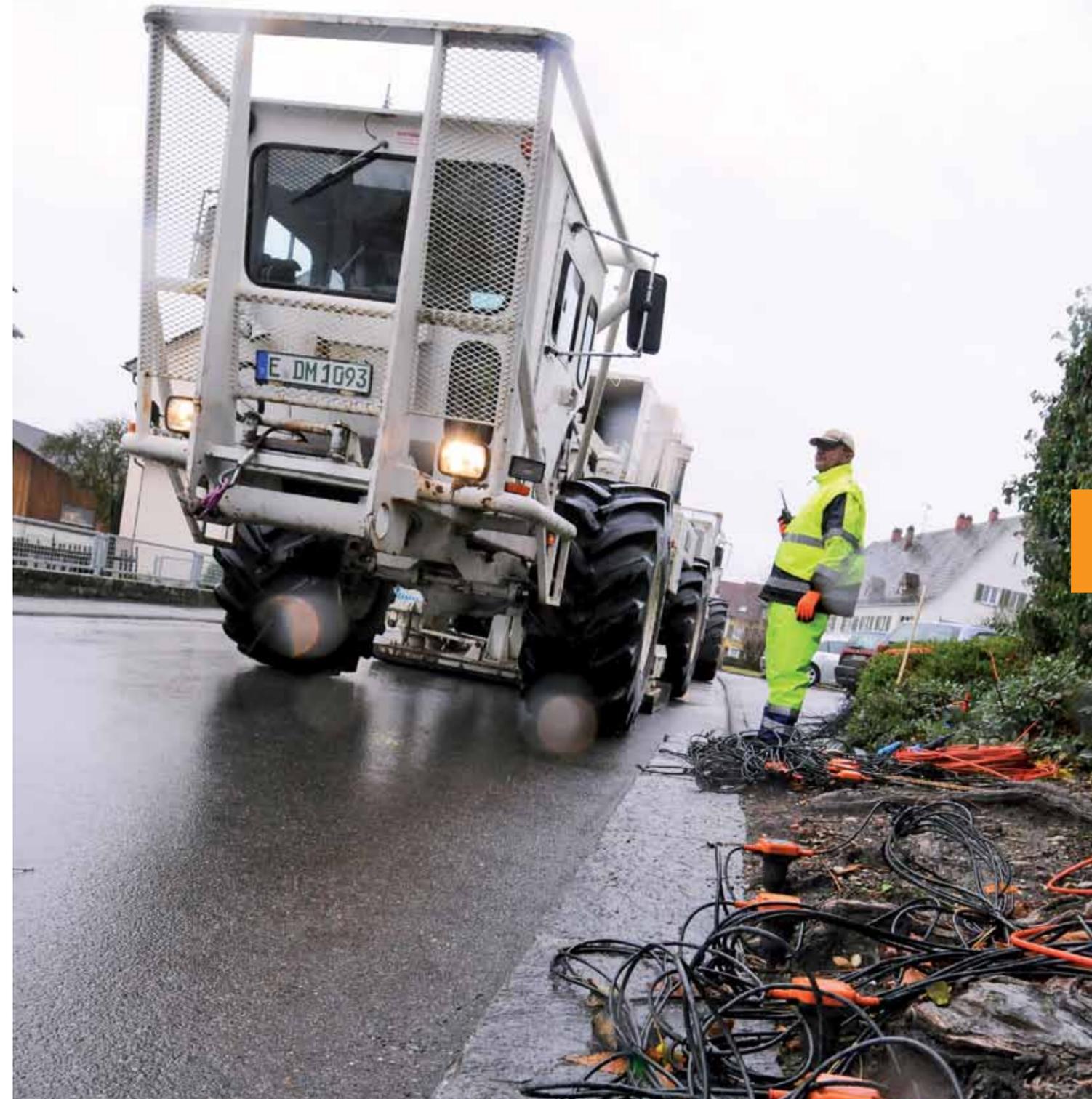
### Design of the geological repositories and the engineered barriers

In 2010, Nagra initiated two large-scale projects on the planning of the repository surface facilities and their access and on the planning of underground installations and the associated construction infrastructure. This work continued in the year of reporting. The resulting conceptual studies on generic facility modules and the overall system provided the basis for reviewing the possibilities for the configuration of the siting areas for the surface facilities within the planning perimeters, taking into account geological and spatial planning boundary conditions. A focal point of the work on the underground facilities was the analysis of different variants for access to the disposal zones. The geological conditions were taken into consideration and the first outlines of potential hazard situations were used.

At the end of 2011, Nagra submitted proposals to the SFOE for potential siting areas for the surface facilities in all six siting regions (NTB 11-01). These proposals serve as the basis for discussions within the framework of regional participation in Stage 2 (see page 15). Nagra prepared the proposals with the support of two external planning teams, taking into account scientific-technical, safety-related, spatial planning, environmental and local-regional

aspects. Extensive background information was prepared and the potential areas for locating the surface facilities were identified in a stepwise narrowing-down process. The results of field campaigns and various site-related planning studies were used in addition to extensive datasets from geological information systems.

In connection with the engineered barriers, the British organisation "The Welding Institute" (TWI) prepared a study on the design of thick-walled canisters of carbon steel for spent fuel assemblies and vitrified high-level waste. The results show that, for the proposed canister design, all fundamental requirements relating to manufacture, operational safety and long-term safety can be met. Projects on other potential canister materials (ceramics, copper shell) and design options are currently underway.



Tests with bentonite.



## Rock laboratories



Investigations on rock samples from the Grimsel Test Site.

Background image: Grimsel Test Site.

### Projects at the Grimsel Test Site

**CFM** (Colloid Formation and Migration)  
Formation and transport of colloids and their influence on radionuclide mobility under realistic conditions

**C-FRS** (Criepi Fractured Rock Studies)  
Hydrogeological and geological characterisation of tectonic fracture systems

**ESDRED plug experiment<sup>1</sup>** (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<sup>1</sup>** (Fate of Repository Gases)  
Experiments on gas migration in engineered barriers (bentonite/sand)

**FUNMIG<sup>1</sup>** (Fundamental Processes of Radionuclide Migration)  
Fundamental aspects of radionuclide migration in crystalline rock

**GAST** (Gas Permeable Seal Test)  
Gas sealing experiment: controlled gas transport through the engineered barriers

**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<sup>2</sup>** (Testing and Evaluation of Monitoring Techniques)  
Testing of monitoring methods

<sup>1</sup>Sub-project of the EU project

<sup>2</sup>Sub-project of the EU project MoDeRn

### Grimsel Test Site (GTS)

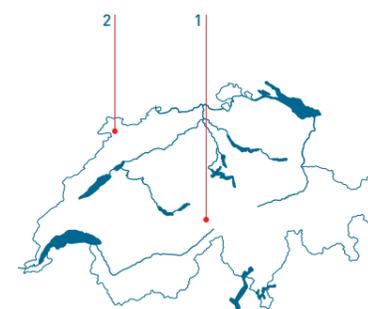
Since 1984, the GTS has provided a platform for Nagra and its partners to perform underground research projects that make an important contribution to the development and testing of safe disposal concepts for radioactive waste in geological repositories and to characterisation of suitable host rock formations. 16 partner organisations from 11 countries as well as the European Union are currently involved in the projects, underlining the international significance of the GTS as a research facility. At the last partner meeting, all participants underlined their interest in the GTS and in the continuation of the work on the long term.

The focus of the current phase is on carrying out field experiments under boundary conditions that are as close as possible to those found in a repository. Also important are projects on the construction of a repository. One highlight in this respect was the build-up phase for the GAST experiment (see text-box for acronyms), in which scientists are checking the concept of gas-permeable tunnel seals for the L/ILW repository under realistic conditions and on a realistic scale. A further example is the FEBEXe experiment, in which the saturation of the bentonite barrier at a temperature of 100°C has been under observation since 1997. The partners in this experiment have already decided to extend it until 2015.

The LTD and CFM experiments are being carried out in the radiation controlled zone. These key international studies are looking at the transport of radionuclides under realistic boundary conditions. In the LTD project, the focus in 2011 was on preparing for the next long-term diffusion experiment using radionuclides. The main activities in the CFM project included preparing for the experiments scheduled for 2012 (also using radioactive tracers). Field tests were also carried out and the instrumentation was modified where necessary. The focus in the LCS project was on modelling studies and laboratory programmes.

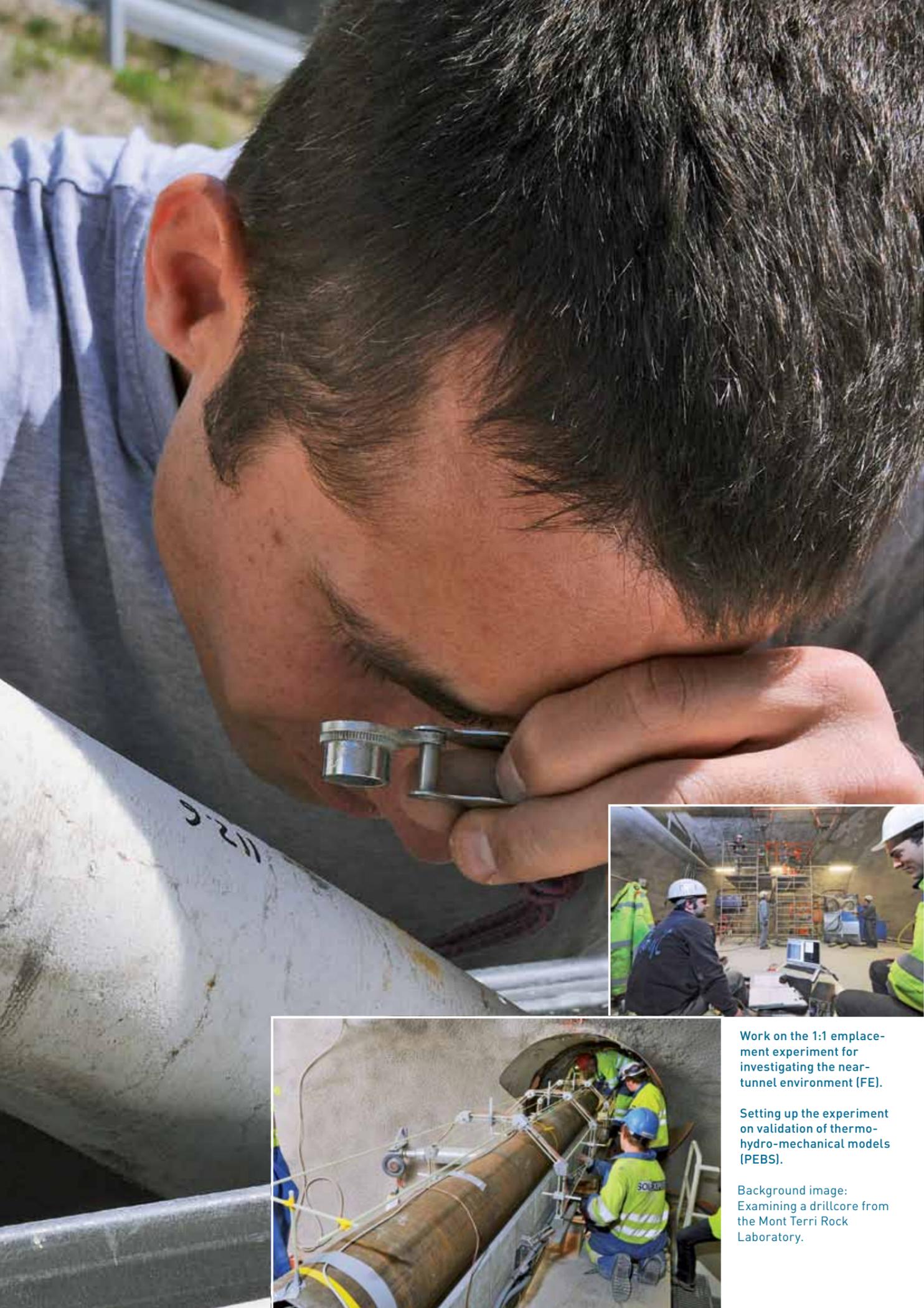
2011 again saw several international research groups using the GTS for carrying out their own experiments and measurements (for example the Japanese C-FRS and JGP projects). The facility is also an important platform for interacting with the public and other interest groups.

The local communities in the area (Guttannen, Innertkirchen and Meiringen), and a number of local companies (e.g. Kraftwerke Oberhasli), have all supported the activities in the rock laboratory. In their own way, they continue to contribute to the success of the projects.



1 Grimsel Test Site  
2 Mont Terri Rock Laboratory

Overview of current investigations:  
[www.grimsel.com](http://www.grimsel.com)  
[www.mont-terri.ch](http://www.mont-terri.ch)



**Key experiments in the Mont Terri Rock Laboratory**

**CI** (Cement-Clay Interaction)  
Mineralogical interaction between claystone and cement

**DR-A** (Disturbances, Diffusion and Retention Experiment)  
Diffusion experiment with changing water chemistry

**DR-B** (Long-term Diffusion)  
Long-term diffusion experiment

**EB** (Engineered Barriers Experiment)  
Demonstration experiment on the long-term behaviour of the bentonite backfill material

**FE** (Full-scale Emplacement Demonstration)  
1:1 emplacement experiment for investigating the near-tunnel environment

**GM-A** (Geophysical Monitoring)  
Monitoring using geophysical techniques

**HE-E** (Heater Experiment)  
Behaviour of the engineered barriers under the influence of heat

**HG-A** (Gas Path Host Rock and Seals)  
Gas flowpaths through the Opalinus 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

**VA** (Investigation of Spatial Variability within Opalinus Clay)  
Variability of the rock properties

**Mont Terri Rock Laboratory (FMT)**

The international Mont Terri research project (St-Ursanne, Canton Jura) has been underway since 1996. The experiments are aimed at the geological, hydrogeological, geochemical and geotechnical characterisation of the Opalinus Clay. The project allows Nagra to investigate in detail, and on a 1:1 scale, the properties of this potential host rock that are relevant for disposal of radioactive waste and to improve process understanding.

The Rock Laboratory is located in side tunnels of the security gallery of the Mont Terri motorway tunnel. 14 partner organisations from 8 countries are currently involved in the extensive research programme. The project is led by the Federal Office of Topography (Swisstopo) and is supported by a "Commission stratégique". The interests of Canton Jura are represented by the "Commission de suivi".

The first half of 2011 saw the completion of the 16<sup>th</sup> programme phase as planned, with Nagra being involved in 29 of a total of 38 experiments. Phase 17 (July 2011 – June 2012) involves continuation of most of the experiments from the previous phase as well as initiation of new ones. Projects from the 6<sup>th</sup> Framework Programme of the EU (HE-E, EB and GM-A) will also be continued. Based on its own experience and on the recommendations arising from the review by the authorities of the "Entsorgungsnachweis" project, Nagra's activities have been directed towards in-depth research in the following areas: heterogeneity of the properties of the Opalinus Clay (VA experiment), radionuclide diffusion in the Opalinus Clay (DR-A and DR-B experiments) and gas transport (HG-A, HG-D and HT experiments). A further focus was on continuation of a long-term experiment on the interaction between clay and cement (CI experiment); the latter is used in a repository (particularly for L/ILW and ILW) as a solidification, backfill and construction material. The year also saw the continuation of the large-scale FE experiment: the project participants excavated the starting niche and installed the instrumentation for the experiment. The objective is to investigate the behaviour of the tunnel vicinity (i.e. the geological environment surrounding the tunnel) under the influence of a simulated section of a spent fuel disposal tunnel. The main interest is in the effect of temperature on hydraulic and mechanical processes in the host rock. Practical experience will also be gained in excavating and securing the disposal tunnels, as well as with emplacing the containers and backfill material. The FE experiment is co-financed by the EU as part of the LUCOEX project (see page 31).



Work on the 1:1 emplacement experiment for investigating the near-tunnel environment (FE).

Setting up the experiment on validation of thermo-hydro-mechanical models (PEBS).

Background image: Examining a drillcore from the Mont Terri Rock Laboratory.

**Review of the costs of deep geological disposal (cost study)**

The owners of the nuclear facilities are required to set aside financial reserves to secure the financing of waste management activities; the amount of these reserves is based on estimated waste management costs. The cost estimates are reviewed periodically; in 2011, Nagra updated the cost estimate for preparing and implementing repository projects. The authorities are currently reviewing the results. With a view to the upcoming socio-economic impact studies to be carried out in Stage 2 of the Sectoral Plan process, Nagra has estimated the potential for granting work contracts within a siting region.

**International Services and Projects (ISP)**

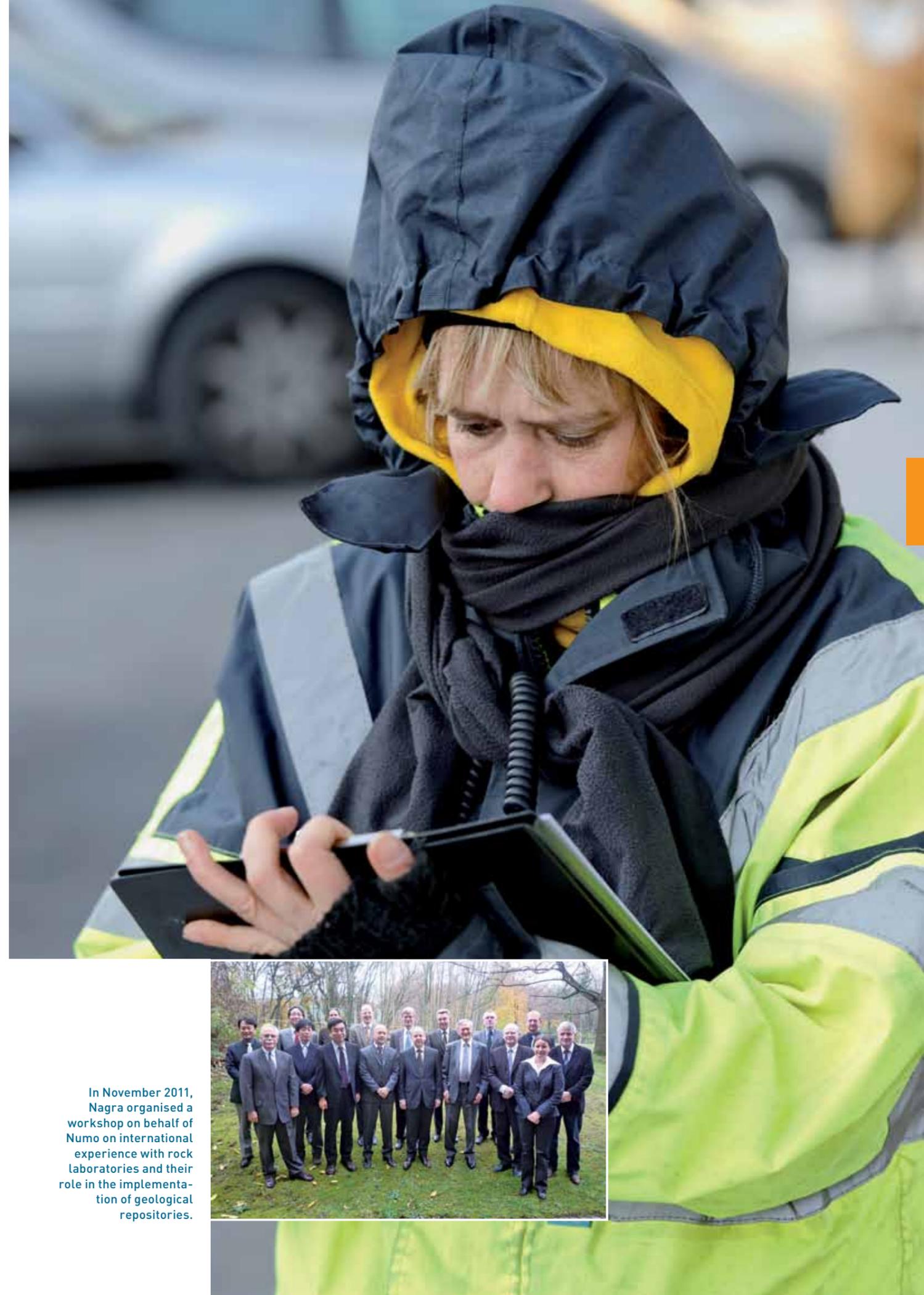
Nagra's ISP Division manages activities with funding sources outside the national programme. These activities cover a wide spectrum of projects in the radioactive waste management field – strategic programme planning, specification of waste inventories, site selection, characterisation and evaluation, repository design, safety case development, safety analyses, public communication, focused training and know-how build-up, as well as projects in other scientific and technical fields such as geothermal exploration.

In 2011, more than 20 projects came from partners in the Far East, Europe and North America. The strong cooperation with our Japanese partners continued during the year. We were deeply saddened by the tragic events of March 2011. The endurance, strength and perseverance of our numerous Japanese colleagues and partners have been both exemplary and impressive.

Highlights of the Numo collaboration were two workshops, one focusing on an international review of Numo's ten years of activities and the roadmap for future steps and one on the accumulated international experience and the role of underground rock laboratories in the development of geological repositories. The JGP project at the Grimsel Test Site led by JAEA (with the support of Obayashi), which is investigating new grouting materials, continued in 2011, culminating with the injection of special grouts and field testing. Nagra also continues to support JAEA's research activities in the Japanese Mizunami and Horonobe rock laboratories.

Criepi initiated a further test phase in the long-term project on the characterisation of fractured rock at the Grimsel Test Site, with tracer injection, immobilisation and excavation of the first set of targeted fractures. In the large-scale laboratory test on gas migration through bentonite materials being considered for Japan's planned intermediate-depth repository, saturation of the emplaced bentonite continued and the first gas injection tests were conducted. The test, which is being carried out by Obayashi on behalf of Japan's JNES, is being performed in a steel shell approximately four metres high and two and a half metres in diameter. Nagra led the instrumentation design activities and is supporting the interpretation of the test data.

In 2011, a new collaboration project with KAERI was initiated, with the focus on exploration strategies and development of detailed investigation programmes for the characterisation of deep geological environments in South Korea.



In November 2011, Nagra organised a workshop on behalf of Numo on international experience with rock laboratories and their role in the implementation of geological repositories.

In Europe, activities included work carried out for Posiva and the NDA (United Kingdom), as well as continuation of a four-year project for Ondraf/Niras (Belgium) supporting the development of the "Safety and Feasibility Case (SFC 1)", with special emphasis on management systems development. In Switzerland, Nagra geoscientists continued to support various geothermal development projects, including deep drilling campaigns.

Finally, our experts participated in NWMO's geoscience review group for the characterisation of the proposed Canadian low-level waste repository site and the international technical advisory group for development of the HLW programme.

## International collaboration

A regular exchange of information between Nagra and 16 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. 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.

During the year, Nagra staff continued to be involved in work at Andra's rock laboratory in Meuse-Haute-Marne in France. These projects were complemented by joint laboratory programmes run by various research institutes on model development and evaluation of databanks. This includes projects under the auspices of the OECD/NEA on sorption (concluded in 2011 with a final report) and thermochemical databanks. Nagra also participated actively in a new OECD/NEA project on transferring information on deep repositories to future generations.

Nagra's involvement in the EU Framework Programmes 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" (IGD-TP), which was set up in 2009. A development programme was drawn up based on the objective of starting operation of the first geological repositories in Europe by 2025.

Nagra staff continue to be represented in various advisory bodies and working groups (particularly in Belgium, Finland, France, Canada and Sweden) and are able to benefit directly from the experience of sister organisations worldwide. Over and above the various specific joint projects, Nagra is also represented in working groups of the OECD/NEA and works together with the IAEA on relevant projects. Nagra is also a member of Edram, an association

### 7<sup>th</sup> EU Framework Research Programme

**MoDeRn** (Monitoring Developments for Safe Repository Operation and Staged Closure).

**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).  
**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).  
**Validation of thermo-hydro-mechanical 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.

**LUCOEX** (Large Underground Concept Experiments).

**Demonstration of the emplacement and backfilling technologies for geological repositories.**

Coordination: SKB (Sweden).  
Participation: 4 organisations from 4 countries. Duration: 2011 – 2014.

### German-Swiss Commission for the Safety of Nuclear Installations

The German-Swiss Commission for the Safety of Nuclear Installations (DSK) has been in existence since 1982. It was set up to implement the agreement between the Swiss and German governments on mutual information on the construction and operation of nuclear installations in the vicinity of national borders. The tasks of the Commission include exchanging information on issues relating to radioactive waste management. The Commission is made up of representatives of Swiss and German federal offices, of the Federal States of Baden-Württemberg and Bavaria and Canton Aargau. The Commission has four working groups:

- WG 1: Facility safety
- WG 2: Emergency protection
- WG 3: Radiological protection
- WG 4: Radioactive waste management

of high-level staff from waste management organisations worldwide. Key results of international collaboration are presented in the project-specific sections of this report.

As in previous years, Nagra took part in international meetings on the topic of waste disposal, with frequent invitations to make presentations and be represented on the programme committee for several events. As part of what is now an annual occurrence, Nagra attended the meeting of the German-Swiss Commission for the Safety of Nuclear Installations (DSK, working group 4 on management of radioactive waste).

### Framework Research Programmes of the European Union (EU)

The Framework Research Programmes of the EU function as an important instrument for collaboration on research projects within Europe. Many of the challenges faced by industry and society today can no longer be solved in isolation by one country alone. The 6<sup>th</sup> and 7<sup>th</sup> Framework Programmes are aimed specifically at creating a European Research Area. The idea is to promote scientific and technological capacities and to encourage European competitiveness and innovation by supporting improved cooperation among researchers.

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 Programmes.

The research projects in the area of deep geological disposal of radioactive waste allow Nagra to expand its technical knowledge base efficiently and continuously and to be instrumental in shaping important developments in Europe. The focus in 2011 was on participation in the 7<sup>th</sup> Framework Programme projects (MoDeRn, FORGE, PEBS and LUCOEX, see text-box). The LUCOEX project began in 2011; it will be carried out in the Mont Terri Rock Laboratory as part of the FE experiment (see page 27).

## Public outreach

The completion of Stage 1 of the Sectoral Plan process and the preparations for Stage 2 involved a large investment of time and effort in the area of public information and communication. The focus for Nagra was on strengthening the links to the siting communities and Cantons, being available as a competent point of contact for questions on waste management and repository site selection, answering questions and informing the public in a transparent manner on the Swiss waste management concept.

### Communication and dialogue

Providing factually correct information and conducting open dialogue form the basis for building trust. Nagra's public relations activities are aimed at maintaining contact with the public and providing them with comprehensive and understandable information. A wide range of communication tools and contact opportunities is used – the internet, brochures, films, media presence, guided tours of the rock laboratories, presentations and lectures, presence at regional trade fairs and discussion platforms.

### Nagra on the road

Nagra was present with its information stand at 19 regional trade fairs, mainly in towns and communities within the siting regions. These events provided the opportunity for numerous contacts with the public.

A total of around 4400 people visited the Grimsel Test Site and the Mont Terri Rock Laboratory. Besides the regular tours of the facilities, there was also an open day at the Grimsel Test Site for people living in the siting regions on 25<sup>th</sup> June.

The new visitors' centre at the Mont Terri Rock Laboratory opened its doors at the beginning of September. Construction of the centre was the responsibility of the Federal Office of Topography (Swisstopo), the Swiss Federal Nuclear Safety Inspectorate (ENSI) and Nagra. It contains exhibits on the rock laboratory and on the topics of radioactivity and nuclear waste management and provides an excellent platform for dialogue with visitors.

Nagra also took part in four so-called TecDays at Swiss schools; these are organised regularly by the Swiss Academy for Technical Sciences and have proved to be very popular with secondary school pupils.

### Large information palette for interested readers

In 2011, Nagra produced four issues of "nagra info" that were sent to around 20,000 subscribers; 300,000 copies were also distributed to households in the siting regions. A separate information brochure was also produced on the seismic investigations that were carried out in winter 2011/2012. Schools were offered two new lesson modules, one on the subject of measuring radioactivity and one on earthquakes. Nagra's brochure on potential areas for siting the repository surface facilities was completed at the end of the year and was made public on the 20<sup>th</sup> of January 2012 on the occasion of the announcement of the proposals. It also contains a DVD, which illustrates the operating procedures in a surface facility using detailed animations.



Exhibit in the new visitors' centre at the Mont Terri Rock Laboratory.



During the seismic measurements, Nagra staff took to the road with a mobile information stand and talked to the local population.

**www.nagra.ch**

The Nagra website serves as a central dynamic information platform. It is continually updated, particularly with news, media releases and materials available for downloading. The number of visitors increased by around 20% compared to the previous year. The new section "Short and simple" provides a short and easily understandable overview of the key facts of nuclear waste management. Nagra also publishes an electronic newsletter with current information; nine issues appeared in 2011. The geology blog ([www.erdwissen.ch](http://www.erdwissen.ch)) has existed since 2010 with weekly contributions and attracts around 30 visitors per day. Various measures in the social media area have had the effect of increasing the awareness of the website.

**Nagra in the media spotlight**

Nagra issued three media releases in 2011. Interest in radioactive waste management is continually increasing in the context of the ongoing Sectoral Plan process and the build-up of regional participation. This has been evidenced by numerous media contributions, both in printed and audio-visual form. Besides Fukushima, the main topics of interest were the possibilities for the public to have their say on the topics of site selection and safety. The interest of the German media and politicians in the Swiss waste management programme and the Sectoral Plan process continued to increase in 2011.

# Organisation and oversight bodies

**President of the Board of Directors**

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

"Understanding the need for safe disposal of radioactive waste is a prerequisite for the acceptance of future repositories. Mutual understanding is encouraged through active dialogue; this builds more confidence than one-sided communication."

**Executive Board**

Dr. Thomas Ernst  
Chief Executive Officer

"Deep geological repositories are best suited to ensuring the safe long-term management of radioactive waste. This was confirmed once again in 2011 by an expert group set up by US President Obama."



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

"Our duty to future generations is to implement this environmental protection task in Switzerland without delay and not to put it on the back-burner. The technical basis for achieving this already exists."



Dr. Piet Zuidema  
Head of Science and Technology

"The research and investigation programmes carried out by Nagra have resulted in a good 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."

**Headquarters**

At the end of 2011, 98 people were employed at Nagra's headquarters (89 full-time employees and 9 part-time staff/assistants), corresponding to 86.4 full-time positions.

In June 2011, Nagra's Quality Management System was recertified in accordance with ISO 9001.

**Board of Directors and annual general meeting**

The Board held four meetings to handle ongoing business, as well as one closed meeting. The focus was on the Sectoral Plan process, Nagra's proposals for siting areas for the surface facilities, the 2011 cost study and the seismic campaigns in 2011/2012. The Board took note of the planned research and development programme for 2012 and approved the required outline credit.

The Technical Committee and the Commission for Communication and Information each met four times. The Finance Commission met twice to consider the closing of the annual accounts for 2010, the budget for 2012 and the accumulated accounts.

The ordinary general meeting of the Members of the Nagra Cooperative took place on 15<sup>th</sup> June 2010 in Bern. The Members approved the annual report and accounts for 2010. At the meeting, Peter Hirt stepped down from the Board and Herbert Meinecke was elected as the new representative for NPP Gösgen-Däniken. Mr. Hirt's successor as Chairman of the Commission for Communication and Information is Hermann Ineichen (BKW AG).

**Members of the Cooperative**

Swiss Confederation  
Bern

Axpo AG  
Baden

BKW AG  
Bern

Kernkraftwerk Gösgen-Däniken AG  
Däniken

Kernkraftwerk Leibstadt AG  
Leibstadt

Alpiq Suisse SA  
Lausanne

**Board of Directors**

Pankraz Freitag  
Haslen (Glarus)  
President  
Nagra

Dr. Stephan W. Döhler  
Vice-President  
Axpo AG

Peter Hirt  
Kernkraftwerk Gösgen-Däniken AG  
(until 15<sup>th</sup> June 2011)

Herbert Meinecke  
Kernkraftwerk Gösgen-Däniken AG  
(from 15<sup>th</sup> June 2011)

Hermann Ineichen  
BKW AG

Martin Jermann  
Paul Scherrer Institute

Dr. Andreas Pfeiffer  
Kernkraftwerk Leibstadt AG

Dr. Michael Plaschy  
Alpiq Suisse SA

Peter Zbinden  
Wallisellen (Zürich)  
Former CEO of AlpTransit Gotthard AG

**Technical Committee**

Dr. Michael Plaschy  
Chairman  
Alpiq Suisse SA

**Finance Commission**

Michael Sieber  
Chairman  
Axpo AG

**Commission for Legal Issues**

Hansueli Sallenbach  
Chairman  
Axpo AG

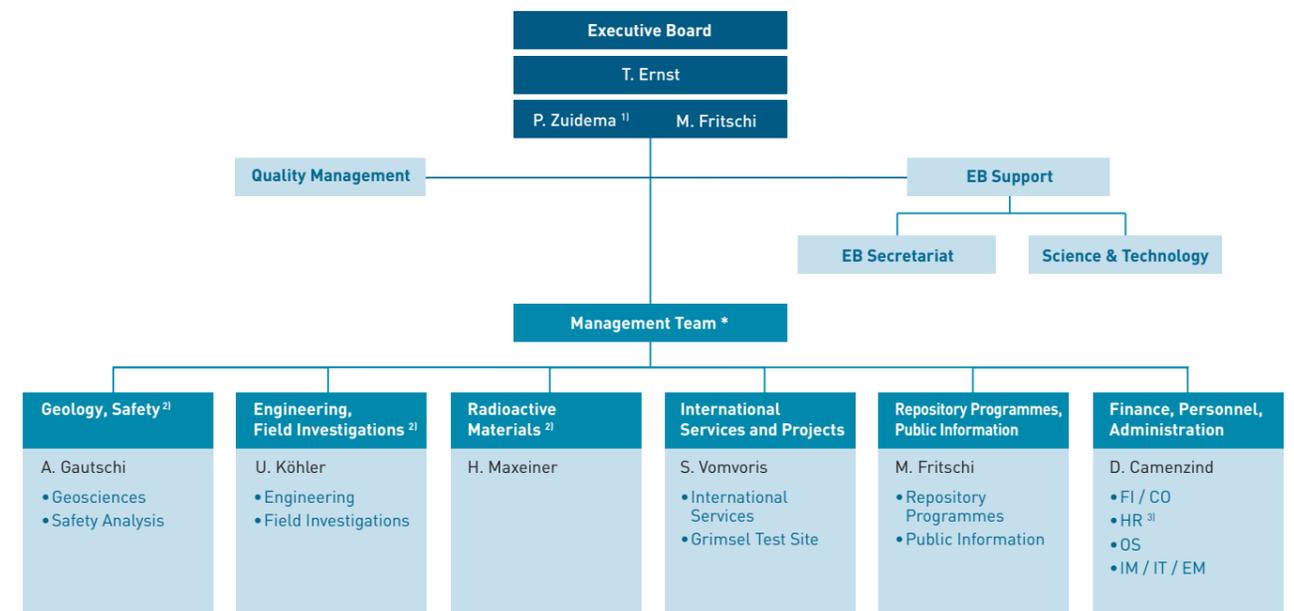
**Commission for Communication and Information**

Hermann Ineichen  
Chairman  
BKW AG

**Statutory Auditors**

PricewaterhouseCoopers AG  
Zürich

**Organigram headquarters**



\* Members of the Management Team: T. Ernst, M. Fritschi, P. Zuidema, D. Camenzind, A. Gautschi, U. Köhler, H. Maxeiner, A. Murer, S. Vomvoris. December 2011

<sup>1)</sup> P. Zuidema is responsible for the overall coordination and management of the Science & Technology programme.

<sup>2)</sup> 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.

<sup>3)</sup> Direct access to the Executive Board.

# Annual accounts 2011

## Comment on the annual accounts for 2011

Total expenditure rose compared to the previous year by around 16.4 million CHF. The reasons for this were increased external costs for the seismic measurements in the siting regions (+ 10.8 million CHF), work on improving the generic database for Stage 2 of the Sectoral Plan process (+ 4.2 million CHF), increased fees (+ 0.3 million CHF) and increased personnel costs, mainly due to the increased number of staff (+ 1.1 million CHF).

Similarly to total expenditure, total revenues also increased by 16.4 million CHF compared to the previous year to 65.5 million CHF. The contributions of the Members of the Cooperative rose by 16.5 million CHF to 60.2 million CHF.

Further information on the different positions can be found in the appendix to the annual accounts.

Wettingen, 30<sup>th</sup> March 2012



Dr. Thomas Ernst, Chief Executive Officer

## Balance sheet

	31.12.2010	31.12.2011	
	CHF	CHF	
<b>Assets</b>			
Land and buildings	1 570 000	1 540 000	
Other property, plant and equipment	243 453	206 401	
<b>Total non-current assets</b>	<b>1 813 453</b>	<b>1 746 401</b>	1
Work in progress	2 078 330	1 354 152	2
Trade receivables	1 472 467	873 459	3
Other receivables	28 263	253 053	
Accrued income and prepaid expenses	986 519	7 161 784	4
Liquid assets	12 809 905	12 047 838	5
<b>Current assets</b>	<b>17 375 484</b>	<b>21 690 286</b>	
<b>Assets</b>	<b>19 188 937</b>	<b>23 436 687</b>	
<b>Liabilities</b>			
Cooperative capital	120 000	120 000	
<b>Equity</b>	<b>120 000</b>	<b>120 000</b>	
Provisions/reserves	6 266 824	6 096 971	6
Trade payables	7 975 421	11 432 949	7
Advance payments	2 881 157	1 375 926	2
Other liabilities	777 695	462 931	
Accrued expenses and deferred income	1 167 840	3 947 910	8
<b>Borrowed capital</b>	<b>19 068 937</b>	<b>23 316 687</b>	
<b>Liabilities</b>	<b>19 188 937</b>	<b>23 436 687</b>	

Explanations in appendix page 44

## Operating accounts

	2010	2011	
	CHF	CHF	
<b>Total revenues</b>			
Contributions to administration costs	600 000	600 000	
Contributions for project expenditure	43 146 838	59 639 022	
<b>Contributions of Members of the Cooperative</b>	<b>43 746 838</b>	<b>60 239 022</b>	
Research contributions	427 053	856 750	
Income from other services for Cooperative Members	965 169	1 152 181	
Income from services for third parties	3 418 062	3 104 529	9
<b>Income from deliveries and services</b>	<b>4 810 284</b>	<b>5 113 460</b>	
<b>Profit from disposal of fixed assets</b>	<b>405 291</b>	<b>994</b>	10
<b>Other operating income</b>	<b>69 187</b>	<b>103 032</b>	
<b>Total revenues</b>	<b>49 031 600</b>	<b>65 456 508</b>	
<b>Total expenditure</b>			
External services	32 665 509	48 221 418	11
Personnel costs	13 302 388	14 406 698	12
Depreciation	169 197	149 078	
Other operating expenditure	2 726 254	2 524 921	13
<b>Operating expenditure</b>	<b>48 863 348</b>	<b>65 302 115</b>	
Financial income	-191 991	-100 059	
Financial expenditure	160 025	172 103	
Taxes	200 218	82 349	
<b>Financial result and taxes</b>	<b>168 252</b>	<b>154 393</b>	
<b>Total expenditure</b>	<b>49 031 600</b>	<b>65 456 508</b>	

Explanations in appendix page 44

## Cash flow statement

	2010	2011	
	CHF	CHF	
<b>Change in cash and cash equivalents</b>			
Annual result	-	-	
Depreciation	169 197	149 078	1
Formation of provisions/reserves	9 221	93 354	6
Application of provisions/reserves	-172 742	-263 206	6
Change in net current assets (without cash and cash equivalents)	-3 623 193	-659 267	
<b>Cash flow from operating activities</b>	<b>-3 617 516</b>	<b>-680 041</b>	
Investments	-	-82 026	1
Disinvestments	903 379	-	
<b>Cash flow from investment activities</b>	<b>903 379</b>	<b>-82 026</b>	
Loan repayments	-650 000	-	
<b>Cash flow from financing activities</b>	<b>-650 000</b>	<b>-</b>	
<b>Change in cash and cash equivalents</b>	<b>-3 364 137</b>	<b>-762 067</b>	
<b>Statement</b>			
Cash and cash equivalents per 01.01.	16 174 042	12 809 905	
Cash and cash equivalents per 31.12.	12 809 905	12 047 838	
<b>Change in cash and cash equivalents</b>	<b>-3 364 137</b>	<b>-762 067</b>	5

Explanations in appendix page 44

**Accounting principles**

Nagra's annual accounts for 2011 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. Depreciation is effected as planned over the expected useful lifetime of the asset category. Investments in hardware below 20 TCHF (one-off) and software below 100 TCHF (one-off) are debited directly to the income statement.

The lifetimes for depreciation fall within the following bandwidths 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 expenditure associated with all ongoing commercial projects is capitalised at the balance sheet date at acquisition or production costs.

**Receivables**

Receivables are shown at nominal value less any necessary value adjustments.

**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.

**Borrowed capital****Provisions/reserves**

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 and workshop	Vehicles	Total
	TCHF	TCHF	TCHF	TCHF
<b>Acquisition value per 01.01.2010</b>	<b>2 728</b>	<b>325</b>	<b>678</b>	<b>3 731</b>
Additions	-	-	-	-
Disposals	-903	-	-	-903
Reclassifications	-	-	-	-
<b>Acquisition value per 31.12.2010</b>	<b>1 825</b>	<b>325</b>	<b>678</b>	<b>2 828</b>
Additions	-	11	71	82
Disposals	-	-	-76	-76
Reclassifications	-	-	-	-
<b>Acquisition value per 31.12.2011</b>	<b>1 825</b>	<b>336</b>	<b>673</b>	<b>2 834</b>
<b>Accumulated depreciations per 01.01.2010</b>	<b>225</b>	<b>195</b>	<b>425</b>	<b>845</b>
Additions	30	55	84	169
Disposals	-	-	-	-
Reclassifications	-	-	-	-
<b>Accumulated depreciations per 31.12.2010</b>	<b>255</b>	<b>250</b>	<b>509</b>	<b>1 014</b>
Additions	30	57	62	149
Disposals	-	-	-75	-75
Reclassifications	-	-	-	-
<b>Accumulated depreciations per 31.12.2011</b>	<b>285</b>	<b>307</b>	<b>496</b>	<b>1 088</b>
<b>Book value per 01.01.2010</b>	<b>2 503</b>	<b>130</b>	<b>253</b>	<b>2 886</b>
<b>Book value per 31.12.2010</b>	<b>1 570</b>	<b>75</b>	<b>169</b>	<b>1 814</b>
<b>Book value per 31.12.2011</b>	<b>1 540</b>	<b>29</b>	<b>177</b>	<b>1 746</b>

The maximum fire insurance payments for property, plant and equipment amounted to 15 601 TCHF as of 31<sup>st</sup> December 2011 (2010: 11 522 TCHF) for each case of damage. The increase for the year 2011 is primarily due to reorganisation of the fire insurance for the Grimsel Test Site.

**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, all costs are capitalised under work in progress and all customer invoices are capitalised under advance payments.

**3 Trade receivables**

	31.12.2010	31.12.2011
	TCHF	TCHF
Receivables from Cooperative Members	221	12
Receivables from third parties	1 251	861
<b>Total</b>	<b>1 472</b>	<b>873</b>

The largest open position relates to a Grimsel project of the Obayashi Corporation (Japan), with around 179 TCHF. A further relevant receivable exists with respect to CIEMAT (Spain), with around 167 TCHF, also in connection with tests at the Grimsel Test Site.

**4 Accrued income**

The accrued income contains outstanding project cost contributions from the Members of the Cooperative (6 631 TCHF) to balance the annual accounts and open reimbursement of project costs to PSI, Villigen, of 450 TCHF, as well as other smaller positions.

**5 Cash and cash equivalents**

Cash and cash equivalents decreased during the year of reporting by 762 TCHF. There were no fixed term deposits as of 31<sup>st</sup> December 2011.

**6 Provisions/reserves**

	<b>31.12.2010</b>	<b>31.12.2011</b>
	<b>TCHF</b>	<b>TCHF</b>
Credit balances for vacation time/overtime of employees and restructuring costs	1 541	1 371
GNW liabilities	4 726	4 726
<b>Total provisions</b>	<b>6 267</b>	<b>6 097</b>

In 2003, Nagra took over possible obligations for the Wellenberg site from the now liquidated company GNW for a one-off payment of around 4 800 TCHF. 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 unchanged and will be dissolved in 2014.

**7 Trade payables**

	<b>31.12.2010</b>	<b>31.12.2011</b>
	<b>TCHF</b>	<b>TCHF</b>
Payables Cooperative Members	1 172	55
Payables third parties	6 803	11 378
<b>Total payables</b>	<b>7 975</b>	<b>11 433</b>

The largest creditors as of the balance sheet date are the company DMT, which was responsible for carrying out the seismic work, PSI and the SFOE, with a total of around 6 700 TCHF.

**8 Accrued expenses and deferred income**

Accrued expenses and deferred income increased in the year of reporting by around 2 780 TCHF; this is due mainly to late submission of invoices for 2011 by the SFOE, ENSI and PSI in the amount of around 2 450 TCHF.

**9 Income from third party services**

The reduced income from services for third parties is offset by reduced costs of an adequate amount for the relevant contracts. These are contained in external services (note 11).

**10 Income from disposal of fixed assets**

Income from disposal of fixed assets in the previous year (2010) relates mainly to the sale of the parcel of land in Hägendorf.

**11 External services**

	<b>2010</b>	<b>2011</b>
	<b>TCHF</b>	<b>TCHF</b>
Projects	21 268	35 250
Communication	2 531	3 731
Fees (ENSI, SFOE)	8 164	8 486
Travel costs	703	754
<b>Total</b>	<b>32 666</b>	<b>48 221</b>

**12 Personnel costs**

Personnel costs increased compared to the previous year by 8.3% to 14 407 TCHF as a result of the personnel strategy approved by the Board of Directors. At the end of the year, staff consisted of 86.4 full-time positions, an increase of 6.9 compared to the previous year.

**13 Other operating expenditure**

This position contains rents of around 980 TCHF, IT costs of around 670 TCHF and miscellaneous operating costs of around 870 TCHF.

**Further information****Risk assessment**

The Board of Directors regularly addresses the risk situation of the Cooperative and the processes for this are well established. The risk situation is assessed based on a systematic survey and evaluation of significant business risks and is documented in a report submitted to the Board of Directors for approval. The Board of Directors approved the risk report for 2011 at their meeting on 15<sup>th</sup> June 2011 and decided on any necessary measures.

**Off balance sheet transactions**

In order to secure project income from Japan, a currency futures transaction was made as of the payment date 27.04.2012 for 40 million JPY. The value as of 31.12.2011 is around 486 TCHF; the non-realised loss of around 63 TCHF was booked under accrued expenses and deferred income. A further currency futures transaction was also made to secure contract work from the UK as of payment date 15.06.2012 for 100 TGBP. The value as of the balance sheet date is around 146 TCHF and the non-realised loss of around 18 TCHF was booked under accrued expenses and deferred income.

**Contingent obligations**

There is a bank guarantee in the amount of around 27 TEUR up to 31.12.2013 for an ongoing 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 31<sup>st</sup> December 2011, no events occurred that are worthy of mention. Events subsequent to the balance sheet date were taken into consideration up to 29<sup>th</sup> March 2012, when the annual accounts were approved by Nagra's Board of Directors.

	Increase	Status	Increase	Status
	2010	31.12.2010	2011	31.12.2011
	CHF	CHF	CHF	CHF
<b>Total revenues</b>				
Swiss Confederation	1 246 582	29 226 079	1 722 554	30 948 633
Axpo AG	9 509 034	220 307 016	13 143 009	233 450 025
BKW AG	4 614 583	101 376 343	6 379 586	107 755 929
Kernkraftwerk Gösgen-Däniken AG	12 631 100	285 024 579	17 458 131	302 482 710
Kernkraftwerk Leibstadt AG	15 145 539	316 520 592	20 935 742	337 456 334
<b>Contributions for project expenditure</b>	<b>43 146 838</b>	<b>952 454 609</b>	<b>59 639 022</b>	<b>1 012 093 631</b>
Contributions to administration costs	600 000	85 520 000	600 000	86 120 000
<b>Contributions of Cooperative Members to Nagra</b>	<b>43 746 838</b>	<b>1 037 974 609</b>	<b>60 239 022</b>	<b>1 098 213 631</b>
<b>Contributions of GNW</b>	<b>-</b>	<b>65 265 331</b>	<b>-</b>	<b>65 265 331</b>
<b>Contributions of Members of the Cooperative</b>	<b>43 746 838</b>	<b>1 103 239 940</b>	<b>60 239 022</b>	<b>1 163 478 962</b>

14

	Increase	Status	Increase	Status
	2010	31.12.2010	2011	31.12.2011
	CHF	CHF	CHF	CHF
<b>Total expenditure</b>				
Geoscientific studies	3 328 474	165 492 781	7 734 049	173 226 830
Nuclear technology and safety	2 133 938	39 421 514	1 977 861	41 399 375
Radioactive materials	1 531 762	33 322 004	1 774 338	35 096 342
Facility planning	2 398 006	22 013 157	2 585 293	24 598 450
Generic (non-site-specific) work	3 420 204	84 527 184	4 937 274	89 464 458
General programme costs	3 517 833	66 780 780	4 152 270	70 933 050
Fees and compensation	4 597 431	30 106 020	4 774 727	34 880 747
<b>L/ILW programme</b>	<b>20 927 648</b>	<b>441 663 440</b>	<b>27 935 812</b>	<b>469 599 252</b>
Geoscientific studies	3 357 201	302 893 436	9 794 199	312 687 635
Nuclear technology and safety	3 570 749	53 933 026	3 347 488	57 280 514
Radioactive materials	866 210	22 696 472	728 180	23 424 652
Facility planning	2 126 154	17 779 528	2 101 344	19 880 872
Generic (non-site-specific) work	5 284 992	87 237 249	8 009 694	95 246 943
General programme costs	3 447 552	52 805 442	4 011 134	56 816 576
Fees and compensation	3 566 332	38 711 347	3 711 171	42 422 518
<b>HLW programme</b>	<b>22 219 190</b>	<b>576 056 500</b>	<b>31 703 210</b>	<b>607 759 710</b>
<b>Project expenditure for repository programmes</b>	<b>43 146 838</b>	<b>1 017 719 940</b>	<b>59 639 022</b>	<b>1 077 358 962</b>
<b>Administration and general project expenditure</b>	<b>600 000</b>	<b>85 520 000</b>	<b>600 000</b>	<b>86 120 000</b>
<b>Total expenditure for L/ILW and HLW programmes and administration and general project expenditure</b>	<b>43 746 838</b>	<b>1 103 239 940</b>	<b>60 239 022</b>	<b>1 163 478 962</b>

15

16

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 among 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 adjustments.

#### 14 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 60.2 million CHF (43.7 million CHF 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.

#### 15 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.

##### a) Geoscientific investigations

Geological investigations for identifying potential siting regions comprise geological studies in the investigation area of Northern Switzerland for 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

This includes 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 the surface and underground facilities for 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.

#### 16 Total expenditure for the HLW and L/ILW programmes and management and general project costs

This is the total sum of the accumulated accounts taking into account the described adjustments. The amount has to agree with note 14, contributions of the Members of the Cooperative.

#### Bericht der Revisionsstelle an die Generalversammlung zur Jahresrechnung 2011

Als Revisionsstelle haben wir die Jahresrechnung der Nagra Nationale Genossenschaft für die Lagerung radioaktiver Abfälle, bestehend aus Bilanz, Betriebsrechnung, Geldflussrechnung und Anhang (Erläuterungen zur Bilanz, Betriebs- und Geldflussrechnung) (Seiten 41 bis 47), für das am 31. Dezember 2011 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 2011 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  
Revisionsexperte  
Leitender Revisor



Mathias Dietrich  
Revisionsexperte

Zürich, 5. April 2012

# Appendices

54 **Waste inventories and volumes**

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

**Waste volumes at the end of 2011**

As a service to the waste producers, Nagra maintains a centralised databank of all waste packages. The following table shows the volumes and activities of waste prepared for geological disposal as of the end of 2011. Not contained in the table are pre-conditioned raw wastes and waste packages, for example waste packaged for processing in the ZWILAG plasma furnace.

<b>Conditioned waste (31<sup>st</sup> December 2011, figures rounded)</b>	<b>Volume (m<sup>3</sup>)</b>	<b>Activity (Bq)</b>
<b>Nuclear power plants</b>	3 520	$1.3 \cdot 10^{15}$
<b>ZWILAG</b>	1 516	$2.9 \cdot 10^{18}$
<b>Federal Govt. interim storage facility (waste from medicine, industry and research)</b>	1 496	$6.3 \cdot 10^{15}$

The ZWILAG waste consists of waste packages 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 input in the form of information on expected waste volumes. The total volume of waste for disposal will be around 99,000 m<sup>3</sup> packaged in disposal containers (see table for details). The volumes were determined assuming a 50-year operating lifetime for the existing power plants. The volume of waste from medicine, industry and research is based on the operational planning of the repositories.

<b>Predicted waste volumes (50-year NPP operation)</b>	<b>L/ILW (m<sup>3</sup>)</b>		<b>ATW (m<sup>3</sup>)</b>		<b>HLW/SF (m<sup>3</sup>)</b>	
	conditioned	packaged	conditioned	packaged	conditioned	packaged
<b>BA-KKW</b> Operational waste from the NPPs (from cleaning systems and mixed waste), inc. post-operational phase before decommissioning	7 260	24 400	10	40		
<b>RA-KKW</b> NPP reactor waste (activated components)	340	1 560				
<b>SA-KKW</b> NPP decommissioning waste	28 265	28 265				
<b>WA-KKW</b> NPP reprocessing waste (substitution BNFL)			200	1 320		
<b>BA-ZWI</b> ZWILAG operational waste	45	140				
<b>SA-ZWI</b> ZWILAG decommissioning waste	620	655				
<b>BA-MIF</b> MIR waste from FOPH and operational waste from PSI	4 270	9 170	325	920		
<b>SA-MIF<sup>1</sup></b> Decommissioning waste from PSI and others	23 000	23 000				
<b>BEVA</b> Waste from the future SF encapsulation plant in the HLW/SF repository	2 220	2 220				
<b>HLW</b> Canisters from reprocessing (completion of existing contracts, with substitution BNFL)					115	730
<b>BE</b> Spent fuel assemblies					1 135	6 595
<b>Total volumes (rounded)</b>	<b>66 020</b>	<b>89 410</b>	<b>535</b>	<b>2 280</b>	<b>1 250</b>	<b>7 325</b>
<b>Percentage (rounded)</b>	97.3 %	90.3 %	0.8 %	2.3 %	1.9 %	7.4 %
<b>Activity<sup>2</sup> Percentage</b>	$4.7 \cdot 10^{17}$ Bq 1.6 %		$3.4 \cdot 10^{16}$ Bq 0.1 %		$3.0 \cdot 10^{19}$ Bq 98.3 %	

<sup>1</sup> This contains a reserve of 12,000 m<sup>3</sup> for the as yet unspecified L/ILW from large-scale research facilities.

<sup>2</sup> Activity inventory for reference year 2050.

Note: For the cost study to be updated in 2011, an interim evaluation of the Model Inventory of Radioactive Materials (MIRAM) was carried out. This took into account the most recent results on packaging of waste from the decommissioning of the nuclear power plants and the influence of the effects of the updated decay concept for waste from research facilities. No reserve volumes for waste from the area of research were considered. The next full update of MIRAM is expected to be published in 2013.

## Publications in 2011

### Nagra Technical Reports (NTBs)

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

#### NTB 11-01

“Sachplan geologische Tiefenlager Etappe 2: Vorschläge zur Platzierung der Standortareale für die Oberflächenanlage der geologischen Tiefenlager sowie zu deren Erschliessung. Genereller Bericht und Beilagenband”; December 2011. (Nagra’s proposals for siting of the surface facilities)

#### NTB 09-08

“Physico-Chemical Characterisation Data and Sorption Measurements of Cs, Ni, Eu, Th, U, Cl, I and Se on MX-80 Bentonite”; December 2011.

### Information for the general public

The website [www.nagra.ch](http://www.nagra.ch) is continually updated with new content, publications, images, animations and short films. The site is available in three languages (German, French and English).

Several print products aimed at the general public were published in 2011 (not available in English), in particular four issues of “nagra info” (current information and news on nuclear waste management).

Updated versions of several print products were also reprinted.

## Internet addresses

### Nagra

National Cooperative for the Disposal of Radioactive Waste [www.nagra.ch](http://www.nagra.ch) (available in English)

### Decommissioning and Waste Management Funds (SFOE)

[www.entsorgungsfonds.ch](http://www.entsorgungsfonds.ch)

### EGT

Expert Group on Nuclear Waste Disposal (from 2012, successor to the Commission for Nuclear Waste Disposal (KNE)) [www.egt-schweiz.ch](http://www.egt-schweiz.ch)

### ENSI

Swiss Federal Nuclear Safety Inspectorate [www.ensi.ch](http://www.ensi.ch) (available in English)

### ESchT

German Expert Group on Swiss Repositories [www.escht.de](http://www.escht.de)

### FMT

Mont Terri Rock Laboratory [www.mont-terri.ch](http://www.mont-terri.ch) (available in English)

### Forum VERA

[www.forumvera.ch](http://www.forumvera.ch) (available in English)

### GTS

Grimsel Test Site [www.grimsel.com](http://www.grimsel.com) (available in English)

### IAEA

International Atomic Energy Agency [www.iaea.org](http://www.iaea.org)

### LES

Waste Management Laboratory (PSI) [les.web.psi.ch](http://les.web.psi.ch) (available in English)

### NSC

Federal Nuclear Safety Commission [www.bfe.admin.ch/kns](http://www.bfe.admin.ch/kns) (available in English)

### Nuclear energy internet portal

[www.kernenergie.ch](http://www.kernenergie.ch)

### Nuklearforum

[www.nuklearforum.ch](http://www.nuklearforum.ch)

### PSI

Paul Scherrer Institute [www.psi.ch](http://www.psi.ch) (available in English)

### Radioactive waste (SFOE)

[www.radioaktiveabfaelle.ch](http://www.radioaktiveabfaelle.ch) (available in English)

### SFOE

Swiss Federal Office of Energy [www.bfe.admin.ch](http://www.bfe.admin.ch) (available in English)

### Swissnuclear

Nuclear energy technical division of Swisselectric [www.swissnuclear.ch](http://www.swissnuclear.ch) (available in English)

### Swisstopo

Federal Office of Topography [www.swisstopo.ch](http://www.swisstopo.ch) (available in English)

### Technisches Forum Sicherheit / Technical Forum on Safety

[www.technischesforum.ch](http://www.technischesforum.ch) (partly available in English)

### ZWILAG

ZWILAG interim storage facility Zwischenlager Würenlingen AG [www.zwilag.ch](http://www.zwilag.ch) (available in English)

## Glossary

### AdK

Cantonal Commission

### Andra

Agence nationale pour la gestion des déchets radioactifs, France

### ATW

Alpha-toxic waste

### BGR

Bundesanstalt für Geowissenschaften und Rohstoffe, Germany

### BGS

British Geological Survey

### 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

### DSK

German-Swiss Commission for the Safety of Nuclear Installations

### 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

### ESchT

Expert Group on Swiss Repositories, Germany

### 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

### FOPH

Federal Office of Public Health

### GNSS

Global Navigation Satellite System

### GTS

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

### HLW

Vitrified high-level waste from reprocessing

### IAEA

International Atomic Energy Agency, Vienna

### ILW

Long-lived intermediate-level waste

### JAEA

Japan Atomic Energy Agency

### JNES

Japan Nuclear Energy Safety Organization

### KAERI

Korea Atomic Energy Research Institute

### KNE

Commission for Nuclear Waste Disposal

### L/ILW

Low- and intermediate-level waste

### MIR

Radioactive waste from medicine, industry and research

### MIRAM

Model Inventory of Radioactive Materials

### NDA

Nuclear Decommissioning Authority, UK

### NEA

Nuclear Energy Agency of the OECD, Paris

### NPP

Nuclear power plant

### NSC

Federal Nuclear Safety Commission

### NTB

Nagra Technical Report: scientific publication series

### 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

### PSI

Paul Scherrer Institute, Villigen, Canton Aargau

### SF

Spent fuel

### SFOE

Swiss Federal Office of Energy

### SKB

Svensk Kärnbränslehantering, Sweden

### Swisstopo

Federal Office for Topography; 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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